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e. The field-testing will be witnessed by the OWNER or its representative. In the event any of the equipment fails to meet the above test requirements, it shall be modified and retested in accordance with the requirements of this Section. The CONTRACTOR shall then certify in writing that the equipment has been satisfactorily tested, and that final adjustments thereto have been made. Certification shall include date of final acceptance test, as well as a listing of all persons present during tests, and resulting test data. The costs of all work by factory-trained representatives shall be borne by the CONTRACTOR. The OWNER will pay for power costs. When available, the OWNER'S operating personnel will provide assistance in the field-testing.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. **Erection and Startup Assistance:** Service and instruction assistance by the manufacturer's service representative for each blower and compressor unit 5 hp and larger shall be provided by the CONTRACTOR during the following periods:

1. One day (minimum) during startup.

B. **Instruction of OWNER's Personnel:** The CONTRACTOR shall provide for the services of a factory service representative to instruct the OWNER's personnel in the operation and maintenance of the equipment.

1.6 GUARANTEES, WARRANTIES

A. After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the equipment will operate with the published efficiencies, heads, and flow ranges and meet these specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature.

PART 2 – PRODUCTS

2.1 GENERAL

A. Wherever it is required that a single designated manufacturer shall be responsible for the compatible and successful operation of the various components of any equipment, it shall be understood to mean that the CONTRACTOR shall provide only such equipment as the manufacturer will certify is compatible with its equipment and with the further understanding that this in no way constitutes a waiver of any requirements.

B. All manufactured items provided under this Section shall be new, current models, and the products of reputable companies specializing in the manufacture of such products, with previous experience in such manufacture. The CONTRACTOR shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this Contract.

C. Where 2 or more units of the same type and/or size of equipment are required, such units shall be from the same manufacturer.

2.2 MATERIALS

A. Materials employed in the compressor equipment shall be suitable for the intended application; material not indicated shall be high-grade, standard commercial quality, free from any defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron casings shall be of close-grained gray cast iron, conforming to ASTM A 48.

2. Stainless steel shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be Type 316.

3. Anchor bolts, nuts, and washers shall be hot-dip galvanized, unless otherwise indicated in individual equipment specifications.

2.3 APPURTENANCES

A. **Nameplates:** Each compressor and motor shall be equipped with a stainless steel nameplate indicating rated head and capacity, impeller size, speed, and manufacturer's name, serial, and model number. Nameplates for electric motors shall be in accordance with Section 16460 - Electric Motors.

B. **Solenoid Valves:** Solenoid valves shall be provided on the water or oil lubrication and cooling lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be provided complete with all necessary conduit and wiring installation from control panel to solenoid.

C. **Gauges:** Compressors shall be equipped with pressure or vacuum gauges, respectively, installed in the discharge lines. Pressure gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings. Pressure gauges shall conform to Section 17220. Where subject to shock or vibrations, the pressure gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

D. Controls shall be in accordance with Sections 17100/17300 - Process Control and Instrumentation Systems.

E. **Electric Motors:** Electric motors shall comply with the requirements of Section 16460.

F. **Flanges:** Suction and discharge flanges shall conform to ANSI B16.1 or B16.5 dimensions.

G. **Lubrication:** Blowers, compressors, vacuum pumps, and motors shall be oil- or-grease-lubricated per individual specifications.

H. **Drains:** Cooling water drains and drains from variable speed drive equipment shall be piped to the nearest floor sink or drain with galvanized steel pipe or copper tube, properly supported with brackets.

2.4 TOOLS AND SPARE PARTS

A. **Tools:** Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for blowers, compressors, and motors shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. **Spare Parts:** The CONTRACTOR shall furnish spare parts subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, etc., as well as a set of spare bearings, and one year's supply of filter elements. Furnish parts suitably packaged and labeled in a box as described above for tools.

PART 3 – EXECUTION

3.1 INSTALLATION

A. **General:** Blowers, compressors, and vacuum pump equipment shall be installed in accordance with the Shop Drawings and as indicated. General installation requirements shall be as indicated in Section 11000.

B. **Alignment:** Equipment shall be field tested to verify proper alignment and operation as specified, and freedom from binding, scraping, excessive noise, overheating, vibration, shaft runout, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. **Piping and Mounting:** Piping shall be provided with sufficient expansion joints, guides, and anchors and be supported so as to preclude the possibility of exerting undue forces and moments on the equipment flanges. Suitable flexible connectors shall be provided to isolate the equipment from the piping system. Each unit shall be mounted on a flat and level concrete pad capable of supporting the dead weight of the unit, by means of restrained vibration isolators or resilient pads of suitable design.

D. **Lubricants:** The installation work shall include furnishing the necessary oil and grease for initial operation and for one year's operation.

- END OF SECTION -

SECTION 11511 - COMPRESSORS, TANK-MOUNTED, RECIPROCATING

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide two (2) package tank-mounted compressors, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11000 - Equipment General Provisions apply to the WORK of this Section.

PART 2 – PRODUCTS

2.1 COMPRESSORS, TANK-MOUNTED

A. **Operating Conditions:** Compressor operating conditions shall be as follows:

Identification number	-	AIR-COMP-00.01 and AIR-COMP-00.02
Location	-	Sludge Dewatering Building, Northeast corner
Service	-	Air
Elevation above sea (ft)	-	888.50
Piston displacement (cfm)	-	10 - 20
Discharge pressure (psig)	-	145
Motor size, min (hp)	-	5
Motor speed, max (rpm)	-	1040
Size of receiver (gal)	-	80
Pressure rating of receiver (psig)	-	200

B. **Equipment Requirements:** The compressors shall consist of tank-mounted compressor units of the positive displacement, air-cooled, 2-stage, V-belt driven, lubricated type.

C. **Receivers:** Each compressor shall be securely mounted on an ASME approved welded steel tank with integral legs, suitable for the working pressure and size specified above. The tank shall have threaded connections for an inlet, outlet, drain, pressure gage, and pressure switch. The outlet shall have an ASME approved pressure relief valve. The drain connection shall have a plug valve, a strainer, and a condensate trap piped to the nearest floor drain or similar drainage point. The receiver shall be securely mounted to the floor with restrained, heavy-duty spring-type vibration isolators and anchor bolts.

D. **Control Panels:** Each compressor shall be controlled from a control panel mounted on the compressor and complying with the area designations in Section 16050 - Electrical Work, General. The panel shall be completely pre- wired to provide a fully automatic operation and include the following features for each compressor:

1. Motor ciruit protector-type circuit breaker;

2. NEMA rated magnetic starter;

3. Push buttons in front panel;

4. Running light in front panel;

5. Warning lights for low oil and high temperature;

6. Contact for remote indication of failure (low pressure);

7. Stainless steel or heavy plastic labels for all controls and functions;

8. All components shall meet the requirements of Section 16485.

E. The control panel shall be connected to the pressure switches and the compressors, as shown.

F. Controls shall be in accordance with Section 17100 - Process Control and Instrumentation System.

G. **Drive:** Drive shall be a V-belt-type with heavy-duty electric motor suitable for installation in the area shown, for 480-volt, 3-phase, 60-Hz supply (460 V motor rating).

H. **Accessories:** Compressors shall be package units and shall be furnished and installed complete with the following accessories, each, as shown:

1	-	air receiver with condensate trap and drain,
1	-	set of galvanized anchor bolts and nuts,
1	-	flexible connector, stainless steel, corrugated or braided,
1	-	pressure relief valve,
1	-	check valve, silent, spring-loaded
1	-	shut-off valve,
1	-	pressure switch,
1	-	safety guard
1	-	pressure gage with valve, and all other controls and appurtenances, shown.

I. **Equipment Construction:** Basic equipment construction and materials required shall be as follows:

Common base-plate (mounted on receiver)	-	cast-iron or steel, with sliding motor base
Crankcase	-	cast-iron
Cylinders	-	precision-honed, with radial fins
Pistons	-	cast-iron or aluminum
Rings	-	oil control and compression rings
Heads	-	cast-iron or aluminum
Crankshaft	-	ductile iron or carbon steel
Bearings	-	heavy duty anti-friction bearings

Lubrication	-	splash-type lubrication
Valves	-	stainless steel
Flywheel	-	cast-iron
Suction filter-silencer	-	particulate dryer type
Starting unloader	-	built-in centrifugal type
Intercooler	-	finned copper tubes
Safety shut-down switches	-	low oil level and high temperature.

J. **Manufacturers:**

1. **Ingersoll-Rand, model T-30 2475N5**
2. **Quincy, model QTV-5-80.**

PART 3 – EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed in strict accordance with the shop drawings and approved written procedures submitted with the shop drawings; provided, that nothing contained in said procedures or shop drawings shall authorize the CONTRACTOR to vary from the requirements of the Contract Documents.

B. General installation requirements shall be as specified in Section 11000.

- END OF SECTION -

SECTION 11562 – BELT FILTER PRESS SYSTEM

PART 1 — GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall install, and test two (2) new belt filter press dewatering systems as specified herein, and as shown on the Contract Drawings. The belt filter press system, including all motors, drives and controls RTU shall be Owner furnished and CONTRACTOR installed. Concrete bases, anchor bolts, spare parts, hangers, supports, and any other appurtenances required for the complete installation of the equipment, shall be furnished by the CONTRACTOR and tested as a unit by the belt press manufacturer. Compliance with the requirements and stipulations specified herein may necessitate modifications to the manufacturers standard equipment. In addition, the contractor shall be responsible for insuring a complete and operable belt press system and shall establish the exact limits of work between the contractor and belt filter press supplier.

B. The belt press system and related facilities are based on the 2.8 Meter SMX-S8 Belt Press manufactured by **Andritz.** The CONTRACTOR shall be responsible for determining any changes to the mechanical, civil, and electrical design necessitated by the use of any other manufacturer/supplier. Any design changes shall be the CONTRACTOR's responsibility, and all design and construction costs associated with any design changes necessitated by a different manufacturer/supplier shall be borne by the CONTRACTOR. All design changes shall be subject to review and approval by the ENGINEER.

C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and applicable provisions of Division 1 Specifications Sections, apply to work of this Section. Work related to the specifications of this section shall be designated in the following:

Section 01000, Summary of Work, Article 1.04, Owner Furnished Products

Section 11000, Equipment General Provisions

Division 17 - Instrumentation

D. APPLICABLE CODES AND STANDARDS

The design, manufacture, and installation of this equipment shall meet or exceed the applicable provisions and recommendations of the following codes and standards:

1. AGMA, American Gear Manufacturers Association.
2. ASME, American Society of Mechanical Engineers.
3. ASTM, American Society of Testing and Materials.
4. ANSI, American National Standards Institute.
5. IEEE, Institute of Electrical and Electronics Engineers.
6. NEC, National Electrical Code.
7. OSHA, Occupational Safety and Health Act.

1.2 DEFINITIONS

A. Solids Capture

The percent of the feed solids that remain in the dewatered end product on a weight basis.

For purposes of this specification, "Capture" is defined as:

% Capture = (C/F) [(F-E)/(C-E)] x 100%

Where:
- C = Dewatered Sludge Total Solids (% TS)
- F = Feed (% TSS); excluding any dilution from polymer solution flow
- E = Filtrate (% TSS); excluding any dilution from polymer solution and belt wash water flows

B. Polymer Consumption

To be based on 100% active polymer.

1.3 SYSTEM DESCRIPTION

A. Design Criteria

The belt filter press shall be designed to extract water from the sludge specified herein after conditioning of the sludge with a polymer solution. The process of dewatering shall produce a finished sludge product meeting the following performance requirements.

B. Performance Requirements

The belt filter press shall operate within the design conditions based on "Conditions of Service" Section 1.08 and meet the following performance criteria:

PARAMETER (EACH PRESS)	PERFORMANCE CRITERIA
1. Minimum dewatered sludge solids (% TS)	20
2. Minimum solids capture (% SS)	95
3. Maximum polymer cost ($/dry ton of sludge)	3.50
4. Minimum hydraulic loading (GPM)	190
5. Minimum solids loadings (dry lbs/hr)	2000
6. Effective working width per press	2.8 meter

1.4 SUBMITTALS

A. Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assembly, parts, instrumentation devices and other accessories forming a part of the equipment furnished shall be submitted for review. The following information shall also be submitted with shop drawings.

1. Drawings showing the manufacturers recommended equipment base(s), including dimensions, weights, loadings, drainage piping and other information necessary to install the equipment.

2. Structural calculations demonstrating compliance with the structural frame design specification.

3. Details of coating system for structural frame, rolls and other metallic components.

4. Details of sludge/polymer mixer assembly.

5. Details of gravity dewatering section including inlet feed chute, plow assemblies, belt support method, sludge retaining barriers, etc.

6. Details of pressure/shear zone including calculations of wedge and "S" roll working areas.

7. Details of filtrate drainage/collection system.

8. Details of belt specification.

9. Statement of minimum hours of belt life warranted.

10. Details of belt drive assembly including belt speed range, drive configuration, speed reducer, motor name plate data, and drive controller features.

11. Details of. belt tracking/tensioning system including schematics, utility requirements, pneumatic or hydraulic components, valves, piping and control devices.

12. Details of doctor blade assemblies.

13. Details of belt wash stations including washwater supply requirements (flow and pressure).

14. Details of roller assemblies including type of construction, materials, dimensions, deflection calculations and coatings.

15. Details of bearings for roller assemblies including bearing manufacturer, type housing, and AFBMA L-10 life calculations.

16. Details of electrical components including enclosures, and machine mounted components.

17. Elevation of local control panel and operator control station showing panel mounted devices. Provide details of power distribution and full load current draw of panel. Provide drawing of all terminations required to receive inputs or a transmit inputs from the local control panel.

18. Nameplate data of each electric motor proposed to be furnished with the belt filter press equipment package (see Section 16460).

19. Wiring diagrams of field connections with identification of terminations between local panel, junction boxes, equipment items, instrument devices, and the like.

20. Complete electrical control schematic diagram.

21. List of spare parts to be furnished.

22. List any exceptions or deviations from the contact documents.

23. Statement of machine warranties.

24. Control philosophy provided in both written and schematic form.

B. **Owners Manuals:** Operations and maintenance information and equipment maintenance summary sheets shall be furnished for the equipment specified herein.

C. A Manufacturers Certificate of satisfactory installation is required for work under this section.

1.5 QUALITY ASSURANCE

A. Other than the named supplier, all manufacturers proposing equipment described herein, shall provide a detailed submittal package which shall consist, at a minimum, all information and details prescribed in Section 1.3 of this specification.

B. If submitted equipment requires arrangement differing from that indicated on the drawings or specified, prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and embodying all special features of equipment proposed. Any changes are at no additional compensation and the Contractor shall be responsible for all engineering costs of redesign by the Engineer if necessary.

C. Only those manufacturers capable of providing irrefutable evidence of a minimum of ten (10) years experience in the manufacture and installation of the exact model or equivalent model meeting the filtration area requirements shall be considered.

D. The manufacturer shall include $1,500 in their bid price, to be used to cover expenses for one trip by the OWNER's personnel to the manufacturers plant. The trip shall be planned to coincide with the roller machining procedure (Section 2.5-M; Paragraph 3). The owner shall have the opportunity to see rollers pertaining to their project and be able to verify compliance with the bidding documents.

1.6 DELIVERY, STORAGE & HANDLING

A. Items to be shipped as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

B. Dewatering belts to be shipped separately.

C. Spare Parts.

1. Pack in containers bearing labels clearly designating contents and pieces of equipment for which the part is intended. Each part shall be identified with a tag bearing its part number and a part description.

2. Delivered at same time as equipment.

1.7 CONDITIONS OF SERVICE

A. Condition of sludge feed shall be based on the following design requirements as specified by the customer:

		Range
1.	Type of Sludge	Polyaluminum Chloride
2.	Feed Solids Concentrations (% TSS).......	expected 2 (Range 0.4 to 10%)
3.	Solids Loading lb (TS/hour)......................	expected 4000 (2000 – 6000)
4.	Hydraulic Loading (gpm)	expected 190 (90 – 350)
5.	Temperature (°F).....................................	expected 55 (45 – 85)
6.	Ash Content (% by weight).......................	expected 90 (70 – 120)
7.	Operating Cycle (hrs/week)......................	expected 35

1.8 WARRANTY

A. The belt filter press manufacturer shall warrant the following components:

1. The manufacturer shall warrant against any defects in material or workmanship to the belt filter press framework and coating for a period of 18 months from date of start up.

2. The manufacturer shall replace any bearing that fails during the prescribed warranty period, provided the owner has lubricated and otherwise maintained the bearing in accordance with the intervals and procedures set forth in the manufacturers operations and maintenance instruction manual. The complete bearing assembly as specified herein shall be warranted for a period of 18 months from the date of start up.

3. The manufacturer shall replace or repair any roller or roller coating that fails during the warranty period, provided the roller or roller coating has not been damaged by external action such as impact, fire, weld splatter, etc. beyond the manufacturers control. The manufacturer shall warrant the roller and roller coating to be free from defects in material and workmanship for a period of 18 months from the date of start up. Neither the rollers nor coating shall require preventative maintenance during the warranty period.

PART 2 — PRODUCTS

2.1 MANUFACTURERS

A. The belt filter press systems shall be the **Andritz-Ruthner 2.8** meter SMX® -S8.

2.2 EQUIPMENT

A. The belt filter press shall be designed to extract water from the sludge type specified herein, after conditioning of the sludge with an appropriate flocculant. This process of dewatering shall be accomplished by the combination of chemical conditioning of the sludge, drainage of free water in the horizontal gravity zone, the gentle compression of the sludge in the wedge zone, and the compression of the stabilized solids in the pressure/shear zone. The belt filter press shall have a minimum effective dewatering width of 2.8 meter and a minimum combined effective filtration area of 450 square feet. All moving wetted parts, and all wetted parts on which moving parts contact, shall be fully corrosion resistant for the material being processed, as specified herein. All components of the belt filter press shall be designed to withstand all stresses which may occur during erection and operation.

B. The belt filter press construction shall allow easy access to internal components, operational adjustments and routine maintenance shall be possible without taking the machine out of service. Any disassembly required for maintenance and repair shall be possible within the clearances shown on the drawings.

C. The belt press shall be delivered to the job site as a completely assembled package and ready for service after connection of piping, wiring and utilities. All piping provided with the belt filter press shall be schedule 80 PVC or flexible hose.

D. The overall length, width, height, of the fully assembled belt filter press shall not exceed 290", 190", 101", respectively. Minimum dry weight of the unit shall be 35,000 pounds.

E. The belt filter press shall be designed such that the "sludge" side of the belt does not come in contact with roller face to prevent the accumulation of material on the roller assemblies.

2.3 COMPONENTS

Each belt filter press shall include structural frame, sludge/polymer mixer, sludge inlet assembly, gravity drainage section, pressure/shear dewatering section, filtrate drainage system, belts, belt drive assembly, belt tracking/tensioning systems, doctor blades, belt wash stations, roller assemblies, bearings, safety devices, electrical components, and any other specified and necessary components.

A. STRUCTURAL FRAME

1. The design of the structural frame shall be based on a minimum belt tension of 50 lb. per linear inch of belt width. The structural frame shall be constructed of welded and bolted structural steel members. The frame shall be designed such that roller assemblies can be removed from the side or end of the belt press without removing structural members or repositioning more than one (1) roller assembly.

2. The structural members shall be a wide flange beam, conforming to the standard specifications for structural steel, ASTM A36. The maximum deflection of each structural member shall not exceed L/480, where L is the span length. The maximum stress of each structural member shall not exceed 1/5 the members yield point. All frame members in the running and cross machine direction shall possess a minimum moment of inertia of 53.4 in the primary load bearing direction.

3. All belt press loads imposed on the building floor shall be vertical. All horizontal loads shall be contained within the structural frame. The belt press frame shall be designed to interface with and facilitate the installation of access platforms along each longitudinal side of the belt press.

4. The structural frame shall be provided with "welded in place" lifting eyes designed to lift the fully assembled belt press.

5. After fabrication the structural steel frame shall be sandblasted according to SSPC SP-10 standards to a near white finish then hot-dip galvanized with a minimum 2.4 ounces of zinc per sq. ft. of metal finish per ASTM A123.

6. All bolted interfaces shall be precision drills. Slot fitted frame interfaces are not acceptable.

B. SLUDGE/POLYMER MIXER

1. Each belt filter press shall be provided with a sludge/polymer mixer for mixing and flocculation of feed sludge conditioned with polymer. Sludge mixer shall be of the variable orifice venturi type. Static mixers with stationary baffles or tanks with mechanical mixers shall not be acceptable.

2. Each sludge/polymer mixer assembly shall include an inline four (4) port UHMW polyethylene polymer injection ring, flow splitting manifold, tubing and fittings between the injection ring and manifold. Each polymer injection ring shall inject polymer at a minimum of four (4) points located 90° apart around the circumference of the ring. The inside diameter of the ring shall not be less than the inside diameter of the sludge feed piping. Each polymer injection port shall be a 1/2" N.P.T. threaded connection and connect with an 5/8" I.D. transparent tube which shall connect with each of the four (4) ports located on the flow splitting manifold.

3. The venturi mixer shall be constructed of 316L stainless steel and provided with a check valve type flapper with an external adjustable stop nut and counterweight. The mixer shall be equipped with ANSI compatible flanges at each end and a removable side plate for inspection and cleaning.

4. The sludge feed piping to the belt filter press shall be provided with two (2) polymer injection locations as shown on the drawings.

C. GRAVITY DRAINAGE SECTION

1. The belt filter press shall be provided with a sludge inlet assembly consisting of a distribution chute and underflow leveling weir designed to uniformly distribute the conditioned feed sludge across the entire working width of the gravity section. The entire assembly and necessary supports and hardware shall be constructed of 316L stainless steel.

2. The belt filter press shall have a horizontal gravity drainage section consisting of a minimum working belt area of 131 sq. ft. Side skirts constructed of 12 gauge 316 stainless steel shall be mounted on both sides of the belt and at the sludge feed end of the gravity section. The side skirts shall be equipped with urethane seals to prevent spillage of sludge. The seals shall be mounted via a slide type bracket that utilizes a set screw to prevent movement.

3. The belt, while in the gravity dewatering section, shall ride on top and be supported by a series of UHMW polyethylene replaceable wear strips held in place and supported by a 316L stainless steel support bracket with a minimum deflection of .040" at mid span under full sludge load. The support shall be a minimum 2" wider than the belt on each side. Wear strips shall be replaceable without removing or disassembly of gravity section sidewalls and plow assembly.

4. There shall be a minimum of seven (7) rows of plows with an average of 10 plows per row in the gravity section. Each plow shall continuously contact the belt and be designed such that it continually lifts and rolls the sludge. Designs which divert the sludge from side to side are not acceptable. Each set of plows shall be mounted on a 316L stainless steel horizontal support bar. Plows shall be liftable

from the belt while the belt filter press is in operation. Hot dip galvanized plow supports and lifting mechanisms are not acceptable.

D. PRESSURE/SHEAR DEWATERING SECTIONS

1. The belt filter press shall have a pressure/shear dewatering zone wherein increasing pressure and shearing forces are applied to the sludge.

2. The first section of this zone is the wedge dewatering area wherein the upper and lower belts converge thus entrapping the sludge between them. This zone shall consist of a minimum 152 sq. ft. utilizing the combined surface area of each belt actually contacting the sludge while the wedge opening is in maximum position.

3. The upper & lower belt shall be supported while in the wedge zone. This shall be accomplished in the same manner as prescribed in the preceding gravity zone specification section. The maximum deflection in this section shall not exceed .060" at 2 PSI wedge pressure at mid span. The use of designs which do not support the belt, or utilize impervious pressure plates to create pressure are not acceptable. All support framework shall be 316L stainless steel.

4. Upon exiting the wedge zone the entrapped sludge shall be conveyed through a series of 8 rolls positioned to create a serpentine ("S") configured belt path. "S" rolls shall decrease in diameter in a progressive fashion. The first "S" roll shall be a minimum 36" diameter, stainless steel perforated roll. The combined area in which one belt is in actual contact with a roll body shall be a minimum of 167 sq. ft. Transition area between "S" roll tangents shall not be considered in this calculation. For details of roll assemblies see Section 2.3M.

5. The "S" rolls in the pressure/shear zone shall be positioned such as to facilitate access to the internal working areas of the belt filter press for wash down, maintenance and process optimization.

E. FILTRATE COLLECTION/PIPING

1. The belt filter press shall be provided with drainage pans and piping to collect and discharge dewatered filtrate from the gravity drainage and pressure/shear dewatering sections. All filtrate shall be captured and contained by the drainage pans without spilling to the floor. The drainage pans shall extend a minimum of 3" beyond the belt width on both sides and shall have a minimum 1" depth at any given point. The drainage pans shall be constructed of a minimum 14 gauge type 316L stainless steel. The use of fiberglass or any non-specified material of construction is not acceptable.

2. The low point of any drainage pan shall be provided with a minimum 4" dia. connection for drain piping. Drainage piping shall be Sch. 80 PVC and shall be routed from each pan and shall terminate within the confines of the filtrate sump. The drainage piping shall be vented and adequately sized to prevent flow restrictions.

F. DEWATERING BELTS

1. The press shall incorporate the use of two dewatering belts (1 set). Belts shall be seamed and fabricated of monofilament polyester, wear-resistant plastic materials. The mesh design shall be selected for optimum dewatering of the sludge to be processed with minimum blinding of the filter belt.

2. Each belt and connecting splice shall be designed for a minimum tensile strength equal to five times the normal maximum dynamic tension to which the belt shall be subjected. The splice shall be designed to fail before the belt and shall be constructed of type 316L stainless steel.

3. Belts shall have a width as specified and shall have a minimum life of 4,000 hours continuous operation at the rated design conditions. Belts shall be designed for ease of replacement with a minimum of belt filter down time.

G. BELT DRIVE ASSEMBLY

1. The belt filter press shall be provided with one belt drive assembly. The drive assembly shall not be positioned in any area which is not readily accessible or subjects the drive assemblies to excess moisture and other undesirable environmental conditions. The drive range shall be 50% to 150% of designed operating speed based upon the required performance. The drive assembly shall be coupled to the drive rollers with shaft mounted helical gear reducers. All exposed gears and couplings shall be enclosed in safety guards.

2. The drive assembly shall consist of a speed reducer, with an integrally mounted C-face motor and panel mounted variable frequency drive controller for belt speed adjustment.

3. The belt filter press speed reducer shall be a shaft mounted, right angle, helical type gear reducer. Worm gear type reducers are not acceptable. The speed reducer housing shall be of cast iron or fabricated steel welded construction and shall be totally enclosed, dust proof, and oil tight.

4. The integrally mounted electric motor shall be rated for a maximum of 10.0 Hp and maximum speed of 1800 RPM. Motor shall provide full load torque from 10 to 100 percent of the maximum speed of the drive motor.

H. PNEUMATIC SYSTEM

1. The belt filter press shall be provided with pneumatic belt tracking and tensioning systems to ensure reliable operation. The belt tracking and tensioning systems shall be of the continuous and non-incremental tracking type. Mechanical limit sensors, electric servo type or systems which do not offer precision adjustment continuously are not acceptable.

2. The pneumatic control system shall consist of a Nema 4X stainless steel wall mounted panel. This control station will include: loss pressure switch, filter regulators-lubricator, glycerin filled gauges, control regulators, valves and tubing as required to provide a complete control system. The pneumatic tubing and fittings shall be 1/4" polyurethane. All tubing shall be firmly attached and routed to eliminate obstruction and terminate at a central manifold block.

I. BELT TRACKING SYSTEM

1. The belt tracking system shall automatically and continuously align and maintain the belt position on the rollers during operation of the belt filter press. The belt position shall be monitored by a stainless steel sensing arm which shall continually contact the belt edge. The sensing arm shall be mechanically linked to a pilot valve which controls the tracking actuator.

2. Pneumatic actuators shall be convoluted type air bellows to provide uniform non-stick movement of the actuator shaft. Cylinders utilizing pressure containment seals are not acceptable.

3. The tracking actuator shall be connected to a pivoting belt alignment roller, which shall be continuously adjusted by the actuator to maintain proper belt alignment. No exceptions to this belt tracking system will be allowed.

4. One (1) limit switch shall be provided on each side of the machine to detect major misalignment of the belt and relay an alarm signal. Each limit switch shall be housed in a NEMA 4X enclosure.

J. BELT TENSIONING SYSTEM

1. The belt filter press tensioning system shall be capable of adjusting belt tension to a maximum of 50 lbs. per linear inch of belt width. Belt tension adjustments shall be manually controlled and shall be capable of adjustment while the belt filter press is operating.

2. The belt tensioning system shall consist of a belt tensioning roller for both upper and lower belts equipped with pneumatic air bellow actuators on each tension roller end. The operation of the belt tensioning system shall be designed to ensure simultaneous and parallel movement of the tensioning roller ends during adjustment and to accommodate up to 3 percent belt elongation. Center pivoting type assembly with only one pressuring device per roll are not acceptable.

3. The tensioning system shall be designed so that the actuators for each independent tension roll is mechanically interconnected so that one side of the roll can not extend further than the other. All interconnecting parts shall be 316L stainless steel.

4. A pressure gauge shall be provided for both upper and lower belt tension regulators. Limits of the belt tension shall be located on the face of the control panel.

K. DOCTOR BLADES AND CAKE DISCHARGE

1. The belt filter press shall be provided with a doctor blade to assist the separation of cake from the belt at the point of cake discharge. The doctor blade and blade holder shall be designed with sufficient stiffness to prevent warping, bowing or distortion of the blade.

2. The doctor blades shall be reversible, replaceable, and shall be constructed of UHMW polyethylene, polyurethane, or similar material. Fiberglass reinforced plastic is not acceptable.

3. Doctor blade tensioning shall be applied by a tensioning device with provisions to adjust the force of the doctor blade against the belt. Each doctor blade assembly

shall be designed to allow quick release of the doctor blade from the belt for inspection and service.

4. The belt filter press shall be equipped with a minimum 14 gauge 316L stainless steel discharge chute with a minimum 1:1 slope, to guide the discharge cake on to the sludge conveyor. The cake discharge chute shall be mounted independently of the doctor blade assembly.

L. BELT WASH STATION

1. The belt filter press shall be provided with an upper and lower belt wash station which shall clean the full width of the belts after the cake has been discharged.

2. Potable water at a minimum pressure of 120 psig shall be provided. The total washwater demand of the two belt wash stations combined shall not exceed 130 gpm. Each belt wash station shall consist of a control solenoid valve, a type 316L stainless steel washwater spray pipe with replaceable spray nozzles and internal handwheel actuated wire brush to facilitate periodic cleaning of the nozzles. Belt wash spray pipe shall be manufactured by Spraying Systems, Inc.

3. Each belt wash station shall be enclosed in a type 316L stainless steel, 14 gauge minimum, enclosure with replaceable urethane seals which shall contain all spray and mist.

M. ROLLER ASSEMBLIES

1. All rollers, except the perforated "S" roll, shall be double separated plate stub shaft design. The stub end shafts and plates must be welded in place. Bolted in place stub end roller shafts are unacceptable. The "S" & drive roll shafts shall have a minimum diameter of 5.88" inside the roller and a minimum of 3.93" journal diameter. The minimum safety factor in relation to the rollers yield point shall be 5 at a maximum loading rate of 50 PLI belt tension. All rollers shall be designed to have a maximum deflection of .05" at mid span when under maximum loading. Rollers shall have a minimum wall thickness of 1/2" and be constructed of A-106 pipe or A519 mechanical tubing. Maximum loading shall be based on the maximum summation of all forces applied to the roller including, but not limited to, the forces exerted by the belt tension, drive torque and roller mass. Certified calculations shall be submitted as a part of the shop drawing submittal verifying compliance. The belt filter press manufacturer shall provide a listing of all additional loads exerted on each roll created by drive torque.

2. The perforated drum roll shall be corrosion resistant and fabricated of minimum 3/16" thick ASTM A320, type 316L stainless steel. The perforated drum roll shall be of through shaft design and internally braced so as to comply with the minimum safety factor and maximum allowable deflection specified. Drum perforations shall have a diameter not less than 1-1/4" and provide a minimum roller face open area of 17%. Flame sprayed stainless steel roll coating or hot dip galvanized material is not acceptable.

3. All rolls shall be statically balanced and machined to ensure total concentricity. Rolls shall be machined on a lathe in 3 separate processes. First the O.D. shall be turned to establish a concentricity of less than 0.02". Based on the concentricity of the O.D., the I.D. shall be turned on a lathe across all end plate contact areas to allow for the journals to be heat shrunk. Journals shall be machined to 0.01" concentricity. A final lathing process once the journal has been seated will produce a roller journal assembly with a concentricity of 0.01".

4. All carbon steel rollers shall be covered to the point of insertion into the bearing housing. Tracking and drive roller bodies shall be a minimum 1/4" Buna N rubber covered to a hardness of 79 shore A. All other rollers shall be surfaced with Rilsan (nylon).

N. BEARINGS

1. The shafts of all rollers shall be supported by greaseable type, self aligning, spherical roller bearings housed in a sealed, splash proof, horizontal split case, cast closed pillow block housing. The housing shall be four bolt base and two or four bolt cap.

2. All bearings shall have a minimum L-10 life of 1,560,000 hours, at a minimum belt speed of 15 feet per minute, calculated by using the ANSI/AFBMA STD 11-1978 with a 1.15 capacity modification factor per ISO recommendations. The L-10 life shall be based on the summation of all forces applied to the bearings including, but not limited to, roller mass forces and drive torque induced belt tension in addition to the 50 PLI tension set by the tensioning rollers. Certified calculations, based on AFBMA ISO capacity formula shall show that all bearings comply with the specified requirements.

3. Bearing housings shall be Class 25 cast iron and shall conform to ASTM A48 standards. Except for where it is necessary for the shaft to extend through the housing, the outer side of the housing shall be solid without end caps or filler plugs. The seals shall be a triple lip design and rotate with the shaft. The housings shall be clean iron phosphate and coated with a heat treated thermal plastic nylon to a thickness of 8-12 mls. All hardware shall be type 316 stainless steel unless specified otherwise. Lubrication of the bearing shall not be required more than once every six calendar months with the manufacturers recommended lubricant.

O. ELECTRICAL COMPONENTS

1. The belt filter press is supplied with the following NEMA 4X rated components: fiberglass terminal box, emergency stop trip cords (one each side), belt tracking limit switch (one each side).

2. All components are wired complete to the terminal box including power leads for main belt drive. Wire runs shall be in PVC coated conduit, non metallic liquid tight flex and connectors, rigidly mounted to the press frame.

P. SYSTEM CONTROLS

The belt filter press shall be supplied with a Nema 4X stainless steel free standing hinged door control panel with a quick release latch. The control panel shall include a through door operated main disconnect, control power transformers, remote terminal unit (RTU), variable frequency drive for belt filter press main drive, control relays, alarm relays, selector switches, pilot lights and pushbuttons as required for a complete integrated control system. This control panel shall be suitable for 460 VAC, 3 Phase, 60 HZ Service. Separate power feeds shall be provided for the RTU versus the rest of the panel. System controls shall meet all requirements of Section 16485.

The control panel shall be completely prewired and factory tested prior to shipment.

The components to be mounted on control panel face shall include the following:

1. Start/Stop, On/Off controls of:

   System Control Power
   Auto/Manual Control

Mushroom Head Emergency Stop
Washwater Booster Pump
Main Belt Drive
Conveyor
Polymer Pump
Sludge Pump
Belt Tension/Tracking
Washwater Valve

2. Indication Lights for:

System Control Power	"On"
System Control Power	"Reset"
Air Compressor	"Run"
Washwater Booster Pump	"Run"
Main Belt Drive	"Run"
Conveyor	"Run"
Polymer Pump	"Run"
Sludge Pump	"Run"
Alarms	Air Loss
	Belt Limit
	Low Washwater psi
	Main Drive VFD Failure
	Conveyor Failure
Auto Start	"Pre-Wash Cycle"
Auto Stop	"Post-Wash Cycle"
Belt Tension Tracking	"On"

3. Alarm Control
   Silence, Reset Push Button
   Horn

4. Selector Switches on the Belt Filter Press 1 Panel for:

   Washwater Booster Pump/1-1 or 2-1
   Polymer Pump/1-1 or 2-1
   Sludge Pump/1-1 or 2-1

5. Control Panel Display Functions
   a. To enter in BPOL PBS matrix
      To enter in BPOL PBS manual stroke setting
      Display BPOL PBS gph operating range

   b. Digital Speed, Flow Indication of:

Main Belt Drive speed	"FPM"
Polymer Feed	"gph"
Sludge Feed	"gpm"

6. In addition to the above controls, the control panel shall include other controls and/or alarms deemed appropriate by the manufacturers.

   A complete sequence of operation, including interactions with ancillary equipment and components, shall be provided in order for the CONTRACTOR to program the belt filter press system RTUs.

Q. I/O INTERFACE REQUIREMENTS

Outputs

Discrete – contact closure
- Conveyor run permit – N.O. contact, close to run
- Polymer feed pump run permit – N.O. contact, close to run
- Sludge feed pump run permit – N.O. contact, close to run
- Washwater feed pump run permit – N.O. contact, close to run

Analog – potentiometer signal
- Polymer feed pump – speed / flow control
- Sludge feed pump – speed / flow control

Inputs

Discrete – contact closure
- Conveyor on – N.O. contact close when conveyor is on
- Conveyor local/remote status
- Polymer feed pump on – N.O. contact close when pump is on
- Polymer feed pump local/remote status
- Sludge feed pump on – N.O. contact close when pump is on
- Sludge feed pump local/remote status
- Conveyor pull cord – N.C. contact close when ok
- Conveyor belt misalign – N.O. contact close when ok
- Conveyor zero speed – N.O. contact close when ok

R. RTU REQUIREMENTS

1. New Remote Terminal Units:

   a. Two new RTUs shall be provided for the two Belt Filter Presses in the new Dewatering building. Each new RTU shall support twelve (12) I/O cards in any combination. I/O cards shall be replaceable under power.

   b. The new RTU racks provided shall be installed in an enclosure.

   c. Each new RTU shall have four (4) communications ports. Each port shall be configurable as either RS 423 or RS 485. Surge protection shall be provided.

   d. Each new RTU shall have an integral keypad only.

   e. Each new RTU processor shall be provided with non-volatile memory (with lithium backup).

   f. Each new RTU shall be a **Bristol Babcock DPC 3330 with a 32 bit 386** processor (real mode).

2. Enclosure

   a. The cabinet shall be free-standing. A fan and compact lighting fixture activated by a door switch shall be included.

b. Vertical stacking of terminal blocks is desired. Staggering or alternating of terminal blocks is not permitted.

c. Install a ground-fault interrupting type convenience receptacle.

d. 120 Vac control wires shall be physically separated from the 4-20 mAdc signal cables as much as practical

e. Instrument shields shall be grounded at the RTU end only

f. The cabinet shall house RTU-based hardware, modems, other necessary communication devices, power supplies, and peripheral equipment. The powering and grounding of these devices shall follow IEEE standard 1100-1992.

g. All I/O: analog inputs, analog outputs, digital inputs, and digital outputs shall be wired to disconnecting or fused type terminal strips.

h. The enclosure shall have the Bristol-Babcock DPC 3330 operator interface display on it's front panel.

Note: Reference Electrical Specification 16485 – Local Control Stations and Miscellaneous Electrical Devices

3. High Density I/O Cards:

a. Analog Input (AI): Cards shall be the source of all loop power. Each AI card shall have a 12 bit A/D converter, the conversion time shall be 200 us. Accuracy shall be 0.2% over -20°C to 70°C. The AI card shall have surge protection conforming to IEEE 472-1974 and C37.90-1978. The analog signal shall be 4-20 mA. The input impedance shall be 250 ohms. Eight (8) inputs per card shall be provided.

b. Discrete Input (DI): The DI cards shall have 1500V common mode optical isolation. The DI card shall provide the voltage to the field contacts. Sixteen (16) inputs per card shall be provided.

c. Discrete Output (DO): The DO cards shall be open drain style. Interposing relays with Form C contacts shall be provided. Sixteen (16) open drain outputs per card shall be provided.

d. Analog Output (AO): Cards shall sink 4-20 mA signals with an impedance of 0 to 650 ohms. Each AO board shall have a 12-bit converter. Accuracy is 0.2% from -20°C to 70°C. The update interval shall be software configurable between 0.02 to 5400 seconds. Four (4) outputs per card shall be provided.

4. Fiber Optic Modems

a. The fiber optic modems shall accept an RS-485 input from the RTU hardware and convert it into optical impulses. The baud rate shall be 187.5 kbaud. All necessary power supplies, RS-485 cables, and fiber optic connectors shall be provided. The fiber optic modems shall be **Manmarc.**

PART 3 — EXECUTION

3.1 INSTALLATION

A. Installation of the belt presses and control panels shall be the responsibility of the CONTRACTOR, and shall be in accordance with the MANUFACTURER's printed recommendations and the requirements herein. The CONTRACTOR shall be responsible for the construction of all equipment pads, including all shims and grouting required for a sound and level installation.

B. The CONTRACTOR shall not make any field attachments for conduit supports, or other item to the frame of the belt press, as this may damage the surface. Bolting or welding items to the frame in the field shall be strictly prohibited.

3.2 FIELD TESTING

A. Functional testing shall be performed for each belt filter press installed. Prior to system start-up, system components shall be inspected for proper alignment, proper connection, and satisfactory operation. The Manufacturer's representative shall inspect installation, check for lubrication and minor adjustments, provide certification that the system components have been installed correctly and are ready for operation. The performance test shall not begin until functional testing has been completed to the Owner's and Engineer's satisfaction.

B. Guaranteed Performance Acceptance Test

1. Performance testing shall be performed for the belt filter press installed. After plant start-up, the Manufacturer shall conduct each performance test using the Owner's sludge to determine the actual system operating conditions and verify that the unit meets the minimum requirements specified herein.

2. Test procedures and polymer recommendations shall be submitted to the Owner and Engineer for review thirty (30) days prior to testing. Submit performance test data and results to the Owner and Engineer.

3. Prior to the performance tests, the Manufacturer shall perform testing as necessary to determine and recommend the most effective type of polymer to produce the specified performance. Additional test shall be at the Manufacturer's own expense, if the prior test fails to meet the specified performance.

4. The Owner shall provide sludge feed, water, electrical power, and sludge cake disposal necessary to conduct the performance tests. The polymers required shall be provided by the Owner at the recommendation of the belt press manufacturer.

5. If, in the opinion of the OWNER, the system meets the minimum performance requirements specified herein, the Engineer will recommend, by letter, the official acceptance of the belt filter press. If, in the opinion of the Engineer, the performance test results do not meet the requirements specified herein, the Engineer will notify the Owner and Contractor of non-acceptable performance.

6. In the case of non-acceptable performance, the manufacturer shall then have 60 days in which to perform at its sole expense, any supplemental testing, equipment adjustments, changes or additions and to perform a retest of the non-acceptable

system. These provisions shall be in addition to any other liquidated damages due to Owner under the Contract.

7. If in the opinion of the Engineer, a performance acceptance test or retest is successful and meets the requirements specified herein, the Engineer will recommend, by letter, the official acceptance of the equipment.

3.3 START-UP AND OPERATOR TRAINING SERVICES

A. The CONTRACTOR shall furnish the services of qualified factory personnel to assist the OWNER's personnel in the start-up and initial operation of the belt press equipment. The manufacturer's representative shall also furnish field instruction and training to the OWNER's operating personnel in the use, operation, and maintenance of the equipment. The representative shall be available for a period of not less than 8 non-consecutive working days within 2 months of completion of installation for start-up (two days) operator training (four days), and follow-up services (two- days). These services shall be in addition to any on-site work necessary for successful completion of the installation check and field testing. The start-up and operator training services shall not be requested until the ENGINEER has approved the sludge dewatering system as ready for start-up and the ENGINEER has received six copies of approved operation and maintenance manuals.

B. The CONTRACTOR shall also furnish the services of experienced manufacturer's mechanical service personnel for a minimum of one day before start-up to assure integral operation, both mechanically and electrically in manual and automatic operation and to demonstrate satisfactory operation.

- END OF SECTION –

SECTION 13300- POLYETHYLENE TANKS

PART 1 – GENERAL.

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing cross-linked, high density polyethylene tanks with lateral restraint anchoring systems, piping connections, and accessories for chemical storage as specified herein and as indicated on the Contract Drawings.

B. The WORK also requires that one manufacturer (or two manufacturers, if bulk and day tanks have different manufacturers) accept responsibility for furnishing the WORK as indicated but without altering or modifying the CONTRACTOR'S responsibilities under the Contract Documents.

C. The WORK additionally requires that the one manufacturer who accepts the indicated responsibilities shall manufacture the specified bulk storage tanks and/or day tanks.

1.2 CODES

A. All codes, as referenced herein, are specified in Section 01090 - Reference Standards.

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	ASTM C177	Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
2.	ASTM C273	Method for Shear Test in Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores
3.	ASTM D638	Test Method for Tensile Properties of Plastics
4.	ASTM D746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
5.	ASTM D790	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
6.	ASTM D1505	Test Methods for Density of Plastics by the Density-Gradient Technique
7.	ASTM D1525	Test Method for Vicat Softening Temperature Plastics
8.	ASTM D1998	Standard Specification for Polyethylene Upright Storage Tanks

9.	ASTM D1621	Test Method for Compressive Properties of Rigid Cellular Plastics
10.	ASTM D1622	Test Method for Apparent Density of Rigid Cellular Plastics
11.	ASTM D1623	Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
12.	ASTM D1693	Test Method for Environmental Stress-Cracking of Ethylene Plastics
13.	ASTM D2126	Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
14.	ASTM D2842	Test Method for Water Absorption of Rigid Cellular Plastics
15.	ASTM D2856	Test Method for Open Cell Content of Rigid Cellular Plastics by the Air Pycnometer
16.	ASTM E84	Test Method for Surface Burning Characteristics of Building Materials
17.	NEMA ICS 6	Enclosures for Industrial Control and Systems

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Tank manufacturer's data and dimensions showing locations of all openings, ladders, locations and details of level indicators, anchoring system details, and location of tank accessories.

2. Details on inlet and outlet fittings, manways, ladders, flexible connections, vents and sight tubes.

3. List of installations in compliance with manufacturer's experience requirements per paragraph 1.8.

4. Statement by the manufacturer indicating compliance with the materials requirements.

5. Tank pad requirements such as pads and blockouts.

1.5 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. Manufacturer's recommendations for installation.

2. Fitting installation and adjustment procedures.

3. Repair procedures for typical situations including small holes, pinholes, and minor cracks in the tank.

4. Certification signed by the manufacturer that the tanks have been factory tested and meet the requirements indicated.

5. Calculations used to determine wall thickness. Hoop stress shall be indicated. Calculations shall be signed by a Registered Structural Engineer.

1.6 SERVICES OF THE MANUFACTURER

A. A representative of the manufacturer shall certify in writing that the tank has been installed in accordance with the manufacturer's recommendations. Certification shall be submitted.

1.7 FACTORY TESTING

A. **Material Testing:** Material taken from each tank shall be tested for the following:

Parameter	Test Standard	Value
Impact	ASTM D1998	120 ft-lb, min
Gel, minimum percent	ASTM D1998	1/32-inch of inner wall: 65 outer wall: 90 total wall: 70

B. Following fabrication, the tanks, including factory applied inlet and outlet fittings, shall be hydraulically tested with water. The factory test shall compensate for the difference in specific gravity between the test water and chemical stored to simulate actual maximum operating pressures. Test methods may include adding a 2.5 psi air pad to a filled tank or filling the tank with standpipes, raising the maximum water surface approximately 5 feet higher than the normal maximum tank level. The test duration shall be 24 hours. Following successful testing, the tank shall be emptied and dried prior to shipment.

C. An affidavit signed by the tank manufacturer shall be furnished indicating that the factory tests have been performed and the indicated conditions have been met.

1.8 EXPERIENCE QUALIFICATIONS

A. The tank manufacturer shall have a record of at least ten installations during the previous 5 years for the tank sizes indicated. The manufacturer must be capable of furnishing names and telephone numbers of locations that can be visibly inspected.

1.9 SPECIAL WARRANTY

A. The tank shall be warranted for 5 years to be free of defects in material and workmanship.

Warranty shall be prorated over the last 3 years.

PART 2 – PRODUCTS

2.1 GENERAL

A. Tanks shall be circular in cross-section, vertical, flat-bottomed, complete with piping inlets and outlets, ventlines, drains, overflows and lateral restraint anchoring system. Covered tanks shall be vented, and where specified, tanks shall be provided with gasketed hatch entrance manways, FRP access ladders and nozzles for level indicators. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, and capacity. Tanks shall meet the requirements of ASTM D1998 unless otherwise indicated.

B. Day tanks of 550 gallons or less shall be cross-linked or linear high density polyethylene. Dome lids will not be permitted for day tanks. Day tanks shall be the open top type.

2.2 TANKS

A. **Materials:** Polyethylene shall be the cross-linked, high density type for bulk storage tanks and linear type for day tanks meeting or exceeding the following:

Parameter	ASTM Test Method	Value
Density, gm/cc	D1505	0.937 to 0.945
Tensile strength at yield, psi minimum	D638	2600
Elongation at break, min percent	D638	400
Stress-crack resistance, min hours for F_{50}	D1693	1000
Vicat softening temperature, deg. F	D1525	230
Brittleness temperature, deg. F, maximum	D746	-180
Flexural modulus, psi	D790	100,000

Resin used in the tank shall be equal to Phillips Chemical Marlex CL-200 or CL-250, or PAXON grade 7004 or 7204, and shall contain a minimum of 0.3 percent ultraviolet stabilizer as recommended by the manufacturer.

B. **Operating Conditions:**

1. Chemical storage tanks provided under this section shall be suitable for the following operating conditions. :

Equipment Number	GPOL-T-00.01	GPOL-T-00.02	BPOL-T-00.01	BPOL-T-00.02
Chemical Stored	**Liquid Polymer**	**Liquid Polymer**	**Liquid Polymer**	**Liquid Polymer**
Active Content, %	28	28	28	28
Unit Weight (lb/gal)	8.6	8.6	8.6	8.6
Max fluid temp, deg F	76	76	76	76

C. **Construction**: Tanks shall be constructed using a rotationally molded fabrication process. Wall thickness of the tank shall be designed by the manufacturer with a hoop stress no greater than 600 psi using 1.5 times the specific gravity indicated. Stress shall be calculated using the Barlow formula.

Tanks shall have the following characteristics:

Equipment Number	**GPOL-T-00.01**	**GPOL-T-00.02**	**BPOL-T-00.01**	**BPOL-T-00.02**
Tank Usage	**5000 gal Bulk Storage**	**100 gal Day Tank**	**2500 gal Bulk Storage**	**100 gal Day Tank**
Type (See Note 1)	CD	FLR 28" dia. cover	CD	FLR 28" dia. cover
Nominal Diameter	7'-10"	30"	8'-0"	30"
Nominal Height	15'-10"	42"	7'-8"	42"
Nominal Capacity, (gal)	5052	100	2291	100
Straight Shell Height	14'-5"	42"	6'-2"	42"
Manway Mounting (See Note 2)	TM	N/A	TM	N/A
Manway Diameter (inches)	24	N/A	24	N/A

Note 1: CD = closed, domed top; CF = closed, flat top; OIF = open, internal flange; OEF = open, external flange; FLR = flat lid removable; FLH = flat lid hinged.

Note 2: TM = top mount, gasketed

2.3 TANK FITTINGS

A. Tank fittings shall be according to the fitting schedule below. Fittings for bulk storage tanks shall be bolted through the wall style flanged fittings with appropriate bolt and gasket material. Fittings for day tanks shall be bulkhead Schedule 80 PVC fittings or bolted flange fittings. Gasket material shall be suitable for continuous immersion in all specified chemicals. PVC fittings shall be compression type Schedule 80 long shank high-torque design with minimum of 85 percent threaded contact. Any screwed fittings shall use American Standard Pipe Threads. No metals shall be exposed to tank contents. All fittings shall be connected to their corresponding pipes with flexible telescoping-type expansion joints.

B. For mounting of level indication instruments on the bulk storage tanks, "universal dome" fittings (flange style) shall be provided. For mounting of level instruments on day tanks, "universal dome" fittings (bulkhead fitting or flange styles) shall be provided.

C. Discharge and overflow fittings shall be located as close to the bottom and top of the tanks, respectively, so that the maximum usable volume of tank can be obtained.

D. Tank fitting schedule in inches:

Equipment Number	**GPOL-T-00.01**	**GPOL-T-00.02**	**BPOL-T-00.01**	**BPOL-T-00.02**
Fill	3	1.5	3	1.5
Overflow	6	2	6	2
Tank Outlet / Drain	2	1.5	2	1.5
Vent	4	2	4	2
Level Indication	1 or 2	1 or 2	1 or 2	1 or 2
Mixer Port	N/A	Slot	N/A	Slot

Notes:
1. Refer to Contract Drawings for fitting locations.
2. The mixer port shall be provided with a neoprene gasket (or other suitable material) surrounding the mixer shaft such that vapors can not escape.

2.4 LEVEL INDICATION

A. Level indication shall be provided where indicated. Graduations shall be provided at every 200 gallon interval with 1,000 gallon intervals clearly labeled for bulk storage tanks; every 10 gallon interval for 100 gallon day tank. Unless otherwise indicated, graduations shall be marked on the tank exterior. Level sensors shall be provided under Division 17.

2.5 LADDERS

A. The bulk storage tanks shall be supplied with ladders at the locations shown on the Contract Drawings. The ladders shall be supplied by the tank Manufacturer and shall be of FRP construction. The ladders shall be coated with a chemically resistant coating as specified in Section 09800 - Protective Coatings. The ladders shall be anchored to the floor and the tank such that any lateral deflection is minimized.

2.6 MIXERS

A. The day tanks shall be supplied with portable mixers capable of maintaining a homogeneous liquid. The mixer shall be functionally tested by the manufacturer to check for excessive noise, vibration, heat build-up and proper motor operation. The mixer shall be provided with a stand for clamp mounting. The mixer shall have a single-phase electric TEFC motor which shall have a cord with plug and switch.

B. Manufacturers:

1. Brawn Mixer, Inc.
2. Lightnin

2.7 WEIGH SCALES

A. A floor weigh scales shall be provided for each day tank of the stainless steel shear beam load cell type with a digital indicator. The stainless steel load cells shall be hermetically sealed and shall be of the temperature stable type. Four load cells shall be provided, one at each corner of the platform, and shall be positioned between a stainless steel platform and the concrete equipment pad. The platform shall have a low profile of not more than 3-inches, be at least ¼ inch thick, have at least 200% overload capacity, have a safety tread on top, and have easy access to the junction box. Cable length shall be a minimum of 25 feet.

B. The scales shall include a wall mounted digital indicator in a sealed stainless steel enclosure. The indicator shall have a high visibility bright red LED display, auto tare and zero buttons, gross/net and units switching buttons, and brackets for mounting on a wall. The weight indicators shall have 4-20 mA analog output and 120 VAC power input. The indicators shall include all necessary connections for remote transmission to a PLC. The 4-20 mA signals shall include low relay contact output alarms. The load cell platform scales shall produce an accuracy of plus or minus 0.25 percent of the full scale.

C. The load cell tank platform floor scales shall be as manufactured by: **Fairbanks Scales.**

D. The load cell tank platform floor scales to be supplied shall be as follows:

Identification	Chemical	Equipment Being Weighed	Capacity	Platform Size
GPOL-WSC-00.01	Polymer	100 Gallon Day Tank	2,500 lbs	4'-0" by 4'-0"
BPOL-WSC-00.01	Polymer	100 Gallon Day Tank	2,500 lbs	4'-0" by 4'-0"

2.6 SAFETY SIGNS

A. Each tank inlet and tank outlet shall be clearly marked with hazardous material warning signs, 10 inches by 14 inches in size. Each sign shall have the word "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign ("DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE"). Signs shall comply with Section 10400 and the requirements herein.

2.7 MANUFACTURERS

A. Polyethylene bulk storage tanks and/or day tanks shall be manufactured by one of the following:

1. Nalgene
2. Poly-Processing Company
3. Chem-Tainer

PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

A. After installation of tank and all fittings, the tank shall be water tested by filling the entire tank with water and monitoring the tank as well as all fitting connections for at least 24 hours. Any leaks shall be corrected prior to acceptance. Following successful field tank testing, the tank shall be completely emptied and dried.

- END OF SECTION -

SECTION 14570 — BELT CONVEYORS

PART 1 — GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install, at the locations shown on the Contract Drawings, as specified or as directed, the belt conveyor, complete with belts, speed reducers, motors, idlers, supporting framework, drip pans, spare parts, shop drawings, operation and maintenance manuals, and other appurtenances, and furnish all labor, supervision, materials, appurtenances, tools and ancillary services as required for a complete and operable installation in accordance with the requirements of the Contract Documents.

B. In general, this work shall include the furnishing and installation of the following:

Sludge Conveying Belts SC-CON-10.01 and SC-CON-20.01

C. The requirements of the drawings and General Conditions of the Contract, including Supplemental General Conditions, Special Conditions and Division 1 Specification sections, apply to the work of this Section. Additionally, the requirements of Section 11000, Equipment General Provisions and Division 16, Electrical, also apply to work in this Section:

D. **Single Manufacturer:** Belt conveyors shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

1. American National Standards Institute (ANSI);
2. American Institute of Steel Construction (AISC);
3. American Society of Testing and Materials (ASTM);
4. American Gear Manufacturers Association (AGMA);
5. Conveyor Equipment Manufacturers Association (CEMA);
6. National Electrical Manufacturers Association (NEMA);
7. Occupational Safety and Health Administration (OSHA);
8. American Welding Society (AWS D.1.1-90)

1.3 CONTRACTOR SUBMITTALS

A. **General:** Contractor submittals shall be in accordance with the requirements of Section 01300 - Contractor Submittals.

B. **Shop Drawings:** In addition to the requirement of Section 01300 Contract Submittals the CONTRACTOR shall furnish the following information with the Shop Drawings.

1. Submit for review Shop Drawings showing the following:

   a. Complete description in sufficient detail to permit an item-by-item comparison with the Specifications.

   b. Electrical motor horsepower (bhp and installed horsepower) for each motor supplied. All calculations for the brake horsepower shall be submitted for all drive components including gear reducers, belts, sheaves and electric motors. The calculations shall show allowances for all service factors and component efficiencies in determining sizing.

   c. Weights to be carried at each support column, bracket or hanger.

   d. Service factor of each gearbox provided based on installed horsepower.

   e. Material list for conveyors and sub-components.

   f. Detailed drawings of proposed system layout. Drawings shall be one 24" x 36" drawing sheets with conveyor elevations at a scale no smaller than 1/4" equals one foot.

   g. Wiring diagrams for all electrical equipment (Schematic and point-to-point).

   h. Deviations from Drawings and Specifications.

   i. Details of all accessories.

   j. Manufacturer's installation and testing instructions.

   k. Manufacturer's standard guaranty.

2. Documentation of the Manufacturer's qualifications.

3. Documentation of the Installer's qualifications, including the Manufacturer's written approval of the Installer and documentation of the Installer's successful experience with the belt conveyors, including names, addresses, and telephone numbers of project owners and sizes of projects with dates of completion.

C. **Owner's Manual:** The OWNER'S Manual shall contain the required information for this Section, including, but not limited to:

1. Complete, detailed operating instructions for each piece of equipment with moving parts.

2. Explanations of all safety considerations relating to operation.

3. All information and instructions required by plant personnel to keep equipment properly lubricated and adjusted so that it functions economically through its full design life.

4. Explanation with illustrations as necessary for each maintenance task.

5. Recommended spare parts lists.

6. Recommended schedule of maintenance tasks.

7. Lubrication charts and table of alternate lubricants.

8. Trouble shooting instructions.

9. List of maintenance tools and equipment.

10. Name, address and phone number of Manufacturer and Manufacturer's local service representative.

11. Copies of all Shop Drawings.

D. **Spare Parts List:** A Spare Parts Lists shall contain the required information for this Section.

E. **Certification:** The following shall be submitted:

1. Manufacturer's certification that the conveyors have been installed satisfactorily.

2. CONTRACTOR's certification of satisfactory field testing.

1.3 MANUFACTURER'S SERVICES

A. A representative of the Manufacturer of the belt conveyors shall visit the job site to inspect the WORK and to certify that the installation is satisfactory.

PART 2 — PRODUCTS

2.1 GENERAL DESCRIPTION

A. **General:** The two (2) belt conveyors SC-CON-10.01 and SC-CON-20.01 shall be of the inclined walled type belt conveyors, as shown on the Contract Drawings. All fabricated belt conveyors shall come complete with motor, speed reducer, belt, idlers, drip pans, belt take-up, motion detector, belt scrapers, pulleys, structural framework and other accessories required for a complete installation.

The locations and lengths of the conveyors shall be as dimensioned on the Contract Drawings. The CONTRACTOR shall coordinate the installation of all accessories and appurtenances on the belt conveyors.

B. **Operating Conditions:** The conveyors shall be capable of continuous duty operation to transfer sludge cake as shown on the Contract Drawings, and shall be suitable for long term operation under the following conditions:

1. Material - Sludge cake 18 - 45 percent solids
2. Sludge Cake Density - 55-70 lbs/ft3
3. Belt Type and Width - sidewall type belt, 24 inches wide
4. Maximum Weight Capacity - 2 tons/hr
5. Maximum Volumetric Loading - 120 cu ft/hr
6. Belt Speed - 100 fpm
7. Minimum Motor HP - SC-CON-10.01 - 10 hp
   SC-CON-20.01 - 15 hp
8. Motor Direction - Single
9. Idler Type - Flat

2.2 REQUIREMENTS

A. **Construction:** Construction of the belt conveyors shall conform to the following requirements:

1. Idlers - 5" mild steel cans covered with 1/8" molded urethane coating
2. Pulleys - Welded steel construction with tapered compression type steel hubs and tapered steel bushings
3. Shafts - Cold-furnished steel, AISI C1045
4. Bearings - Enclosed anti-friction self-aligning roller bearings in pillow block housings
5. Head and Tail Pulleys - Crown face construction, 12 inch diameter. Head pulley will have ¼" neoprene lagging to prevent belt slip. Tail pulley will be supported by protected screw take-ups (including steel adjusting rods with brass bearing capture nuts).
6. Belts - 2-Ply nylon carcass belt, 24" wide, of cross rigid construction, with 1/8" x 1/16" oil resistant covers and a rated tension of 220 p.i.w.. Belt shall be equiped with 3" high corrugated sidewalls to contain sludge on belt.
7. Belt Splice - Splice shall be stainless steel mechanical hinged fastener, drawn and recessed into

the belt cover. Sidewalls shall be spliced using cold vulcanization with a single plate stainless steel fastener.

8. Discharge chute - Stainless steel three sided deflection discharge chute.

B. **Drive Assembly:** The belt conveyor drive assembly located at the head (loading) end of the conveyor as shown on the Contract Drawings shall consist of a motor, speed reducer, belt and sheaves. The speed reducer shall be direct connected to the drive pulley shaft and be connected to the motor located below the conveyor frame by a belt and sheave arrangement.

The helical type gear reducer shall produce a constant speed. The motor mounting base shall be adjustable to allow for belt tightening. A torque arm complete with fulcrum and turnbuckle shall be provided and rigidly attached to the conveyor frame.

The speed reducer shall be equipped with high grade anti-friction bearings, have oil and dust tight housings and be provided with rigidly constructed and mounted guards of not less than 12-gage metal. Speed reduction shall be achieved by the use of dual B-Section vee belts and sheeves through an AGMA Class II helical shaft mount gear reducer. Reducer shall have an AGMA service factor of 1.5. Speed reducers shall be those manufactured by **SEW Eurodrive, Horsburgh and Scott Co., or the Philadelphia Gear Corporation.**

C. **Structural Framework:** All idlers shall be mounted on structural type 304 stainless steel channel stringers of sufficient depth and section modulus to support the conveyors in a rigid manner without excessive deflection. A system of cross and diagonal bracing of structural steel angles shall be provided to brace the stringers. Conveyors shall be supported off the floor, as required by the belt conveyor manufacturer. The supports – including those located outside the dewatering building - shall be furnished and installed by the conveyor manufacturer under this Section. Supports shall be of ample size and thickness, not less than 1/4-inch thick steel, and adequately braced. All anchor bolts shall be of stainless steel.

D. **Skirting:** Each conveyor shall be provided with continuous 3/16" thick continuous Fiberglass Reinforced Plastic (FRP) skirting at loading area. Skirting shall have an adjustable neoprene seal strip at the belt to guide and control the sludge.

E. **Drip Pans:** Each conveyor shall be supplied with FRP drip pans, extending not less than 3 inches on each side of the return belt and turned-up at the edges so that side walls are perpendicular with the bottom of the drip pan. Side walls shall have a minimum height of not less than 3 inches. The bottom of the drip pans shall be at least 6 inches off the floor. Drip pans shall be fabricated watertight, and sloped to the location of the floor drains, at which point the drip pans will be provided with flanged 3-inch openings.

F. **Belt and Belt Take-Up:** Belt take-up shall be designed to furnish ample adjustment and pull to maintain proper belt tension in the belts.

G. **Belt Scrapers:** A Belt scraper shall be provided at the tail (discharge) end of each conveyor. Belt scrapers shall be spring tensioned with adjustable neoprene scrapper blades. Blade tension shall be maintained by two (2) stainless steel springs.

H. **Belt Motion:** All conveyors shall have a belt motion detector in contact with the underside of the conveyor belt. The motion sensor shall be the positive contact wheel type bolted to the conveyor frame. Positive contact shall be maintained with the use of springs. The motion sensor shall be approved by the ENGINEER. Switches shall be SPDT, 120 V ac.

I. **Idlers:** Belt will be supported on the carrying run by Conveyor Equipment Manufacturers Association (CEMA) C-5, flat idlers on 3'-0" (max.) centers, except at the loading points where spacing shall be reduced to 1'-0" and on the return run where spacing shall be increased to 4'-0". Idlers shall be covered with corrosion and wear resistant 1/8" thick molded urethane coating and supported from the frame by hot dipped galvanized steel brackets. Idlers will include 5" diameter shafts and tapered, controlled greasing roller bearings. Shaft seals will be multi-passage labrynth type with positive wiper and outer shield constructed in accordance with CEMA requirements. Belt shall also be equiped with hold down idlers at transition point from horizontal to angled section. Hold down idlers shall be identical in size and material to the support idlers specified above.

J. **Guards:** All conveyors shall be provided with OSHA standard guards at all pinch points and at the location of all motor driven rotating components, including motor drive, tail pulley and head pulley. All guards shall, unless otherwise shown on the Construction Drawings, shall be constructed of Fiberglass Reinforced Plastic.

K. **Safety Switch:** All conveyors shall be provided with a cable operated OSHA safety stop switch with continuous cable run on both sides. Switches shall be SPDT, 120 V AC.

L. **Discharge Chute:** Each conveyor shall be provided with a stainless steel three sided deflection/discharge chute.

M. **Coatings:** Component hardware will have one shop coat epoxy over manufacturers standard finish for additional corrosion protection. Fabricated stainless steel frames and supports will be shop brush blasted after fabrication to remove heat tint scale. Non-ferrous items will remain unfinished. Shafting will be coated with a rust inhibitive compound.

N. **Fasteners:** Component assembly will be achieved with 304 stainless steel bolts, nuts flats and lock washers and be prepared with anti-seize compound prior to engagement.

O. **Belt Misalignment:** All conveyors shall have belt misalignment detectors in contact with each side of the conveyor belt. The misalignment sensor shall have a positive contact wheel aligned with the side of the belt. Their function is to detect belt misalignment. The misalignment detectors shall be approved by the ENGINEER. Switches will be SPDT, 120 V ac.

2.3 MOTORS

A. All motors shall be furnished and installed under this Section but shall meet all of the requirements of Section 16460. All motors shall be of the energy efficient, totally enclosed fan cooled type wound for 460 volts, three phase and 60 Hz. The maximum motor loading shall not exceed the nameplate horsepower rating, exclusive of service factor. All motors shall be of ample size and construction to carry continuously all loads which may be imposed through their full range of operation, but in no case less than the following horsepowers:

1. SC-CON-10.01 10 Horspower;

2. SC-CON-20.01 15 Horsepower.

2.4 CONTROLS

A. Internal panel wiring shall have wire numbers at both ends of termination as developed from schematics. The Conveyor MANUFACTURER shall also furnish all schematic panel layout drawings, wiring diagrams and instructions for proper wiring of equipment.

B. The Conveyor MANUFACTURER shall furnish all conveyor combination starters, control relays, control panels, and pilot devices. Controls furnished under this Section shall meet also meet the requirements listed in Sections 16485 and 16050.

C. All other electrical controls and wiring other than that specifically included under this Section shall be furnished and installed under Division 16.

D. Each conveyor shall have its own control panel. Control panels shall be NEMA 4X.

2.5 SPARE PARTS: The following spare parts shall be furnished for each belt conveyor:

A. Three (3) 24-inch wide carrying idlers.

B. Three (3) 24-inch wide return idlers.

C. Three (3) each size of bearings.

D. Six (6) rubber scraper blades.

E. Two (2) 10 feet lengths of 24-inch trough type idler belt.

F. Five (5) belt splicing kits with stainless steel mechanical fasteners.

G. One (1) set of grease seals and bearings for speed reducers.

H. One (1) gallon gear drive-lubricating oil.

I. One (1) set of special tools which shall be as recommended by the manufacturers, and approved by the ENGINEER.

Spare parts shall be suitably packaged for extended storage. The outside of each package shall be labeled with the equipment name and number, a description of the spare part(s) contained in the package, and the manufacturer's stock number.

2.7 **Manufacturer's:**

A. **Manufacturer's Qualifications:** The belt conveyors shall be the product of a manufacturer which has been successfully engaged in belt conveyors production for a period of not less than ten (10) years.

B. **Installer's Qualifications:** Installation of the belt conveyors shall be by a Manufacturer-trained applicator or a firm approved in writing as an installer by the belt conveyors Manufacturer.

C. **Manufacturer's:**

1. **Custom Conveyor Corporation;**
2. **Continental Conveyor Co.;**
3. **American Bulk Handling.**

PART 3 — EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the Manufacturer.

B. **Storage:** Products shall be properly protected and carefully stored in a manner that will prevent damage and in an area that is protected from the deleterious effects of the elements.

3.2 INSTALLATION

A. The products shall be installed in accordance with the Manufacturer's written instructions.

3.3 FIELD TESTING

A. Field testing demonstrate the reliability of the conveyors, and that they are capable of operating as specified in paragraph 2.1.B. Field testing procedures shall be according to manufacturer's recommendation and as approved by the ENGINEER.

3.4 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** As a minimum, the service representative of the Manufacturer shall be present at the site for two work days per conveyor (for a total of four days), to furnish the services required by this Section. If additional days are necessary to provide a complete and operating system, the additional time should be included in the bid price for this project.

B. **Instruction of OWNER'S Personnel:** The training representative of the Manufacturer shall be present at the site for one work day to furnish the services required by this Section.

C. For the purpose of this paragraph, a work day is defined as an eight hour period at the site, excluding travel time.

3.5 CLEANUP AND DISPOSAL

A. After completion of the installation and testing, the WORK shall be cleaned and readied for the OWNER.

— END OF SECTION —

SECTION 15000 - PIPING, GENERAL

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all piping sections in Divisions 2 and 15.

C. The mechanical drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are **not** pipe construction or fabrication drawings. It is the CONTRACTOR's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, and connectors for a complete and functional system.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including all necessary dimensions, details, pipe joints, fittings, specials, valves, appurtenances, anchors, guides, and material lists. Fabrication drawings shall indicate all spool pieces, spacers, adapters, connectors, fittings, and supports to accommodate the equipment and valves in a complete and functional system.

C. **Samples:** All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR at no increase in cost to the OWNER.

D. Certifications

1. All necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. Fabricator Statement: A statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the ENGINEER for review prior to the fabrication of any pipe.

PART 2 – PRODUCTS

2.1 GENERAL

A. **Extent of Work:** All pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 2 and 15 and as indicated.

B. **Pipe Supports:** All pipes shall be adequately supported, restrained, and anchored in accordance with the requirements of Section 15006 - Pipe Supports, and as indicated.

C. **Lining:** Application, thickness, and curing of pipe lining shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated.

D. **Coating:** Application, thickness, and curing of pipe coating shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. Pipes above ground or in structures shall be field-coated in accordance with Section 09800 - Protective Coating.

E. **Pressure Rating:** All piping systems shall be designed for the maximum expected pressure as defined in Section 02643 - Water Pipeline Testing and Disinfection, or as indicated on the Piping Schedule.

F. **Inspection:** All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with requirements.

G. **Tests:** Except where otherwise indicated, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. The CONTRACTOR shall perform all tests at no additional cost to the OWNER.

H. **Welding Requirements:** All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

I. **Welder Qualifications:** All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the WORK shall be used in qualification tests. The CONTRACTOR shall furnish all material and bear the expense of qualifying welders at no increased cost to the OWNER.

2.2 PIPE FLANGES

A. **Flanges:** Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, 150-lb class. Where the design pressure is greater than 150 psi up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E or Class F, or ANSI/ASME B16.5 150-lb class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI/ASME B16.5, 300-lb class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards indicated for these pipes.

B. **Blind Flanges:** Blind flanges shall be in accordance with ANSI/AWWA C207, or as indicated for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. **Flange Coating:** All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. **Flange Bolts:** All bolts and nuts shall conform to Section 05500 - Miscellaneous Metalwork. Studs and bolts shall extend through the nuts a minimum of 1/4-inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

E. **Insulating Flanges:** Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter.

F. **Insulating Flange Sets:** Insulating flange sets shall be provided where indicated. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2-inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2-inch, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325 - Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength. Insulating gaskets shall be full-face.

G. Insulating Flange Manufacturers

1. **JM Red Devil, Type E;**

2. **Maloney Pipeline Products Co., Houston;**

3. **PSI Products, Inc., (Frost Engineering Service Co., Costa Mesa, California.).**

H. **Flange Gaskets:** Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of aramid fiber base, with nitrile binder and non-stick coating, suitable for temperatures to 700 degrees F, a pH of one to eleven, and pressures to 1000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted, unless otherwise indicated.

I. Flange Gasket Manufacturers

1. **John Crane, Style 2160;**

2. **Garlock, Style 3000.**

2.3 THREADED INSULATING CONNECTIONS

A. **General:** Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. **Materials:** Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. **General:** Cast mechanical-type couplings shall be provided where indicated. The couplings shall conform to the requirements of ANSI/AWWA C606 - Grooved and Shouldered Joints. Bolts and nuts shall conform to the requirements of Section 05500 - Miscellaneous Metalwork. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling Manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections with mechanical-type couplings shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. All mechanical-type couplings on buried piping shall be bonded. The CONTRACTOR shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer.

B. Manufacturers of Couplings for Steel Pipe

1. **Gustin-Bacon (Aeroquip Corp.)** (banded or grooved);
2. **Victaulic Style 41 or 44** (banded, flexible);
3. **Victaulic Style 77** (grooved, flexible);
4. **Victaulic Style 07 or HP-70** (grooved, rigid).

C. Manufacturers of Ductile Iron Pipe Couplings

1. **Gustin-Bacon, (Aeroquip Corp.);**
2. **Victaulic Style 31** (flexible or rigid grooving).

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Manufacturers of Couplings for PVC Pipe

1. **Gustin-Bacon, (Aeroquip Corp);**
2. **Victaulic Style 775.**

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

2.5 SLEEVE-TYPE COUPLINGS

A. **Construction:** Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe, and shall be of steel with steel bolts, without pipe stop, and be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05500 - Miscellaneous Metalwork. Buried sleeve-type couplings shall be epoxy-coated at the factory as indicated.

B. **Pipe Preparation:** The ends of the pipe where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. **Gaskets:** Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:

1. Color - Jet Black
2. Surface - Non-blooming
3. Durometer Hardness - 74 ± 5
4. Tensile Strength - 1000 psi Minimum
5. Elongation - 175 percent Minimum

The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. **Insulating Couplings:** Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. **Restrained Joints:** All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the appropriate reference standard, or as indicated.

F. Manufacturers

1. **Dresser, Style 38**;

2. **Ford Meter Box Co., Inc., Style FC1 or FC3**;

3. **Smith-Blair, Style 411**.

2.6 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise indicated. The connectors shall be a minimum of 9 inches long, face-to-face flanges, unless otherwise indicated. The final material selection shall be approved by the Manufacturer. The CONTRACTOR shall submit manufacturer's shop drawings and calculations.

2.7 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. The CONTRACTOR shall submit detailed calculations and manufacturer's shop drawings of all proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature and pressure ratings.

2.8 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), made up with Teflon tape, unless otherwise indicated.

2.9 PIPE INSULATION

A. Hot and cold liquid piping, flues, and engine exhaust piping shall be insulated as indicated, in accordance with the requirements of Section 15145 - Pipe and Equipment Insulation. No unprotected hot piping shall be within reach of operating personnel or other persons.

2.10 HEAT TRACING

A. All pipes subject to freezing shall be protected by heat tracing in accordance with Section 16850 - Electric Heat Tracing.

2.11 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shut-off valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-lb iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers

1. **Armstrong International, Inc.**;

2. **Spirax Sarco, Inc.**

2.12 STEAM TRAPS

A. Steam traps shall be installed in all low points of steam piping, at minimum 300-foot intervals in mains, at steam appliances, heat exchangers, heaters, and control valves, and where indicated. Steam traps shall be preceded by drip legs, gate valves and strainers, and shall be connected to the condensate system. Steam traps shall be of the float and thermostatic type, the bucket type, or the disc type, as best suited for the service, with cast iron or steel body, stainless steel or monel trim, and screwed connections, with minimum rating of 150 psig.

B. Manufacturers

1. **Armstrong International, Inc.**;

2. **Dunham-Bush**;

3. **ITT, Fluid Handling**;

4. **Spirax Sarco, Inc.**

2.13 GLASS LINING

A. **General:** Ductile iron or steel pipe and fittings shall be glass-lined where indicated. The glass lining shall be suitable for handling sewage, primary sludge, digested sludge, and scum. It shall be smooth, continuous, and suitable for prevention of grease and foam build-up. The glass lining shall be capable of withstanding thermal shock of 350 degrees F (430 degrees to 80 degrees) without crazing, blistering, or spalling.

B. **Criteria:** The glass lining shall consist of a vitreous material to meet or exceed the following criteria:

1. Unaffected by scraping with a sharp knife, simulating the effects of rodding.

2. Unaffected by the continuous application of live steam from a steam generator, immediately followed by a cold water quench.

3. Unaffected by an 8 percent sulfuric acid solution at 148 degrees F for a ten-minute period.

4. Minimum thickness: 10 mils by micro test.

5. Spark tested: Surface must be free of pinholes.

6. Hardness: 5-6 Mohs.

7. Density: 2.5-3.0 g/cu cm, measured by ASTM D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

C. **Application:** Cast or ductile iron pipes and fittings shall be bored or machined smooth to remove voids or protrusions. Steel pipe shall be seamless pipe, with all internal fitting welds ground smooth, slag holes ground out, re-welded, and ground smooth. All interior surfaces shall be grit blasted to white metal and lining shall be fused on to chemically clean metal at above 1400 degrees F. All welded flanges shall be factory-installed before lining. Screwed flanges or cast and ductile iron pipes shall be installed after lining. All pieces shall be sealed and tested prior to shipment. Finish shall be subject to the ENGINEER'S approval.

D. Manufacturers

1. **The Pfaudler Co, Inc., Rochester, New York**;

2. **A.O. Smith Corp., Florence, Kentucky;**

3. **Waterworks, Mfg. Co., Marysville, California.**

PART 3 – EXECUTION

3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

3.2 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Divisions 2 and 15.

B. **Lined Piping Systems:** The lining manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.

C. **Core Drilling:** Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.

D. **Cleanup:** After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

- END OF SECTION -

SECTION 15005 - PIPING IDENTIFICATION SYSTEMS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish, mark, and install identification devices for all exposed piping and valves using color bands, lettering, flow direction arrows, and related permanent identification devices, and all appurtenant works, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

ANSI A13.1	Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit samples of all types of identification devices to be used in the work.

B. The CONTRACTOR shall submit to the ENGINEER, for approval, a list of suggested wording for all valve tags prior to fabrication.

C. All submittals shall be in strict accordance with the requirements of Section 01300 - Contractor Submittals.

PART 2 – PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Identification of all exposed pipe shall be accomplished by color-coding with bands and by lettering as specified in Part 3, herein, and in Section 09800 - Protective Coating. Color bands shall either be painted directly upon the pipe or shall be pressure-sensitive adhesive-backed vinyl cloth or plastic tape.

B. Each pipe identification shall consist of 2 color-coded bands, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. All labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels.

C. Letter sizes and colors for lettering, arrows, and background shall conform to ANSI A13.1.

D. Preprinted identification devices shall be as manufactured by **W.H. Brady Co.; Seton Nameplate Corp.**

2.2 EXISTING IDENTIFICATION SYSTEMS

A. The CONTRACTOR shall continue to use the existing identifcation system or follow the requirements set forth by the 10 State Standards. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the 10 State Standards system. The objective is to fully identify all new piping, valves, and appurtenances to the level specified herein.

2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal or plastic tags as specified herein.

B. Metal tags shall be of stainless steel with embossed lettering. Plastic tags shall be of solid black plastic laminate with white embossed letters. All tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

PART 3 – EXECUTION

3.1 GENERAL

A. All labels and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.

3.2 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

B. The wording on the valve tags shall describe the exact function of each valve, e.g., "HWR-BALANCING," "CLS THROTTLING", "RAS-PUMP SHUT-OFF," etc.

3.3 PIPE IDENTIFICATION

A. Each pipe shall be identified at intervals of 20 feet, and at least one time in each room. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

B. Pipe identification shall consist of 4 elements, i.e., 2 color bands, a lettered label, and a directional label. The bands shall be arranged so that the lettered label and the directional arrow is placed between the 2 bands.

3.4 IDENTIFICATION SCHEDULE

A. Application of identifying devices shall conform to the color codes as established by the Owner.

- END OF SECTION -

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide pipe supports, hangers, guides, and anchors, complete, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop drawings shall include the following information:

1. Drawings of pipe supports, hangers, anchors, and guides

2. Calculations for special supports and anchors.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS

A. **Code Compliance:** All piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. All supports and parts thereof shall conform to the requirements of ANSI/ASME B31.1 - Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. **Structural Members:** Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the CONTRACTOR at no additional cost to the OWNER. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the ENGINEER.

C. **Pipe Hangers:** Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. All hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. All hanger rods shall be subject to tensile loading only.

D. **Hangers Subject to Horizontal Movements:** At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. **Spring-Type Hangers:** Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. All spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

F. **Thermal Expansion:** Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. All components shall be structurally suitable to withstand all loads imposed.

G. **Heat Transmission:** Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. **Riser Supports:** Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. **Freestanding Piping:** Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. **Materials of Construction:**

1. General: All pipe support assemblies, including framing, hardware, and anchors, shall be steel construction, galvanized after fabrication, unless otherwise indicated.

2. Submerged Supports: All submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.

3. Corrosive: All piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

K. **Point Loads:** Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. **Noise Reduction:** To reduce transmission of noise in piping systems, all copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1-1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Ductile-Iron Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
All Diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

3. Support Spacing for Copper Tubing:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1-1/2	6
2 to 4	10

4. Support Spacing for Schedule 80 PVC Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (at 100 degrees F) (feet)
1/2	4
3/4	4.5
1	5
1-1/4	5.5
1-1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

2.3 MANUFACTURED SUPPORTS

A. **Stock Parts:** Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

B. **Manufacturers:**

1. **Basic Engineers Inc.,** Pittsburgh, PA;

2. **Bergen-Paterson Pipesupport Corp.,** Woburn, MA;

3. **Grinnell Corp. (Supply Sales Company),** Cranston, RI;

2.4 COATING

A. **Galvanizing:** Unless otherwise indicated, all fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. **Other Coatings:** Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 09800 - Protective Coating.

PART 3 – EXECUTION

3.1 INSTALLATION

A. **General:** All pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ANSI/ASME B31.1 - Power Piping. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. **Appearance:** Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. All hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

3.2 FABRICATION

A. **Quality Control:** Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

- END OF SECTION -

SECTION 15025 - STEEL PIPE
(ASTM A 53 / A 106, MODIFIED)

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 15000 - Piping, General apply to the WORK of this Section.

PART 2 – PRODUCTS

2.1 PIPE MATERIAL

A. **Water, Air, Fuel Gas, Oil, Steam, and Waste Service:** Unless otherwise indicated, galvanized and black steel pipe shall conform to ASTM A 53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A 106 - Specification for Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 40 or 80, as indicated in the Piping Schedule. Galvanized steel pipe shall not be cement mortar lined unless so indicated.

B. **Chlorine and Sulfur Dioxide Pressure Service:** Black steel pipe shall conform to Chlorine Institute Pamphlet 6, ASTM A 106, Grade A or B, and shall be Schedule 80.

2.2 PIPE JOINTS

A. Black steel pipe for general service shall have screwed ends with NPT threads, welded joints, or flanged joints. Screwed joints shall be made up with Teflon tape and welded joints may have butt-weld fittings, socket-weld fittings, or flanges. Where indicated, black steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

B. Black steel pipe for chlorine or sulfur dioxide pressure service shall be socket-welded except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, diaphragm units, gauges, and switches.

C. Galvanized steel pipe shall have screwed ends with NPT threads made up with Teflon tape. Where indicated, galvanized steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

D. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

2.3 FITTINGS

A. **Common Use:** The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:

1. Threaded malleable iron fittings conforming to ANSI/ASME B 16.3 - Malleable-Iron

Threaded Fittings, Classes 150 and 300.

2. Threaded cast iron fittings conforming to ANSI/ASME B 16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

3. Forged steel socket welded fittings conforming to ANSI/ASME B 16.11 - Forged Fittings, Socket - Welding and Threaded.

4. Butt welding fittings conforming to ANSI/ASME B 16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 40 or 80, as indicated.

5. Threaded cast iron drainage fittings conforming to ANSI/ASME 16.12 - Cast Iron Threaded Drainage Fittings.

6. Flanged cast iron fittings conforming to ANSI/ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.

7. Flanged steel fittings conforming to ANSI/ASME B 16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

8. Grooved ductile iron fittings with grooving dimensions conforming to ANSI/AWWA C 606 - Joints, Grooved and Shouldered Type.

9. Compression-type steel fittings with armored Buna S gaskets for plain end pipe.

B. **Special Applications:** Fittings for chlorine and sulfur dioxide under pressure shall be 3,000 lb forged steel socket welded fittings conforming to ASTM A 105, Grade 2 - Specification for Forgings, Carbon Steel, for Piping Components, and 300 lb forged steel fittings conforming to ANSI/ASME B 16.11, as indicated in the Piping Schedule.

Flanges for chlorine and sulfur dioxide pressure service shall conform to ASTM A 105, ANSI/ASME B 16.5, Class 300, with 1/16-inch raised face, with 1/16-inch high temperature, compressed, self-centering ring type gaskets to ANSI/ASME B 16.21 - Nonmetallic Flat Gaskets for Pipe Flanges. Unions shall be four bolt tongue and groove, ammonia type, suitable for chlorine and sulfur dioxide service, with female threads and lead gaskets.

High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions. Unions shall be rated for 500 lb CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment. Unions shall be as manufactured by **Henry Valve Company or Vogt Valve Co.**.

PART 3 – EXECUTION

3.1 INSTALLATION

A. **General:** All steel pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site, to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the ENGINEER.

B. **Supports and Anchors:** All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. **Valves and Unions:** Water, steam, condensate, gas, vacuum, and air supply piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. **Branch Connections:** Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assemblage.

3.3 PIPE JOINTS

A. **Threaded Joints:** Pipe threads shall conform to ANSI/ASME B 1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.

B. **Welded Joints:** Welded joints shall conform to the specifications and recommendations of ANSI/ASME B 31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 - Piping, General.

C. **Grooved Joints:** Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the Manufacturer's recommendations and conform to ANSI/AWWA C 606. All grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

D. **Push On Joints:** Push on joints and gasket installation shall be in accordance with the Manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

3.4 INSPECTION AND FIELD TESTING

A. **Inspection:** All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damage shall be repaired to the satisfaction of the ENGINEER.

B. **Field Testing:** Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish all test equipment, labor, materials, and devices at no extra cost to the OWNER. For additional testing requirements, refer to Section 02643 - Water Pipeline Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. After completion of the pressure tests, all chlorine gas piping shall be tested for leakage using chlorine gas under operating pressures. Piping shall be thoroughly clean and dry before admitting chlorine gas into the system. Chlorine shall be slowly admitted to the piping system. Leakage shall be checked with a swab soaked in aqua ammonia solution and waved in the vicinity of each fitting. Ammonia solution shall not be applied to the fittings. Formation of white fumes will be evidence of leaks. All chlorine gas shall be purged from the line before leaks are repaired.

3. Leaks shall be repaired to the satisfaction of the ENGINEER, and the system shall be re-tested until no leaks are found.

- END OF SECTION -

SECTION 15036 - COPPER PIPE
(ASTM B 42, MODIFIED)

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide copper pipe, complete and in place, in accordance with the Contract Documents

B. The requirements of Section 15000 - Piping, General apply to the WORK of this Section.

PART 2 – PRODUCTS

2.1 PIPE MATERIAL

A. Copper pipe shall be hard drawn and shall conform to the requirements of ASTM B 42 - Specification for Seamless Copper Pipe, Standard Sizes, with regular or extra strong wall thickness, as indicated in the Piping Schedule.

2.2 PIPE JOINTS

A. Copper pipe shall have screwed ends for NPT fittings or brazed joints. Screwed joints shall be made up with Teflon tape. Brazed or screwed joints may be used in connection with flanges and flanged fittings.

2.3 FITTINGS

A. **Threaded Fittings:** Threaded cast bronze fittings for copper pipe shall be in accordance with ANSI/ASME B 16.15 - Cast Bronze Threaded Fittings, Classes 125 and 250, as indicated in the Piping Schedule.

B. **Flanged Fittings:** Cast copper alloy flanges and flanged fittings shall be in accordance with ANSI/ASME B 16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings, and ASTM B 62 - Composition Bronze or Ounce Metal Castings, with 150 lb rating, or as indicated.

PART 3 – EXECUTION

3.1 INSTALLATION

A. **General:** All copper pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the ENGINEER.

B. **Supports and Anchors:** All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 - Pipe Supports.

Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. **Valves and Unions:** Unless otherwise indicated, piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. **Branch Connections:** Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe to avoid drainage of condensate into the equipment.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assembly.

3.3 PIPE JOINTS

A. **Threaded Joints:** Pipe threads shall conform to ANSI/ASME B 1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies and friction tools. Not more than three threads shall remain exposed after installation.

B. **Brazed Joints:** Brazed joints shall conform to the specifications and recommendations of ANSI/ASME B 31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 - Piping, General.

3.4 INSPECTION AND FIELD TESTING

A. **Inspection:** All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the ENGINEER.

B. **Field Testing:** Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish all test equipment, labor, materials, and devices at no extra cost to the OWNER. For additional testing requirements refer to Section 02643 - Water Pipeline Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines be plugged or capped as required during the testing procedures.

2. Leaks shall be repaired to the satisfaction of the ENGINEER, and the system shall be re-tested until no leaks are found.

- END OF SECTION -

SECTION 15060 - PVC PRESSURE PIPE, SOLVENT-WELDED (ASTM D 1785, MODIFIED)

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide Polyvinyl Chloride (PVC) pressure pipe, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 15000 - Piping, General, apply to the WORK of this Section.

C. This Section specifies PVC pressure pipe with solvent-welded, flanged, or screwed joints.

PART 2 – PRODUCTS

2.1 PIPE MATERIAL

A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be normal impact class 12454-B, Schedule 80, unless otherwise indicated, in accordance with ASTM D 1785 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120, as called out in the Piping Schedule.

2.2 PIPE JOINTS

A. Pipe joints shall be solvent-welded with solvent cement in accordance with ASTM D 2564 - Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems, and with primer in accordance with ASTM F 656 - Specification for Primers for use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings. Screwed joints that are necessary to match up to threaded valves or fittings shall be made up with Teflon tape only. Flanged joints shall be made with solvent-welded PVC flanges, drilled to ANSI/ASME B 16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene.

2.3 FITTINGS

A. **Solvent Welded Fittings:** Solvent-welded fittings shall be Schedule 80 PVC fittings in accordance with ASTM D 2467 - Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

B. **Threaded Fittings:** Threaded fittings shall be Schedule 80 PVC fittings in accordance with ASTM D 2464 - Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

C. **Flanged Fittings:** Flanged fittings shall be Schedule 80 fabricated PVC fittings with 150 lb. flanges to ANSI/ASME B 16.5.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** All PVC pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the ENGINEER. It is recommended that the CONTRACTOR obtain the assistance of the pipe manufacturer's field representative to instruct the pipe fitters in the correct installation and support of all PVC piping.

B. **Supports and Anchors:** All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. **Valves and Unions:** Unless otherwise indicated, all connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assembly.

3.3 PIPE JOINTS

A. **Threaded Joints:** Pipe threads shall conform to ANSI/ASME B 1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation. All joints shall be made with Teflon tape.

B. **Solvent-Welded Joints:** Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept closed at all times and the joints shall be made up at the recommended ambient temperatures, to the pipe Manufacturer's written recommendations. All pipe ends shall be inserted to the full depth of the socket.

C. **Flange Joints:** Flanged joints shall be made with gaskets and Type 316 stainless steel bolts and nuts. Care shall be taken not to over-torque the bolts.

3.4 INSPECTION AND FIELD TESTING

A. **Inspection:** All finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the ENGINEER.

B. **Field Testing:** Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish all test equipment, labor, materials, and devices at no extra cost to the OWNER.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines be plugged or capped as required during the testing procedures.

2. Leaks shall be repaired to the satisfaction of the ENGINEER, and the system shall be re-tested until no leaks are found.

- END OF SECTION -

SECTION 15145 - PIPE, DUCTWORK AND EQUIPMENT INSULATION

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide pipe, duct, and equipment insulation in accordance with the Contract Documents.

B. This work shall include the insulation of all new sealing water lines, service water lines and cooling water lines inside structures, standby generator exhaust piping and silencer, compressed air lines outdoors, all aeration and channel aeration piping inside buildings, including inlet discharge, blowoff and silencers, and all valves and fittings, to the limits indicated or required. Existing uninsulated piping of the above services shall also be insulated if indicated on the Drawings.

C. Except where otherwise indicated, all new potable hot and cold water lines, all horizontal roof drains, all other lines requiring insulation which are furnished and installed under Section 15430 - Plumbing Specialties, and all valves and fittings on said lines shall be insulated to the limits indicated. All existing uninsulated piping of the above specified services shall also be insulated as indicated.

D. All new hot water supply and return lines, steam supply and return lines, condensate lines, liquid and gas refrigerant lines, ductwork, all other lines requiring insulation which are furnished and installed under Section 15500 - Heating, Ventilating, and Air Conditioning, and all valves and fittings on said lines and ducts shall be insulated to the limits indicated. All existing uninsulated piping of the above specified services shall also be insulated.

E. In addition to the insulation indicated, the CONTRACTOR shall insulate any cold or hot piping, flue duct, and exhausts that could be hazardous to plant personnel upon contact.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings:

1. Drawings of all thermal insulation.

2. Manufacturer's data on materials of coverings, jackets, and surface finishes.

C. Certificates:

1. Certification from the stero-heat system manufacturer that the installation has been made in accordance with the manufacturer's recommendations.

2. Certification from the accoustic insulation/duct lining manufacturer that the lining has the sound absorption coefficients as indicated in these Specifications.

1.3 WORKMANSHIP

A. The work shall be installed by workers thoroughly experienced in such work, and the workmanship shall be first class in every respect. The CONTRACTOR's attention is called to the fact that neat and workmanlike appearance in the finished work will be required.

PART 2 – PRODUCTS

2.1 GENERAL

A. All components of the insulation, including covering, mastics and adhesives shall have a flame-spread rating of not over 25, and a smoke development rating of not over 50. Ratings shall be as established by tests in accordance with ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials, ASTM C547 - Specification for Mineral Fiber Preformed Pipe Insulation, and Federal Specification HH-1-558B - Insulation Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type). The integrated insulation assemblies shall also conform to the above standards. Insulation shall be applied in strict accordance with the manufacturer's instructions.

2.2 PIPING INSULATION

A. All piping, fittings, and valves to be insulated shall be clean and dry prior to installation of insulation. All piping of the services described herein shall be completely insulated inside structures, except where otherwise indicated.

B. All piping, except as indicated herein, shall be insulated with heavy density, unfaced, fiberglass pipe insulation. The insulation shall have an average density of 4 pounds per cubic foot or greater. The "K" factor shall not exceed 0.23 Btu-In/SF/ degree F/Hr at 75 degrees F.

C. The fiberglass insulation shall be securely held in place before the final covering is applied. A scrim fabric, similar to a 20 x 10 thread count mesh, 100 percent fiberglass, shall be used for this purpose. The scrim fabric shall be pasted in place to hold the pipe insulation securely to the pipe. The scrim fabric shall be at least 4-inches wide, with at least two applications per length of pipe insulation, and one at each joint.

D. A final covering of the insulation for all piping shall be of 0.030 inch thick PVC. All valves, flanges, fittings, and ends of insulation shall be covered with a pre-molded, high-low temperature PVC fitting cover or end cap, or similar preformed unit. The pre-molded cover shall be sized to receive the same thickness of insulation as used on the adjacent piping. Pre-molded fittings shall be **Zeston, 2000 PVC.**

E. All joints shall be neatly finished with no ragged ends. When finished, the PVC covering shall show no exposed staples or other binding used during installation. Staples, if used, shall be stainless steel.

F. On piping 3-inches and larger, the insulation shall be protected at supporting hangers by the installation of suitable hollow steel protection saddles, filled with loose glass fiber insulation as indicated.

G. Piping smaller than 3-inches shall have a 1/16-inch thick sheet metal shim placed between the insulation and the supporting hanger. The shim shall be at least 6-inches long.

H. Valves, fittings and flanges on all lines shall be covered in a similar manner to the adjacent piping.

I. **Manufacturers:**

1. The insulation shall be manufactured by:
    a. **Manville, Flame Safe Fiberglass, unfaced.**
    b. **Owens-Corning Fiberglass, unfaced.**
2. The scrim fabric shall be manufactured by:
    a. **Alpha Associates, Inc., Luben #58 (White).**
    b. **Southern Asbestos Company**

J. Pipe insulation thickness shall be as follows:

	Minimum Thickness of Insulation (inches)
Hot and cold water (domestic) -	
6 inches and smaller	1
8 inches and larger	1-1/2
Hot and chilled water process -	
6 inches and smaller	1-1/2
8 inches and larger	2
Low pressure steam (50 psig and less) -	
4 inches and smaller	1
5 inches and larger	1-1/2
High pressure steam (51 psig and greater)-	
All sizes	3
Condensate, boiler blowdown, and boiler feed -	
8 inches and less	1-1/2
10 inches and larger	2
Heated sludge and process piping -	
6 inches and smaller	1
8 inches and larger	1-1/2

Compressed air piping and liquid refrigerant piping exposed to the weather - All sizes	2
Heat traced piping -	
3 inches and smaller	1
4 inches and larger	1-1/2

K. All exterior non-buried pipe insulation shall be protected with an aluminum-magnesium alloy jacket having a minimum thickness of 0.016 inch with built-in isolation felt. Lap jacket at least three inches on all joints and secure with stainless steel bands on six inch centers.

L. The acoustical insulation shall be covered by a fiberglass thermal insulation and fiberglass lagging fabric. The thermal insulation shall be three inches thick rigid fiberglass having a "K" factor of not greater than 0.23 Btu-In/SF/degree F/Hr at 75 degrees F mean temperature. The density shall be not less than four pounds per cubic foot and the fiberglass shall have a compressive strength of not less than 50 psi.

M. The thermal insulation shall be as manufactured by **Manville, or Owens-Corning.**

N. The final covering shall be a 100 percent fiberglass lagging fabric, 0.034 inch thick and weighing 19 oz. per sq. yd. The lagging fabric shall be **Alpha Associates - Style 2025; or J.P. Stevens Co.**

O. The final lagging fabric shall be neatly pasted in place with a three inch longitudinal overlap using a **Luben No. 9 adhesive.** Each transverse joint shall have a three inch butt strip of the same fiberglass fabric. All final joints shall be neatly finished with no ragged ends and the covering shall present a neat, uniform surface when finished. The fabric shall show no exposed staples or other binding used during construction. Staples, if used, shall be stainless steel.

P. Compression couplings and expansion joints on all piping shall be covered as indicated on the Drawings. The rigid insulation block indicated shall be of hydrous calcium silicate, segmented to wrap around piping and shall be **Manville, Thermo 12; Owens-Corning, or Kaylo 10.** The blocks shall be held in place with stainless steel bands, approximately 1/2-inch wide by 0.015-inch thick. After banding, the blocks shall be finished with a trowel coat of insulating cement, filling all voids and trowelling to a smooth, neat finish. This installation shall then be covered with an acoustical insulation consisting of a fiberglass fabric weighing 24.6 oz. per square yard coated with a loaded vinyl weighing 83.4 oz. per square yard. The acoustical insulation shall be **Alpha-Sonic Style No. 75.** The acoustical insulation shall be covered with a 100 percent fiberglass lagging fabric equal to that indicated above.

Q. Valves and flanges on all piping shall be covered in a similar manner to the adjacent piping.

R. Insulation shall be installed in strict accordance with the manufacturer's recommendations.

2.5 ANTI-CONDENSATION PIPING INSULATION

A. In general all piping 5 inches and larger in diameter for raw water, settled water, filtered water, service water, water tanks, and as indicated, shall be insulated with **Armstrong or AP Armaflex Sheet and Roll Insulation.** It is a flexible closed cell elastomeric thermal insulation, black in color and furnished with a smooth skin on one side which forms the outer exposed insulation surface.

B. The insulation shall be supplied in sheets and rolls, 1/8 inch to 2 inches thickness, with a thermal conductivity of 0.27 Btu x inch/hr x sq. ft. x degree F. at 75 degrees mean temperature, a water vapor permeability of 0.10 perm-inch, a water absorption of 6 percent max., a upper use limit of 180 degrees F., a lower use limit of -40 degrees F. a flame-spread rating of 25 or less and a smoke-developed rating of 50 or less for insulation thickness to 3/4 inch, and a flame-spread rating of 25 or less and a smoke-developed rating of 100 or less for insulation thickness of 1 inch and greater.

C. For controlling outer insulation surface condensation for pipes or tanks at a metal surface temperature of 35 degrees F., in normal design conditions an insulation thickness of 3/4 inch is recommended. In severe design conditions an insulation thickness of 1-1/2 inches is recommended.

D. The insulation shall be applied to clean, dry surfaces. Remove all oil, grease, dust, scale, rust and moisture before applying the insulation. No protective finish is required indoors, but may be desirable. A weather-resistant protective finish is recommended if installed outdoors. Install insulation according to manufacturers recommendations.

2.6 DUCTWORK INSULATION

A. All HVAC ductwork with exterior insulation shall be a minimum 1-inch thick, rigid board, having a thermal conductivity of not greater than 0.23 Btu/SF/degree F/Hr at 75 degrees F mean temperature with a foil faced reinforced facing. The insulation shall be applied with edges tightly butted and secured by impaling on pins fastened to the ductwork. The pin spacing shall be sufficient to hold the insulation firmly to the duct surface and the insulation shall be held with speed clips. Pins shall be clipped after installation. All joints shall be sealed with a minimum 3-inch vapor barrier tape. The final outer covering shall be a rewetable, incombustible, 100 percent fiberglass lagging. The finish covering shall be neatly pasted in place with joint taping as required. All pasting of lagging shall be done with manufacturers recommended adhesive. The insulation shall be **Owens Corning Type 705, or Johns Manville.** The lagging fabric shall be **Alpha Associates, Alpha-Matrix 3451-RW, or J. P. Stevens.**

B. All ductwork with exterior insulation which is exposed to the weather shall be protected with an aluminum-magnesium alloy jacket having a minimum thickness of 0.016 inch with built-in isolation felt. Lap jacket at least three inches on all joints and secure with stainless steel bands on six inch centers.

C. **Duct Lining:** Ductwork lining shall be 1-inch thick, 1-1/2 lbs/cu. ft. density fiberglass duct liner as manufactured by **Manville Products Corp., Linacoustic-HP; or Owens-Corning.** The liner shall have a flame spread rating of 25 or less, a smoke development rating of 50 or less, an average thermal conductivity not to exceed 0.23 Btu-In/SF/Degree F/Hr at a mean temperature of 75 degrees F, and shall be suitable for duct velocities up to 5,000 FPM.

1. The liner shall have sound absorption coefficients as follows:

Sound Absorption Coefficients
as Frequencies (Hertz) of

125	250	500	1000	2000	4000	NRC
.15	.55	.71	.94	1.03	1.05	.80

2. The liner shall be installed per manufacturer's recommendations

3. The duct sizes shown on the Drawings are the airway dimensions of the duct system which does not include any provisions for the duct liner. The CONTRACTOR shall add the duct liner thickness to the indicated duct sizes.

D. The CONTRACTOR shall replace insulation damaged or removed by modifications to existing ductwork. The insulation shall be new and all joints between new and existing insulation shall be made water-tight.

PART 3 – EXECUTION

3.1 INSTALLATION

A. All insulation shall be installed by a qualified insulation CONTRACTOR in strict accordance with the manufacturer's recommendations.

— END OF SECTION —

SECTION 15200 - VALVES, GENERAL

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

C. **Unit Responsibility:** A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the Manufacturer of the valve.

D. **Single Manufacturer:** Where two or more valves of the same type or size are required, the valves shall be furnished by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop drawings shall contain the following information:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.
2. Complete information on valve actuator, including size, Manufacturer, model number, limit switches, and mounting.
3. Cavitation limits for all control valves.
4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
5. Data in accordance with Section 16460 - Electric Motors for all electric motor-actuated valves.
6. Complete wiring diagrams and control system schematics.
7. Valve Labeling: A schedule of valves to be labeled, indicating in each case the valve location and the proposed wording for the label.

C. **Owner's Manual:** The Owner's Manual shall contain the required information for each valve.

D. **Spare Parts List:** A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. **Factory Test Data:** Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 – PRODUCTS

2.1 PRODUCTS

A. **General:** All valves and gates shall be new and of current manufacture. All shut-off valves 6-inches and larger shall have actuators with position indicators. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.

B. **Valve Actuators:** Unless otherwise indicated, valve actuators shall be in accordance with Section 15201 - Valve and Gate Actuators.

C. **Protective Coating:** The exterior surfaces of all valves and the wet interior surfaces of all ferrous valves of sizes 4 inches and larger shall be coated in accordance with Section 09800 - Protective Coating. The valve Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

D. **Valve Labeling:** Except when such requirement is waived by the ENGINEER in writing, a label shall be provided on all shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, as indicated in Section 15005 - Piping Identification Systems, and shall by permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.

E. **Valve Testing:** As a minimum, unless otherwise indicated, each valve body 4 inches and larger shall be tested hydrostatically to 1.5 times its rated 100 degrees F design water-working pressure, for a period of 5 minutes, without showing any leaks or loss of pressure. In addition, each valve 4 inches and larger shall undergo a functional test to demonstrate satisfactory operation throughout its operating cycle, and a closure test at rated 100 degrees F water-working pressure for a period of 5 minutes to demonstrate tight shut-off. Stem seal leakage shall not be a cause for rejection. All valves 3 inches and smaller shall undergo the Manufacturer's standard test.

F. **Certification:** Prior to shipment, the CONTRACTOR shall submit for all valves over 12 inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, and ASTM.

G. **Valve Marking:** All valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. **General:** All materials shall be suitable for the intended application. Materials not specified shall be high-grade standard commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise specified, valve and actuator bodies shall conform to the following requirements:

1. **Cast Iron:** Close-grained gray cast iron, conforming to ASTM A 48 - Specification for Gray Iron Castings, Class 30, or to ASTM A 126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. **Ductile Iron:** ASTM A 536 - Specification for Ductile Iron Castings, or to ASTM A 395 - Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

3. **Steel:** ASTM A 216 - Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.

4. **Bronze:** ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Specification for Copper Alloy Sand Castings for General Applications.

5. **Stainless Steel:** Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Specification for Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.

2.3 VALVE CONSTRUCTION

A. **Bodies:** Valve bodies shall be cast, forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. All welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

B. **Bonnets:** Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

C. **Stems:** Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Where subject to dezincification, bronze valve stems shall conform to ASTM B 62, containing not more than 5 percent of zinc or more than 2 percent of aluminum, with a minimum tensile strength of 60,000 psi, a minimum yield strength of 40,000 psi, and an elongation of at least 10 percent in 2 inches. Where dezincification is not a problem, bronze conforming to ASTM B 584 may be used.

D. **Internal Parts:** Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

E. **Nuts and Bolts:** All nuts and bolts on valve flanges and supports shall be in accordance with Section 05500 - Miscellaneous Metalwork.

2.4 VALVE ACCESSORIES

A. All valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. Where indicated, the CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. All spare parts are intended for use by the OWNER, only, after expiration of the guarantee period.

2.6 MANUFACTURERS

A. **Manufacturer's Qualifications:** All valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.

PART 3 – EXECUTION

3.1 VALVE INSTALLATION

A. **General:** All valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the Manufacturer's written instructions and as indicated. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. **Access:** All valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are indicated, the CONTRACTOR shall properly assemble and install such items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

- END OF SECTION -

SECTION 15201 - VALVE AND GATE ACTUATORS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and gates, except where otherwise indicated in the Contract Documents.

C. **Unit Responsibility:** The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves, gates, and actuators with the Contract Documents.

D. **Single Manufacturer:** Where two or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals and Section 15200 - Valves, General.

B. **Shop Drawings:** Shop Drawings of all actuators shall be submitted together with the valve and gate submittals as a complete package.

PART 2 – PRODUCTS

2.1 GENERAL

A. **General:** Unless otherwise indicated, shut-off and throttling valves and externally-actuated valves and gates shall be provided with manual or power actuators. The CONTRACTOR shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers.

B. **Manufacturers:** Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate Manufacturer. Where actuators are furnished by different manufacturers, the CONTRACTOR shall coordinate selection to have the fewest number of manufacturers possible.

C. **Materials:** Actuators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.

D. **Mounting:** Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48 and 60 inches above the floor or the permanent working platform.

E. **Standard:** Unless otherwise indicated and where applicable, actuators shall be in accordance with ANSI/AWWA C 540 - AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates.

F. **Functionality:** Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 16 and instrumentation equipment indicated in Section 17100 - Process Control and Instrumentation Systems.

2.2 MANUAL ACTUATORS

A. **General:** Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4 inches shall have direct acting lever or handwheel actuators of the Manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear actuators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 6 inches to 24 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

B. **Buried Valves:** Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the ENGINEER. Wrench-nuts shall comply with AWWA C 500 -Metal - Seated Gate Valves for Water Supply Service, and a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished.

C. **Chain Actuator:** Manually-activated valves with the stem located more than 7 feet above the floor or operating level shall be provided with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains provided by the valve Manufacturer. The wheel and guide shall be of ductile-iron, cast-iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5 feet 6 inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. **Floor Boxes:** Hot-dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

E. **Manual Worm-Gear Actuator:** The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. All gearing shall be designed for a 100 percent overload.

F. **Traveling-Nut Actuator:** The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weather-proof cast-iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of grease nipples. All gearing shall be designed for a 100 percent overload.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adaptor piece.

2. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. All gearing shall be accurately cut with hobbing machines. All power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the electric actuator.

3. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.

4. Switches and Wiring: Travel in the opening and closing directions shall be governed by a switch responsive to mechanical torque developed in seating the valve, or by an obstruction met in opening or closing the valve, or by an on-board microprocessor. The torque switch shall be adjustable and shall function without auxiliary relays or devices, or it shall be adjustable in one-percent increments, sensed by a pulse-counter which receives 15 pulses per rotation of the unit. The geared limit switches shall be of the open type and shall be actuated by a rotor cam with 4 contacts to each cam or gear train. The actuator shall have a number of gear trains as required to produce the operation indicated. The actuator shall be wired in accordance with the schematic diagram. All wiring for external connections shall be connected to marked terminals. One 1-inch and one 1-1/4-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch

correlating the dial setting to the unit output torque. Position limit switches and associated gearing shall be an integral part of the valve actuator. To provide the best possible accuracy and repeatability, limit-switch gearing shall be of the "counting" intermittent type, made of stainless steel, grease-lubricated, and enclosed in its own gearcase to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over-travel. Traveling-nuts, cams, or microswitch tripping mechanisms shall not be used. Limit-switches shall be of the heavy-duty open contact type with rotary wiping action.

5. Handwheel Operation: A permanently-attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel.

6. Motor: The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. Actuators for valves 6" and greater shall be suitable for operation on 480-volt, 3-phase, 60-Hz current, and have Class F insulation and a motor frame with all dimensions in accordance with the latest revised NEMA MG Standards. Actuators for valves less than 6" shall be suitable for operation on 120-volt, 1-phase, 60-Hz current, and have Class F insulation and a motor frame with all dimensions in accordance with the latest revised NEMA MG standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. Bearings shall be of the ball type and thrust bearings shall be provided where necessary. All bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. The motor shall be provided with a space heater suitable for operation on 120-volt, single-phase, 60-Hz circuit unless the entire actuator is an hermetically-sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.

B. Electric Motor Actuators (AC Reversing Control Type)

1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open/close and local/remote selector switches.

2. Actuator Appurtenances: The actuator for each valve shall be supplied with open and close status lights; open, close and lock-out-stop push-buttons, and all other devices indicated.

3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 120-volt, 1-phase, 60-Hz current. A control power

transformer shall be included to provide a 120-volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120-volt ac, single-phase, 60-Hz space heater to prevent moisture condensation on electrical components.

4. Manufacturers:

   a. **Limitorque Corporation**
   b. **Rotork**
   c. **EIM**

PART 3 – EXECUTION

3.1 SERVICES OF MANUFACTURER

A. **Field Adjustments:** Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

A. Valve and gate actuators and accessories shall be installed in accordance with Section 15200 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance, without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

- END OF SECTION -

SECTION 15202 - BUTTERFLY VALVES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

C. The requirements of Section 15201 - Valve Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200.

PART 2 – PRODUCTS

2.1 BUTTERFLY VALVES (AWWA)

A. **General:** Butterfly valves for water working pressures up to 150 psi shall conform to ANSI/AWWA C504 - Rubber Seated Butterfly Valves, subject to the following requirements. Valves shall be of the size and class indicated. Flanged valves shall have ANSI 125-lb flanges. Shaft seals shall be designed for use with standard split-V type packing, or other acceptable seal. The interior passage of butterfly valves shall not have any obstructions or stops. The seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats which rely on a high coefficient of friction for retention shall not be acceptable.

B. **Manual Actuators:** Actuators shall conform to Section 15201 and to ANSI/AWWA C540 - Power Actuating Devices for Valves and Sluice Gates, subject to the following requirements. Unless otherwise indicated, all manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30 inches in diameter and larger.

C. **Worm Gear Actuators**: Valves, 30 inches and larger, as well as all submerged and buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

D. **Manufacturers:**

1. **De Zurik Corporation**
2. **Henry Pratt Company**
3. **Clow Valve Company (Manually Operated Valves Only)**

PART 3 – EXECUTION

3.1 INSTALLATION

A. All exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. The installation shall be in accordance with Section 15200.

- END OF SECTION -

SECTION 15203 - CHECK VALVES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200 - Valves, General.

PART 2 – PRODUCTS

2.1 SWING CHECK VALVES (3-INCH AND LARGER)

A. **General:** Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with ANSI/AWWA C 508 - Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. They shall have a flanged cover piece to provide access to the disc.

B. **Body:** The valve body and cover shall be of cast iron conforming to ASTM A 126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ANSI/ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or mechanical joint ends, as indicated.

C. **Disc:** The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings.

D. **Seat and Rings:** The valve seat and rings shall be of bronze to conforming ASTM B 62 or B 148 - Specification for Aluminum-Bronze Castings, or of Buna-N.

E. **Hinge Pin:** The hinge pin shall be of bronze or stainless steel.

F. **Manufacturers:**

1. **APCO (Valve and Primer Corp.)**
2. **Golden Anderson**
3. **Cla - Val**
4. **Val - Matic**

2.2 SWING CHECK VALVES (2-1/2-INCH AND SMALLER)

A. **General:** Swing check valves for steam, water, oil, or gas in sizes 2-1/2-inch and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. They shall have screwed ends, unless otherwise indicated, and screwed caps.

B. **Body:** The valve body and cap shall be of bronze conforming to ASTM B 61 - Specification for Steam or Valve Bronze Castings, or ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, and with threaded ends conforming to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch).

C. **Disc:** Valves for steam service shall have bronze or brass discs conforming to ASTM B 16 - Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.

D. **Hinge Pin:** The hinge pins shall be of bronze or stainless steel.

E. **Manufacturers:**

1. **Crane Company**

2. **Milwaukee Valve Company**

3. **Stockham Valves and Fittings**

4. **Wm. Powell Company**

2.3 PLASTIC BALL CHECK VALVES

A. **General:** Plastic ball check valves for polymer fluids, in sizes up to 4-inch, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. **Construction:** The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections, or flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. All seals shall have Viton O-rings and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. **Manufacturers:**

1. **NIBCO Inc. (Chemtrol Division);**

PART 3 – EXECUTION

3.1 GENERAL

A. All valves shall be installed in accordance with provisions of Section 15200 - Valves, General.

- END OF SECTION -

SECTION 15204 - BALL VALVES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

C. The requirements of Section 15201 - Valve and Gate Actuators apply to this Section.

D. The requirements of Section 11258 - Chemical Feeding Equipment, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200 - Valves, General.

PART 2 – PRODUCTS

2.1 PLASTIC BALL VALVES

A. **General:** Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the Manufacturer for the specific application. All valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators, unless otherwise indicated.

B. **Construction:** All plastic ball valves shall have union ends or flanged ends to mate with ANSI B 16.5, class 150, for easy removal. The balls shall have full size ports and Teflon seats. All body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements of Section 11258. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC, with decreasing ratings for higher temperatures and other plastics.

C. Manufacturers:

1. **NIBCO Inc., (Chemtrol)**

PART 3 – EXECUTION

3.1 GENERAL

A. All valves shall be installed in accordance with provisions of Section 15200 - Valves, General. Care shall be taken that all valves in plastic lines are well supported at each end of the valve.

- END OF SECTION -

SECTION 15207 - PLUG VALVES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

C. The requirements of Section 15201 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200.

PART 2 – PRODUCTS

2.1 ECCENTRIC PLUG VALVES (1/2-inch to 72-inch)

A. **Construction:** Eccentric plug valves shall be of the non-lubricated, eccentric plug design with cast iron bodies conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with ANSI 125 lb. flanged ends for valves 3-inch and larger, and screwed or flanged ends for smaller sizes. The plugs and shafts shall be of cast iron or ductile iron conforming to ASTM A 536 - Specification for Ductile Iron Castings, and the plugs shall be lined with a resilient coating, best suited for the specific service. The body shall be lined with a suitable elastomer, where required for a special service, or it shall be epoxy-lined in accordance with Section 09800 - Protective Coating. The seats shall be of nickel or stainless steel welded to the body. Eccentric plug valves for digester gas service shall have Type 316 stainless steel plugs and suitable resilient seating like Buna-N, or Hycar. All top and bottom shaft bearings shall be of permanently lubricated stainless steel, or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals. Valves up to and including 20-inch in size shall have an unobstructed port area of not less than 80 percent of full pipe area, and not less than 70 percent for larger valves. All eccentric plug valves shall have a pressure rating of not less than 150 psi WOG, for bubble-tight shut-off in the standard flow direction, and 25 psi WOG in the reverse flow direction. When equipped with worm gear actuator, the pressure rating shall be 150 psi WOG in both directions. The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing.

B. **Actuators:** Unless otherwise indicated, all eccentric plug valves 3-inch and smaller shall have operating levers; all larger valves shall have worm-gear actuators. Valve actuators shall be in accordance with Section 15201.

C. **Manufacturers:**

1. **DeZurik Corporation**
2. **Henry Pratt Company**
3. **Keystone**

PART 3 – EXECUTION

3.1 INSTALLATION

A. All plug valves shall be installed in strict accordance with the Manufacturer's published recommendations and the applicable provisions of Section 15200.

B. **Eccentric Plug Valves:** Unless otherwise directed, the following rules shall be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:

1. The valves shall be positioned with the stem in the horizontal direction.

2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.

3. The orientation of the valve shall prevent the valve body from filling up with solids when closed; however, where the pressure differential through the valve exceeds 25 psi, the higher pressure for valves without worm gear, electric, or air operators shall be through the valve to force the plug against the seat.

4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines) and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for all sizes.

5. For special applications or when in doubt, consult with the Manufacturer prior to installation.

- END OF SECTION -

SECTION 15215 - PRESSURE REDUCING VALVES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide pressure reducing valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200, including a cavitation study from the valve manufacturer.

PART 2 – PRODUCTS

2.1 GENERAL

A. **Function:** Pressure reducing valves shall reduce a higher upstream pressure to a pre-set, lower, constant pressure, regardless of fluctuations in the upstream pressure.

B. **Operation:** The valves shall be suitable for water service and shall be of the globe patterns.

2.2 SIZES 1/2 TO 2-1/2 INCHES

A. **Valve Body:** The valve body shall be bronze to ASTM B 62 or cast steel, with a minimum pressure rating of 300 psi, and with threaded ends. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm or piston.

B. **Valve Trim:** The valve stems, springs, body seats, and washers shall be of Series 300 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B 62.

C. **Operating Conditions:** The valves shall be sized to coincide wit the pipeline size and shall be designed to operate under the following conditions:

Location	**Belt Press Water Inlet**	**Belt Press Polymer System**	**Gravity Thickener Polymer System**	**Washwater Polymer System**
Number	2	1	1	1
Maximum inlet pressure (psi)	150	150	150	150
Minimum inlet pressure (psi)	130	130	130	130

Location	Belt Press Water Inlet	Belt Press Polymer System	Gravity Thickener Polymer System	Washwater Polymer System
Minimum outlet pressure (psi)	120	80	80	80
Maximum flow (gpm)	130	15	10	15

D. **Spare Parts:** The following spare parts shall be furnished in accordance with Section 15200:

1. One set of all resilient seals and discs

2. One diaphragm (for diaphragm valves, only)

E. Manufacturers:

1. **GA Industries**

2. **Watts, ACV**

PART 3 – EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in accordance with provisions of Section 15200.

3.2 SERVICES OF MANUFACTURERS

A. **Inspection, Startup, and Field Adjustment:** The service representative of the valve Manufacturer shall be present at the site for 1 work day, to assist the CONTRACTOR in the installation and adjustment of the valve(s).

B. **Instruction of OWNERS Personnel:** The training representative of the valve Manufacturer shall be present at the site for 1 work day to instruct the personnel in the operation, adjustment, and maintenance of the valves.

C. For the purpose of this paragraph, a work day is defined as an eight hour period, excluding travel time.

- END OF SECTION -

SECTION 15226 - TELESCOPING VALVES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install four (4) 10" interior diameter (nominal), motor-operated telescoping valves, complete and operable, as shown and specified, including appurtenances, operators, and accessories, in accordance with the requirements of the Contract Documents.

B. The requirements of Section 15200 – Valves, General, Section 15201 – Valve and Gate Actuators, Section 17100 – Process Control and Instrumentation Systems, and Section 17300 – Control Descriptions, also apply to the work included in this Section.

PART 2 – PRODUCTS

2.1 VALVE ASSEMBLY

A. **General:** The telescoping valve assembly shall be actuated through a rising stem and bearing, of the size shown. The travel range shall be at least the amount shown on the Contract Drawings. Assemblies shall consist of a floor stand/pedestal assembly with motor operator, a rising stem, slip tube with two V-notched skimming funnels equally spaced apart, a tube guide collar with companion flange and gasket and a mounting bracket. The depth of submergence for each valve shall be controlled by open/close signals from the manual local valve control station or the automatic control system, in response to the level of the lagoon supernatant.

B. **Construction:**

1. Slip Tube: The slip tube and skimming funnel shall be of Type 316, Schedule 40 stainless steel, with a seal to prevent leakage at the seam.

2. Stem: The stem shall be threaded 3/4-inch (minimum) brass or stainless steel, with a travel and height indicating device calibrated in 1/2-inch increments. A suitable stem lock shall be provided for holding the stem at the desired level.

3. Guide Collar: Guide collar shall include a neoprene gasket and cast iron companion flange for securing to the receiving pipe as shown.

4. Floor Stand/Pedestal: A floor stand/pedestal assembly shall be provided to support the rising stem and motor operator.

4. Mounting Bracket: A cast iron bracket shall be provided for mounting the floor stand assembly with stainless steel anchor bolts.

5. Fastening Hardware: All nuts and bolts and other fastening hardware shall be Type 316 stainless steel.

6. Actuator: An actuator shall be provided, consisting of a modulating duty (unlimited starts – bi-directional) electric motor driven worm and gear reduction unit, with declutch device and manual handwheel, complete with torque switches to assure power cut-off if the valve travel is restricted.

7. Motor: A 5 horsepower (max.), enclosed squirrel cage, induction type shall be provided, capable of operation on 480 volt, 3 phase, 60 Hertz power, conforming to NEMA standards.

C. **Manufacturers:**

1. **Envirex, Inc.;**

2. **On-Line Engineering;**

3. **U.S. Filter Co..**

PART 3 – EXECUTION

3.1 INSTALLATION

A. All telescoping valves shall be installed in strict accordance with the manufacturer's printed recommendations and the applicable provisions of Section 15200 - Valves, General.

B. The CONTRACTOR shall include with his bid the services of the Equipment Manufacturer's field service technician for a period of one (1) trip of one (1) day duration, for final adjustment during the plant start up period.

- END OF SECTION -

SECTION 15230 - MISCELLANEOUS VALVES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200.

PART 2 – PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

A. **Air and Vacuum Valves:** Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

B. **Air-Release Valves:** Air-release valves shall vent accumulating air while system is in service and under pressure and be of the size indicated and shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. **Combination Air Valves:** Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.

D. **Sewage Air Release Valves:** Sewage air release valves shall vent accumulating gases during system operation. Valves shall have long float stems and bodies to minimize clogging. The same general requirements shall apply as indicated for air and vacuum valves. Each sewage air release valve shall be furnished with the following backwash accessories, fully assembled on the valve:

1. Inlet shut-off valve.
2. Blow-off valve.
3. Clear water inlet valve.
4. Rubber supply hose.

5. Quick disconnect couplings.

E. Manufacturers:

1. **APCO (Valve and Primer Corporation)**

2. **GA Industries**

2. **Val-Matic (Valve and Manufacturing Corporation)**

2.2 BACKFLOW PREVENTER VALVES

A. **General:** Backflow preventers shall work on the reduced pressure principle. They shall consist of 2 spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.

B. Manufacturers:

1. **Cla-Val Company**

2. **Febco, (CMB Industries)**

3. **Hersey Products (Grinnell Corporation)**

4. **Watts, ACV**

5. **Wilkins Regulator Division (Zurn Industries)**

2.3 CORPORATION STOPS

A. Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or ironpipe thread, as required.

B. Manufacturer:

1. **Ford Meter Box Company, Inc.**

2. **James Jones Company (Watts, ACV)**

3. **Mueller Company (Grinnell Corporation)**

2.4 SOLENOID VALVES

A. Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled.

Solenoid valves in corrosive environment shall have stainless steel bodies. For chemicals and all corrosive fluids, solenoid valves with Teflon bodies and springs or other suitable materials shall be used. Enclosures shall be NEMA rated in accordance with the area designations of Section 16050 - Electrical General Provisions. All coil ratings shall be for continuous duty. For electrical characteristics see electrical drawings or specifications.

B. For each solenoid operated valve for all types of operators, there shall be a local control station with open-close pushbuttons. Local/remote selector switch shall also be provided if shown on Process and Instrumentation Diagram Drawings. The local control stations shall be in a separately mounted, stainless steel NEMA 4 enclosure, as shown on the Contract Drawings.

C. Manufacturers:

1. For general duty:

a. **Automatic Switch Co. (ASCO), Model "RED HAT"**

PART 3 – EXECUTION

3.1 INSTALLATION

A. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, and wherever there is any danger of contamination, and where indicated.

B. All valves shall be installed in accordance with the Manufacturer's printed recommendations, and with provisions of Section 15200.

C. All backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

- END OF SECTION -

SECTION 15430 — PLUMBING PIPING AND SPECIALTIES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide plumbing and specialties, complete and operable, in accordance with the Contract Documents.

1.2 WORKMANSHIP AND MATERIALS

A. All work shall in strict accordance with the Uniform State Plumbing Code, and codes of the State of Kentucky, City of Lexington, and any other authorities having jurisdiction. The Contractor shall have required certifications and be thoroughly familiar with the local codes. The Contractor shall obtain and pay for all necessary permits.

B. Care shall be taken at all times to protect floors, stairways, and walls during the make-up, erection of piping, and placing of equipment. The contractor shall remove all stains and repair all damage before final acceptance of the work.

C. If, during the construction of this project, the Engineer finds materials that have identifying marks removed or lack such marks completely, he may reject such items until the Contractor has furnished proof that said items conform to the Specifications. Adequacy and extent of such proof shall be determined by the Engineer.

PART 2 —PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.

B. Floor drains or floor sinks shall be provided for all equipment drains. No equipment drains shall discharge to floor slabs.

2.2 PIPING AND FITTINGS

A. All cast iron sanitary, storm, and vent pipe and fittings shall be manufactured in accordance with and shall meet the requirements of ASTM A 74 - Cast Iron Soil Pipe and Fittings. Dimensions of cast iron soil pipe and fittings shall be as given in Table 2 of ASTM A 74.

B. Hub-Less cast iron soil pipe and fittings with Clamp-All Type pipe couplings, shall be used for above ground sanitary, storm, and vent piping where approved for use by local authorities. Hub-Less cast iron soil pipe and fittings shall meet CISPI Standard 301. Pipe couplings shall have Hi-Torque capacity and meet FM standard 1680.

C. All copper pipe and fittings for potable and service water 3 inches and smaller shall be Type L medium wall hard temper copper pipe with soldered fittings.

D. Vent piping passing through the roof shall be flashed. Flashing shall extend a minimum 12 inches from the outer surface of the pipe in all directions. Flashing shall be fabricated from 4-pound lead sheet.

2.3 INSULATION

A. All hot and cold water piping, valves, fittings, and exposed horizontal sanitary, storm, and vent piping shall be provided with one-inch thick insulation in accordance with Section 15145 - Pipe and Equipment Insulation.

B. Cover all valves, flanges, fittings and ends of insulation with a pre-molded high and low temperature PVC fitting cover or end cap, or similar preformed units. The pre-molded cover shall be sized to receive the same thickness of insulation as used in the adjacent piping and shall be in accordance with Section 15145 - Pipe and Equipment Insulation.

C. Exposed supply and drain piping for lavatories shall be insulated under the wash basins to prevent burns and abrasions to handicapped persons. Removable insulated covers shall be **Plumberex Specialty Products Handy-Shield type.**

2.4 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

A. **General:** The CONTRACTOR shall provide all necessary hangers and supports. No perforated strap hangers and no wire supports will be permitted. Pipe supports shall be as indicated in Section 15006 - Pipe Supports.

B. angers supporting insulated piping shall be sized to fit the pipe plus the insulation. Insulation at support points shall be provided with metal shields to prevent damage to the insulation.

C. Spacing

1. Pipe support spacing for steel and cast iron pipe is given in Section 15006 - Pipe Supports.

2. Copper pipe support spacing shall be not more than 6 feet between supports.

D. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.

E. Pipe hangers used to support uninsulated copper piping shall be copper or copper plated.

F. All vertical piping shall be supported at the base with fittings made for this purpose or supported from the nearest horizontal member or floor with a riser extension pipe clamp

G. Anchors that are installed into existing concrete shall be **Grinnel Figure 117 or Modern Figure 740**, expansion case inserts. Drill clean holes for insertion of case and patch concrete around hole as required.

H. Continuous slotted concrete inserts, if used, shall be **Crawford Figure 148 or Fee & Mason Figure 9000**. The CONTRACTOR shall provide secondary angle supports between main inserts to handle the loads which can be properly supported by such arrangement.

I. Concrete inserts shall be as indicated in Section 15006 - Pipe Supports. All inserts shall be galvanized.

2.5 PIPE SLEEVES

A. Where pipes pass through floors, sleeves shall extend 3 inches above the finished floor. Where pipes pass through walls, sleeves shall be flush with the wall surface.

B. All sleeves shall be Schedule 40 galvanized steel pipe for interior walls, and steel or PVC pipe for exterior walls, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.

C. At exposed wall or ceiling surfaces, the CONTRACTOR shall install a suitable chromium plated brass wall plate approved by the ENGINEER.

2.6 VALVES

A. **General:** All water shut off valves shall be the gate type, except on fixture supply piping where globe valves shall be used.

B. All interior hose valves shall be provided as indicated. The globe valve shown shall be as given herein before for valves. The hose nipple shown on the detail shall be a female iron pipe thread inlet with hose thread outlet. All hose bibbs shall be 3/4-inch in size.

C. Gate, globe, check, plug, and angle valves shall be in accordance with the following:

1. Section 15206 - Gate Valves
2. Section 15204 – Ball Valves
3. Section 15203 - Check Valves
4. Section 15207 - Plug Valves
5. Section 15200 – Valves, General

D. The CONTRACTOR shall provide shutoff valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shut-off control on the water system. Shut off valves shall be placed on all hot and cold water connections to equipment and fixtures. Lavatory and sink stops with wheel handle shall be brass with chrome plating. Extra long barrel stops shall be used where supply piping is concealed behind partitions.

E. All valves shall open by turning counterclockwise and shall have suitable handwheels or nuts as required.

F. Provide a temperature and pressure relief valve for each water heater. Provide pressure relief valves at other locations where indicated. Relief valves shall be equipped with manual test levers. The CONTRACTOR shall provide piping to convey relief valve discharge to the nearest floor drain, the building exterior, or as approved by the ENGINEER.

2.7 ACCESS DOORS AND COVERS

A. Access doors, where required in ceilings for access to valves, controls, and other equipment, shall be **Karp Assoc., Maspeth, N.Y., Style DSC-210 or Inryco-Milcor, Milwaukee, Wisconsin, Style AT.** Doors shall be of sufficient size to allow access but shall be not less than 12 inches by 12 inches. Ceilings with lay-in acoustical tile will not require access panels. Valves and equipment located above ceiling tile shall have a 3/4-inch diameter blue plastic button with a letter "V" set in tile.

B. Floor access covers in unfinished concrete floors not exposed to chemicals shall be iron with a clear opening of not less than 8 inches by 8 inches, and shall be as manufactured by **Alhambra Foundry Company, Model A-2015; or Neenah Foundry Co., No.R-6687.** In traffic or chemical areas, access covers shall be as manufactured by **Alhambra Foundry Company, Model A-1240; or Neenah Foundry Co., Model R-1977**, with clear opening of not less than 10 inches in diameter.

2.8 ROOF DRAINS

A. Roof drains shall have galvanized cast iron drain bodies, threaded outlet, removable locking mushroom aluminum or brass stone stainers, clamping collars with integral gravel guards, receiver, deck clamp and extension sleeves where required.

B. **Manufacturers**

1. **Josam Mfg. Co., Series 21500**
2. **Jay R. Smith Mfg. Co., Fig. 1010**
3. **Zurn Industries, Inc., Series Z-100**

2.9 FLOOR DRAINS IN CONCRETE FLOORS

A. **General:** Floor drains in concrete floors shall be of cast iron, in the sizes indicated, with sediment buckets. Each floor drain located on an upper floor shall have a clamping collar, with 4-lb sheet lead flashing, 12 inches minimum all around.

B. **Manufacturers**

1. **Josam Mfg. Co., Series 31120**
2. **Jay R. Smith Mfg. Co., Fig. 2350**
3. **Zurn Industries, Inc., Series Z-520-Y**

2.10 TRAP SEALS AND PRIMERS

A. Where required by code, floor drains and floor sinks connected to the sanitary sewer shall be protected by trap primers connected to the water supply to the nearest plumbing fixture. One half-inch copper tubes shall run from the primers to the traps. Trap primers shall be mounted in accessible locations. Trap primers shall be **Josam Mfg. Co., Model 88250; Jay R. Smith Mfg. Co., Model 2699; or Zurn Industries, Inc., Model Z-1022.**

2.11 CLEANOUTS

A. **General:** All cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs. Where underground or concealed, cleanouts shall be brought to floor level and to accessible locations with access covers and frames.

B. **Manufacturers:** The following cleanouts, shall be provided:

Josam Series	J.R. Smith No.	Zurn No.	
Exposed Locations	58500-20	4405	Z-1440-A
Underground (finished floors)	56010/30	4143	ZN-1400-2
Walls, Concealed	58790-20	4535	ZN-1445-1-A
Traffic Areas	56070	4240	Z-1420-27

C. All clean outs shall have a minimum diameter of 3 inches.

D. Stack cleanouts shall be installed at the base of each stack. Cleanouts shall be galvanized cast iron with ABS plastic cleanout plugs.

2.12 HOSE BIBBS AND HYDRANTS

A. **General:** All hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs "DO NOT DRINK," in clearly legible letters, and permanently attached at the hose bibb. Where indicated, hose bibbs shall be provided with vacuum breakers as furnished by **Crane Co., American Standard.**

B. **Manufacturers:**

Dwg. Callout	Fixture Type	Description
HB-1	Non-freeze wall-type	Heavy duty bronze hydrant with nickel-bronze face, hinged cover, recessed box, and key. Length to suit wall. 1. **Josam Mfg. Co., Series 71000** 2. **Jay R. Smith Mfg. Co., Fig. 5510/5511** 3. **Zurn Industries, Inc., Fig. Z-1300.**
HB-2	Hose valves	Size 3/4-inch, without cap and chain: 1. **Apollo (Conbraco Industries, Inc.) Model 70-804, or 78-104** 2. **Chicago Faucet No.7T** 3. **Ford Meter Box Co., Model B8H-233HB2** 4. **Woodford Manufacturing Co., Model Y24 or 24P**

2.13 SHOCK ABSORBERS

A. All cold and hot water piping in buildings connecting to self-closing faucets, quick-action valves, water closets, emergency showers, washers, and dishwashers shall be protected by shock absorbers located at each fixture or battery of fixtures. Shock absorbers shall be corrosion-resistant, permanently sealed, and shall be sized and installed to the manufacturer's printed recommendations.

B. **Manufacturers**

1. **Josam "SHOKTROLS"**

2. **Jay R. Smith "HYDROTROL"**

3. **Zurn, Model Z-1022**

2.14 WALL-MOUNTED HOSE RACKS

A. The CONTRACTOR shall provide wall-mounted hose racks at locations indicated. Racks shall be all welded steel construction, of minimum 8-gage sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of 3/4-inch or 1-1/2-inch hose. Where racks are located in the open, they shall be supported from two 2- by 2- by 1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.15 HOSES AND NOZZLES

A. The CONTRACTOR shall furnish the following lengths of hose:

3 - 75 ft lengths of 3/4-inch hose

B. Each length of hose shall be provided with male and female connectors and nozzle. Hoses shall be seamless extruded rubber with dacron cotton exterior designed for a working pressure of at least 200 psi.

C. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog. Nozzle material shall be polished brass. Nozzles shall have rubber bumpers.

D. **Manufacturers**

1. **W.D. Allen Mfg. Co., Illinois**

2. **Fire-End and Crocker Corp., New York**

3. **Halprin Supply Co., Illinois**

4. **Western Fire Equipment Co., California**

2.16 PAINTING

A. All ferrous metal, except finished, galvanized and machine surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09900 -

Architectural Finishes. Prime colors shall be compatible with finish coats to be applied in the field.

B. Self contained units such as wall-mounted hose racks shall be supplied with factory applied finish coats of baked enamel.

C. All field painting shall comply with Section 09900 - Architectural Finishes and Section 09800 – Protective Coatings.

PART 3 — EXECUTION

3.1 PREPARATION

A. The CONTRACTOR shall coordinate roughing-in with provisions for wall-and floor sleeves, pipe inserts, cutting of roof and floor penetrations so that drain lines will have the required invert elevations and slopes.

3.2 OPENINGS

A. **New Construction:** The CONTRACTOR shall provide all necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the buildings. All openings shall be as indicated on the Contract Drawings or as required to provide passage for the plumbing work.

3.3 INSTALLATION AND APPLICATION

A. The CONTRACTOR shall provide all plumbing specialties in accordance with manufacturer's printed instructions.

B. All pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

C. All pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.

D. All piping in buildings shall be as close to the ceilings or walls as possible unless indicated otherwise.

E. Screwed joints shall be made with joint compound and be tight and leakproof. A sufficient number of brass to ferrous metal seat unions shall be placed in lines so that any pipe, valve or piece of equipment may be easily disconnected.

F. All drainage and sanitary lines shall be properly run, trapped, and be vented to conform with Code requirements. All changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe. Changes in pipe size shall be made with reducing fittings. Minimum depth of cover shall be 3 feet.

G. Horizontal soil, drain and waste pipes shall be given a slope of at least 1/4-inch per foot unless indicated otherwise.

H. Floor drains and cleanouts shall be installed so the tops of the drains are flush with the finished floor.

3.4 EQUIPMENT - DAMAGE AND REMOVAL

A. The CONTRACTOR'S operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment which are to remain in the finished work. Any damage caused by the CONTRACTOR or SUBCONTRACTOR through their operations, shall be repaired by the CONTRACTOR to the satisfaction of the ENGINEER and at no additional cost to the OWNER.

3.5 TESTING

A. CONTRACTOR shall make such tests as are required by the local ordinances and codes in the presence of a local governing authority inspector to show that all piping is tight, leak free and satisfactory, and shall also perform such tests as the ENGINEER may direct to insure that all fixtures and equipment operate properly. The CONTRACTOR shall pay all costs in making such tests and the costs of making all changes or repairs until the WORK is acceptable to the governing authorities.

3.6 DISINFECTION

A. After potable water supply lines are tested, they shall be disinfected by introducing into the line HTH solution, liquid chlorine, or chlorine solution of sufficient strength. Then the line shall be filled with water and maintained under not less than 10 pounds per square inch pressure, for not less than 48 hours, during which period all valves on the lines shall be opened and closed several times, after which it shall be flushed clean, and then tested by the OWNER. This procedure shall be repeated as often as necessary until the line is pronounced safe for use, by the OWNER. No cross connection between the water mains and any pipe not yet disinfected will be permitted.

- END OF SECTION –

SECTION 15440 - PLUMBING FIXTURES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide plumbing fixtures, complete and operable, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Show material type, material thickness, sinks, counters, splashes, drawers shelves, legs, frame, supports, and anchors or fasteners for the counter sink unit.

PART 2 — PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be of the latest design, new, first-quality products, manufactured for the intended usage, and shall be compatible with elements of related or connected WORK.

B. Plumbing fixtures shall be without flaws and with white finish unless otherwise indicated. Exposed brass, faucets, valves, wastes, traps, piping, and escutcheons shall be chrome-plated. Each fixture shall be provided with individual stops and shall be anchored firmly to the building wall or floor. Softeners, water heaters, and lab equipment shall have drains and isolating valves on each side.

2.2 FIXTURE SCHEDULE

Dwg. Callout	Fixture Type	Description
MS	Mop Sink	Floor-mounted mop sink of porcelain-enameled cast-iron, with integral back, size 28 x 28-inch with rim guard, drain channels; 3-inch outlet with "P" trap and stainless steel strainer; and chrome-plated service sink faucet with vacuum breaker, hose, and hose bracket.
EW-1	Eye-Face/Wash Fountain	Stainless steel bowl, pipe (pedestal)-mounted; with push-type ball valve, chrome-plated twin heads with spray head covers, face ring and flow control. **HAWS Model 7461; Bradley Corp., Model S19-210X.**
EW-2	Eye-Face/Wash Fountain (non-freeze type)	Stainless steel bowl, pipe (pedestal)-mounted; with hand-operated, non-freeze valve, crome-

plated twin heads with spray head covers, and face ring or heads, **HAWS Model 7461-FP; Bradley Corp., Model S19-210HFP.**

2.3 MANUFACTURERS

A. Unless indicated otherwise, fixtures shall be:

1. **Crane Co.**
2. **Kohler**
3. **American Standard**

PART 3 — EXECUTION

3.1 INSTALLATION

A. Each fixture shall be installed with trap, easily removable for servicing and cleaning, and be vented in accordance with the applicable plumbing code.

B. The CONTRACTOR shall provide chrome-plated rigid or flexible supplies to fixtures with angle stops, reducers, and escutcheons.

C. All components shall be installed level and plumb. Supplies and wastes shall be centered on or between the wall tiles.

D. Fixtures shall be sealed to wall and floor surfaces with sealant as indicated in Section 07920-Sealants and Caulking. Color shall match fixture.

E. All fixtures shall be mounted to the following heights above finished floor:

Emergency Eye And Face Wash:

Standard	38 in.	(965 mm) to receptor rim
Handicapped	34 in. (max)	(864 mm) to receptor rim
Handicapped	27 in.	(686 mm) to spray head

Emergency Shower:

Standard	84 in.	(2130 mm) to bottom of head
Handicapped	48 in. (max)	(1220 mm) to pull handle

3.2 ADJUSTING AND CLEANING

A. Stops or valves shall be adjusted for intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion, the CONTRACTOR shall clean all plumbing fixtures and equipment.

C. Water closets shall be solidly attached to floor or wall carrier with lag screws. Lead flashing shall not be used to hold fixture in place.

- END OF SECTION -

PART 1 – GENERAL.

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install gas and electric water heaters, circulating pumps, tempering tank and other plumbing equipment as shown, complete with water, gas, and/or electric connections and hook-ups for a complete and operable installation as specified herein and in accordance with the requirements of the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.3 GENERAL

A. All plumbing piping, fixtures, specialties, equipment, and appurtenances shall be new, first-quality products manufactured for the intended usage. Materials, capacities, features, finishes, and manufacturers shall be as specified herein and shall be compatible with elements of the work to which they relate or connect.

PART 2 —PRODUCTS

2.1 ELECTRTIC WATER HEATERS

A. **General:** Electric water heaters shall be furnished as shown, complete with electric, cold and hot water connections; 3/4-inch drain and valve piped to drain; 3/4-inch (min) temperature and pressure relief valve, piped to floor sink or drain; and aquastat. The tank shall be of welded steel construction for a working pressure of not less than 150 psi, with glass-lining, minimum 1-inch fiber glass insulation, enameled steel jacket, and feet. The burners shall be of the electric immersion type. The tank shall be protected against premature failure in the following ways:

1. Against electrolytic corrosion by conveniently located, easily replaceable magnesium anode rod.

2. Against failure due to overheating caused by the build-up of scale, film and other sediment, by a construction which incorporates an annular ring which fits inside the tank at the base. The ring shall be equipped with a group of calibrated jets, properly positioned so that they will direct the inlet water in such a way that particles of sand, silt or scale present in the water shall be burned and agitated, kept in suspension, and carried out of the water heater on that or on succeeding water draws.

B. ELECTRIC WATER HEATER MANUFACTURERS

1. **State Industries, Inc.;**

2. **A.O. Smith;**

3. **Rudd.**

PART 3 — EXECUTION

3.1 WATER HEATER INSTALLATION

A. The CONTRACTOR shall install water heaters in accordance with manufacturer's printed instructions.

B. Tank shall be cleaned and flushed prior to delivery to site and after installation. All openings shall be sealed until pipe connections are made.

- END OF SECTION -

SECTION 15500 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all heating, ventilating, and air conditioning systems and equipment complete with all supports, mounting frames, ventilators, ductwork, piping, louvers, panels, filters, grilles, electric drive units and controls, mechanical equipment, electrical work, appurtenances, testing and balancing, ready for operation as shown and specified herein, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Codes:** All codes, as referenced herein, are specified in Section 01090 – Reference Standards.

B. All work and materials shall be in full accordance with the latest rules and regulations or publications of the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning systems), the local Plumbing Code, the local Building Code, and all other local codes. Nothing in the Contract Documents shall be construed to permit work in violation of the above codes, rules and regulations. In the absence of applicable codes, the installation and workmanship shall follow the standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** Shop drawings shall be submitted for all equipment and for all specified heat tracing in accordance with Section 01300 - Contractor Submittals.

B. **Equipment Numbers:** Equipment is identified by assigned numbers for reference and location purposes in the Contract Documents. The appropriate equipment numbers shall be indicated on the Shop Drawings and on other submittals by the CONTRACTOR.

C. **Fan Curves:** Certified fan curves for each fan are required.

1.4 WARRANTY

A. The air conditioners, heaters, and all fans, ventilators, grilles, etc., furnished and installed by the CONTRACTOR shall carry the manufacturer's standard warranty, and all such warranties shall be furnished to the ENGINEER upon final acceptance of the completed systems by the OWNER. All refrigerant compressors shall carry a 5-year warranty by the manufacturers.

PART 2 – PRODUCTS

2.1 GENERAL

A. **Quality:** All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be of the manufacturer's top line, industrial-commercial grade.

B. **Supports:** All equipment and appurtenances shall be firmly anchored or connected to supporting members. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided by the HVAC CONTRACTOR, unless otherwise shown. Equipment shall be supported on restrained spring-type vibration isolators.

C. **Noise/Vibration Control:** The system shall be free of any objectionable vibrations and noise. Flexible connections shall be provided in all ducts and piping connections to fans, compressors, and any other vibrating equipment.

2.2 MOTORS

A. All motors supplied for equipment shall conform to the latest IEEE and NEMA requirements for mechanical and electrical characteristics including service factors. In addition, motors shall meet the requirements of Section 16460 – Electric Motors. Each motor shall bear the manufacturer's nameplate with complete motor data. Each motor shall be of ample size and construction to carry continuously all loads which might be imposed by the piece of equipment it drives throughout the full range of operation of the equipment and the maximum motor loading shall in all cases be less than or equal to the nameplate horsepower rating, exclusive of the service factor.

2.3 ELECTRICAL WORK

A. The HVAC CONTRACTOR shall furnish and install all controls, sensors and control panels relating to the HVAC systems including starters, thermostats, motorized dampers and louver operators and as indicated, and shall install all control wiring of 120 volts and less under this Section, but shall meet the requirements of Division 16 – Electrical. Local power disconnects, where required, shall be installed by the ELECTRICAL CONTRACTOR.

B. The ELECTRICAL CONTRACTOR under Division 16 – Electrical, shall install all circuit breakers, all starters in motor control centers, all 120, and 480 volt power feeders from starters and circuit breakers to the HVAC equipment shown on the Contract Drawings. Equipment locations on the Electrical Drawings are shown for reference only and actual locations are shown on the HVAC Contract Drawings.

C. All starters whether as an integral part of the equipment or as a separate part shall meet the specifications as given in Section 16480 – Low Voltage Motor Control Centers. Enclosures shall be of the same NEMA class as the electrical equipment in that area and all starters shall be of the same manufacturer as starters specified under Section 16480 – Low Voltage Motor Control Centers.

D. All low voltage control wiring shall be in accordance with the National Electric Code. All control wiring for line voltage 120 volts and higher shall conform to Section 16120 – Wires and Cables.

E. Details of individual control panels shall be similar to those shown on Electrical Drawings. Control Panels shall conform to Section 16485 – Local Control Panels and Misc. Electric Devices.

F. CONTRACTOR to note that all conduit in this Section shall conform to that specified in Sections 16110 – Electrical Raceway Systems, and 16111 – Underground Raceway Systems.

2.4 FIRE ALARM AND DETECTION SYSTEM

A. The CONTRACTOR shall furnish and install a complete, electrically supervised, non-coded, 24-volt DC, 2-wire automatic, fire alarm system as described herein. Operation shall be such that actuation of any automatic smoke detector shall cause building alarm devices to sound, and designated HVAC equipment to shut down. The smoke detector shall be of the type that is either automatic resetting or is reset from a remote control panel.

2.5 FLASHING

A. All equipment that passes through roofs of buildings or structures will be provided with proper flashing in accordance with the specifications and as indicated on the Contract Drawings. The flashing shall comply with Section 07600 – Flashing and Sheet Metal of this Specification.

2.6 PIPE AND FITTINGS

A. All piping and fitting material used in the fulfillment of this Contract shall be new and the best of its respective class.

B. The extent of all piping work is shown on the Contract Drawings. All refrigerant piping shall be type L hard temper copper with cast brass fittings. Provide a drain at all low points in piping system.

C. All copper and steel pipe and fittings shall meet the specifications for Section 15010 – Mill Piping – Exposed and Buried, insofar as it applies. All joints in refrigerant piping shall be made with silver solder.

2.7 INSULATION (PIPING/DUCTWORK)

A. All refrigerant piping, supply, and outside air ductwork shall be insulated under this Section in accordance with the specifications and as shown on Contract Drawings.

B. The insulation shall comply with Section 15145 Pipe, Ductwork and Equipment Insulation of these Specifications.

2.8 HANGERS AND SUPPORTS

A. The CONTRACTOR shall provide all necessary hangers, supports, concrete inserts, anchors and guides for material and equipment to be installed in this Contract.

B. No perforated strap hangers and no wire supports will be permitted.

C. Hangers supporting insulated pipe shall be sized to fit the pipe plus the insulation. The insulation at support points shall be provided with metal shield to prevent damage to insulation.

D. Anchors and guides shall be built of steel.

E. Pipe hangers used to support uninuslated copper piping shall be copper plated.

F. Hangers for ductwork and equipment shall be in accordance with the details shown on the Contract Drawings and also in accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

G. All inserts shall be galvanized.

2.9 PIPE SLEEVES

A. The CONTRACTOR shall examine the Contract Drawings carefully for all sleeves that are to be built into the construction and plan his work accordingly, so that sleeves are placed well in advance of construction work, and care taken with their location and support until encased.

B. Sleeves shall be standard weight galvanized steel pipe for dry interior installation. Sleeves for exterior or wet installation shall be standard weight ductile black steel, stainless steel, or standard weight PVC for pipe temperatures below 120 degrees F.

C. All sleeves shall be sized one pipe size larger than uninsulated piping and one pipe size larger than piping plus insulation on insulated pipe.

D. Where pipes pass through floors, sleeves shall extend three inches above finished floor. Where pipes pass through walls, sleeves shall be flush with wall.

2.10 ALUMINUM DUCTWORK

A. The CONTRACTOR shall furnish and install ductwork as shown on the HVAC Contract Drawings.

B. All low pressure ductwork shall be designed for 3 inches vacuum and pressure and be constructed of sheet aluminum of not less than eighteen gauge where the largest dimension of a duct is twelve inches or less in width or diameter, and not less than sixteen gauge for widths or diameters larger than 12 inches. Gauge designations refer to Brown and Sharpe Standards. Ductwork sheets, unless otherwise specified, shall be of Aluminum Association Alloy 3003-H14.

C. Ductwork shall be air tight and well braced. It shall be carefully supported in horizontal runs with rod and angle supports at no greater than 8 feet intervals. Ductwork shall be run as close as possible to the layouts as shown on the Drawings. Vertical aluminum ductwork shall be adequately guided and shall be firmly supported by standard framing angles of Aluminum Alloy 6061-T6.

D. All seams shall be double locked. Rectangular ducts with longer than a 12 inch dimension shall have full perimeter standing seams not less than 1 inch high. Reinforcements shall be at intervals of not greater than 30 inches along the duct. No "S" seams will be permitted.

E. Except where permitted by the ENGINEER, fan discharge connections and ductwork reductions shall have duct side slopes not to exceed 30 degrees.

F. Radius of bends shall be not less than 1½ duct diameters, unless otherwise shown. All mitered elbows and extractors on supply air ductwork, shall have turning vanes as shown on the Contract Drawings.

G. Care shall be taken to properly insulate aluminum duct and supports from concrete or dissimilar metals by an applied bituminous coating or by rubber gaskets at all contact points.

H. **Access Doors:** Access doors shall be provided in the ductwork at all fire dampers, motorized and back draft dampers, filters and as shown on the drawings. They shall be continuously hinged, double skinned, of either 22 gage galvanized steel or 20 gage aluminum to match the ductwork material, with one cam lock for sizes up to 16 inches square or two cam locks for sizes over 16 inches square, must match insulation thickness in door with ductwork insulation and have foam sealing gaskets on all four sides. Access doors shall be **Ruskin SMACNA Standard Duct Access Doors.**

I. Flexible duct may be used to attach air outlets to duct banks when outlets are fitted in a finished ceiling. Flexible duct shall be insulated. Maximum length of flexible duct shall not exceed 10 feet. Materials joining and supporting of flexible duct shall be in accordance with the latest edition of SMACNA.

J. **Flexible Connections:** Equipment shall be attached to ducts through approved flexible connections to facilitate removal of the units and for sound isolation. Flexible connections consisting of heavy duct canvas or woven glass fabric silicon coated shall be provided. Canvas connections shall be a heavy cotton impregnated for waterproofing and fire retardant. Glass fabric shall be used where temperatures exceed 200 degrees F. Weight of Canvas shall be 20 ounces Per sq. yd. Weight of glass fabric shall be approximately 12 ounces. per sq. yd.

2.11 MOTORIZED DAMPERS

A. CONTRACTOR shall furnish and install the motorized opposed blade dampers as shown on the Contract Drawings.

B. The damper and frames shall be of minimum aluminum B & S 12 gauge. Aluminum blades shall have interlocking edges with one center and two edge crimps, and brass bearings. The frame shall be welded channel construction with lugs and mounting brackets for damper operators. Dampers shall have felt or rubber seals at edges to minimize air infiltration, when closed.

C. Damper motors shall be electric with necessary linkages for positioning the damper blades. Damper sizes and capacities shall be as called for on the Contract Drawings. The motors shall be powered open and spring closed except as noted.

2.12 BACKDRAFT OR GRAVITY DAMPERS

A. Furnish and install gravity (Backdraft) dampers on the exhaust fans and ventilators where called for on the Contract Drawings. Dampers shall be multi-blade, with soft seating gaskets for minimizing noise and air leakage when closed. The blades shall be constructed of 16 gauge aluminum, and be of air foil design. Frames shall be 16 gauge extruded aluminum alloy. The frames shall be totally out of the air stream, and arranged for flange mounting.

B. Dampers shall be **Air Balance, Inc.; Air Dynamic; or Ruskin Model BD2A1**, and shall be designed to operate at 0.05 inch w.g. S.P. or less. Blades shall be individually counter balanced and shall have non-ferrous pins turning in nylon bearings. Damper sizes and capacities shall be as called for on the Contract Drawings.

2.13 VOLUME CONTROL DAMPERS (MANUAL AND MOTORIZED)

A. Furnish and install volume control dampers in accessible locations in branch supply ducts and at each exhaust air opening to properly regulate the volume of air delivered or withdrawn from each inlet and outlet and as indicated on the Drawings.

B. The volume dampers shall be of the opposed blade type and be constructed of aluminum B & S fourteen gauge, suitably reinforced with sturdy control shafts. Ductwork shall be reinforced to double thickness at damper shaft openings.

C. The volume control dampers of the air extractor type as indicated on the Drawings shall be constructed of stainless steel, 20 gauge for frames and 24 gauge for blades.

D. No splitter dampers will be allowed. All manual control dampers shall have provisions for adjustment and locking in position after being set.

E. Damper motors shall be [electric] [pneumatic] with either modulating or two positioning control and necessary linkages. Damper sizes and capacities shall be as called for on the Contract Drawings. The motors shall be powered open and spring close except as noted.

2.14 FIRE DAMPERS

A. Furnish and install fire dampers in ductwork at all floor penetrations and all fire rated wall penetrations where shown or not on the Contract Drawings. Fire dampers to be of the fusible link type and have Underwriter's approval.

B. Fire dampers shall be 1½ hour **Ruskin FD35**. The units shall be arranged for horizontal or vertical mounting, and be provided with a 165 degree F.fusible link.

C. Furnish and install an end switch on fire dampers to signal fire alarm and de-energize fan motors in the event of a fire.

D. Fire dampers shall be in accord with the codes of the State of Kentucky and the provisions of the NFPA Bulletin 90A.

2.15 REGISTERS, GRILLES AND DIFFUSERS

A. Furnish and install all supply and return registers and grilles and all supply diffusers as shown on the Contract Drawings. The sizes, capacities, and deflection of each unit shall be as shown on the Contract Drawings.

B. **General:** The following schedule shall be followed for all units:

1. Supply Diffusers (SD): **Titus Model TMS-AA with optional dampers or Metalair.**

2. Return Grilles (RG): **Titus Model 50-F or Tuttle and Bailey**; with ½" x ½" x ½" aluminum grid and no dampers.

3. Supply Registers (SR): **Titus Model 272FL or Tuttle and Bailey; with opposed blade dampers.**

C. All registers, grilles and diffusers are to be constructed of aluminum. Finish to be a white baked-on enamel. Accessory equipment shall be aluminum, or if not available, steel with a white baked-on enamel. The proper border style shall be selected by the CONTRATOR to suit the installation conditions.

D. All registers, grilles and diffusers located in corrosive atmospheres as indicated on the Drawings shall be painted with a special protective coating. See Section 09900 – Painting.

2.16 FLAT AIR FILTERS

A. **General:** The flat air filters used in the air handling units, packaged and split air conditioning units, and the electric heat pumps shall be 1 inch thick throw-away type supplied as an integral part of each unit.

B. Provide three complete spare filter changes for all flat filters in all units, plus provide one new filter set in each unit at time of turning units over to the OWNER. Filters used in the units during construction are <u>not</u> included in the above, these filters are additional ones that shall also be furnished by the CONTRACTOR.

C. The flat air filters shall be one inch thick throw-away type made of an adhesive coated fiber media and rated at 300 fpm face velocity, 0.04 inch wg initial resistance and a 0.50 inch wg recommended final resistance. The filters shall be by **Airguard Industries; Farr Co.; Snyder General Corp.**

2.17 WALL LOUVERS

A. Furnish and install wall louvers as hereinafter specified, and where shown on the Contract Drawings. Louvers shall be Adjustable Type and Fixed type as called for with a drain gutter in each blade and downspouts in jambs and mulllions. All louvers shall be furnished with extended sill. Stationary blades and adjustable blades shall be contained within a single 6" louver frame. Adjustable section shall include low leakage blade and jamb seals. Louver components (heads, jambs, sills, blades & mullions) shall be factory assembled by the louver manufacturer. Water stop at sill shall be factory caulked watertight.

B. Adjustablel Type shall be **Ruskin Model ELC 6375D**. Fixed Type shall be **Ruskin Model ELF 6375D**, with extruded 6063T5 aluminum alloy construction as follows:

1. Frame: .125" wall thickness, box type.

2. Blades: Stationary section and adjustable center pivoted section .125" wall thickness. 37½ degree angle on approximate 4½" centers.

3. Operator: Electric Type furnished with louver, 120 volts max.

C. Published louver performance data bearing the AMCA Certified Ratings Seal for Air Performance & Water Penetration must be submitted for approval prior to fabrication and must demonstrate pressure drop and water penetration equal to or less than the model specified.

D. Louvers shall be complete with aluminum bird screen and all necessary linkages for operating section. Size and capacities shall be as called for on the Construction Drawings.

E. Louvers shall be furnished with clear anodized finish.

2.18 VIBRATION ISOLATORS

A. Vibration control isolation shall be provided for all rotating equipment, except electric motors. Where rotating units are part of factory assembled package units, such as a package air handling unit, the isolator shall be provided under the unit casing.

B. All suspended equipment shall be supported by combination spring and fiberglass isolation hangers, incorporating minimum two inch thick neoprene jacketed fiberglass inserts in series with springs, all encased in steel brackets.

C. All floor mounted or platform mounted built-up or package air handling units shall be mounted on structural steel or concrete bases with isolator springs and brackets.

D. All springs used in the vibration isolators shall have approximately one inch deflection under load and shall have a minimum additional travel of 50 percent between the design height and the solid height. All isolation equipment shall be provided and installed in strict compliance with the manufacturer's recommendations.

E. For vibration isolation between HVAC equipment and supports and where indicated on the Contract Drawings, 3/4 inch thick rubber pads shall be used for full contact between equipment and support. The pads shall be as manufactured by **Mason Industries or Super W Pads.**

2.19 AIR CONDITIONING UNIT - SPLIT SYSTEM

A. Furnish and install, where shown on the Contract Drawings, a split system air conditioning unit. Indoor unit shall be single-packaged vertical type and shall include provisions for connection of the remote, air-cooled condenser.

B. Compressor shall be welded hermetic type and equipped with suitable vibration isolators, crankcase heaters, filter drier and shall be located in a sound attenuating compartment within the cabinet. Power input to the compressor motor shall not exceed 7 kw at the conditions specified. Compressor shall be of the same manufacturer as the unit.

C. Condensing unit shall consist of: coil, with integral sub-cooling, supporting casing with stand, and wind deflector. Coil shall be constructed of aluminum plate fins on expanded copper tubes, cleaned, dehydrated, sealed, leak tested at 150, and pressure tested at 420 psig. Casing shall have Weather Armor baked enamel finish. Access panels shall be provided for electrical connections.

D. Fan shall be direct drive, propeller type, protected by guards. Motor shall be permanent split capacitor type. All motors shall be pre-lubricated, with built-in overload protection. Fan shaft shall be corrosion protected. Fan blades shall have iridite or aluminum furnish. A magnetic contractor shall be field supplied for all condensers.

E. Controls shall be factory wired to operate on 24-volt, single-phase, 60 Hz power supply. A factory-mounted multi-position switch will control the unit for continuous fan and cooling operation. Units shall have a 24-volt control circuit suitable for connection to the 24-volt remote room thermostat. Compressor protection shall include high- and low-pressure switches, current lockout and inherent over-temperature protection. A condenser fan interlock shall be included. Units shall include evaporator defrost thermostat to provide coil freeze-up protection under low-ambient conditions. Condenser fan cycling control shall be provided with a control to cycle fan in response to outdoor ambient temperature. Motormaster type solid state head pressure control shall be provided with a solid state control for variable fan speed to maintain a 100°F condensing temperature. The control enclosure shall be weathertight and shall have Weather Armor finish.

F. Evaporator coils shall be of nonferrous construction with aluminum plate fins mechanically bonded to seamless copper tubing and shall be fed by the thermostatic expansion valve.

G. Evaporator air fan shall be capable of delivering the proper CFM of air at an external static pressure as indicated on the Contract Drawings. Evaporator air fan shall be centrifugal forward curved and belt driven by a motor operating at 1725 RPM. On leaving air provide a 10 KW manufacturers Standard Electric Heating Accessory Unit.

H. Cabinet shall be zinc surface alloyed steel with is bonderized and painted with a polyester enamel. Unit sections shall be insulated to prevent sweating and to muffle sound. A self-contained filter frame for use of standard 1 inch throwaway filters shall be located inside of cabinet. Filters shall be factory supplied.

I. Hot gas and liquid line shutoff valve shall be provided to connect remote, air-cooled condenser coil. Unit shall be shipped with a holding charge.

J. Air conditioner shall be manufactured by **York; Trane; Carrier or McQuay.** Both condensing unit and indoor evaporator shall be by the same manufacturer.

2.20 PROPELLER WALL FANS

A. Furnish and install panel mounted belt driven, propeller wall fans as shown on the Contract Drawings.

B. The propeller fans shall be , belt driven with an aluminum blade, a spun steel venturi mounting panel, a steel wire guard and motor mount with resilient anti-vibration pads at mounting points with panel. The propeller blade shall be statically and dynamically balanced. The fans shall be complete with gravity shutters, wall mount housing, bird screen, motor side guard, externally mounted disconnect switch and weather hood.

C. **Fan manufacturers:**

1. **Greenheck;**

2. **Aerovent;**

3. **Penn.**

2.21 INLINE EXHAUST FANS

A. Furnish and install duct mounted fans of the centrifugal direct drive in-line type as shown on the Contract Drawings

B. The fan housing shall be of the square design construction of heavy gauge galvanized steel and shall include square duct mounting collars and removable access panels. The fan wheel shall be centrifugal backway inclined, aluminum construction and include a wheel cone matched to the inlet cone. Motor shall be heavy duty ball bearing type mounted out of the airstream and be provide with belt guards.

C. **Fan manufacturers:**

1. **Greenheck,**

2. **Cook.**

2.22 CEILING PADDLE FANS

A. Furnish and install the ceiling paddle fans as shown on the contract Drawings.

B. The paddle fans CPF-1 through CPF-8 shall be 120 volt, 1 phase, 56 inch blade sweep, each with its own variable speed motor controller and complete with hardware including secondary support cable. The paddle fans shall be manufactured by **Leading Edge, Inc. Model # 5600 – 1.**

2.23 UNIT HEATERS

A. Unit heaters shall be of the horizontal or vertical type as shown on the Contract Drawings, complete with motor, fan, wire guard, heating element, casing, vibration isolators and support brackets.

B. Fan casings shall be steel reinforced to provide a suitable support for the heating element and for attachment of the support brackets. Casings shall be finished with factory finish. All units shall be provided with their own wall mounting brackets.

C. Fans shall be multi-blade propeller type units direct connected to the motor shaft and/or centrifugal fan and motor units all statically and dynamically balanced

D. Motors shall be especially designed for unit operation. Fan shafts shall be equipped with self-aligning ball or roller bearings and shall extend a sufficient length to received the fan hub. The fan shall be keyed and locked to the fan shaft. Fan and motor unit shall be mounted on vibration isolators to prevent noise.

E. Electric heating bank shall consist of metal sheath aluminum-finned heating elements. Automatic reset thermal over-heat protection shall be of the linear capillary type wired for instantaneous de-energizing. Heating bank to have protective air inlet louvers. Units shall be U.L. listed and meet the requirements of the National Electric code.

F. Low voltage control transformers shall be furnished.

G. All heaters shall be provided with power disconnect switches (field installed kits) and a built-in thermostat

H. The heaters shall be manufactured by **Reznor; Chromalox.**

2.24 TEMPERATURE AND EQUIPMENT CONTROL

A. The CONTRACTOR shall design, furnish and install a complete electric-electronic system of automatic temperature control as specified herein. The system shall be designed and furnished by **Johnson Controls; Honeywell.**

1. After completion of the installation, the automatic temperature control manufacturer shall adjust all thermostats, sensors, in the motors and other equipment provided under this contract with trained personnel in the direct employ of the temperature control manufacturer. He shall place them in complete operating condition subject to the approval of the ENGINEER, and instruct the operating personnel in the operation of the control system.

2. The control system as specified herein shall be guaranteed free from defects in workmanship and material under normal use and service for a period of one year after acceptance of the ENGINEER. Any equipment herein described proves to be defective in workmanship or material during the guarantee period shall be adjusted, repaired, or replaced by the automatic control manufacturer at no charge to the OWNER.

3. All wiring incidental to the temperature control system including electrical interlock shall be provided by the TEMPERATURE CONTROL CONTRACTOR.

4. Detailed wiring diagrams along with necessary supervision shall be provided by the TEMPERATURE CONTROL CONTRACTOR.

5. All control wiring (line voltage or low voltage), required to complete the temperature control system (by interconnecting starters, thermostats, PE switches, relays, and like devices) shall be installed by the TEMPERATURE CONTROL CONTRACTOR, but in accordance with Section 16050 - Electrical Work - General of this Specification.

6. All thermostats, controllers and amplifiers shall be suitable for the applications in which they are used.

7. Electric actuators for louvers shall be sized with sufficient reserve power to provide two position power as required.

8. All H.O.A. (Hand-Off-Auto) switches shall be furnished and installed by the TEMPERATURE CONTROL CONTRACTOR, but in accordance with Section 16485 Local Control Panels and Misc. Electrical Devices.

9. The control manufacturer shall furnish all two-position relays, capacity relays, sequencing relays, plus all other controls necessary to meet the specifications and provide for properly operating automatic control system. All electric switches and relays must be UL listed and of a type to meet the current and voltage requirements of the particular application.

B. CONTROL PANELS

1. **General:** Control panels shall contain all relays, control switches, transformers, pilot lights, timers, time clocks, step controllers, gages, thermostats (unless otherwise shown), and other accessories necessary for the particular system. Panels shall be aluminum with baked enamel finish, hinged front door, and locking handle. All manual switches and direct-reading gauges shall be flush-mounted on the front face, identified by engraved and riveted Bakelite or laminated plastic nameplates with white letters on black background. Manual switches shall be of heavy-duty, oil-tight construction.

2. **Wiring:** Control devices shall be prewired internally. All wires leaving the panel shall be terminated at separate numbered terminal strips. Individual connectors shall be provided for every item of mechanical equipment, all integral and remote pilot lights, and other devices described for each panel. Power and control circuit requirements shall be as shown on the Electrical Drawings. All wires shall be identified by color coding or numerical tags at both ends. Each control device shall be wired without splices to the terminal strip. Integral circuit protection shall be provided for all panel-mounted control devices. Each panel shall be wired with a single 20-amp, 120-volt, ac feeder in accordance with Section 16485 - Local Control Panels and Misc. Electrical Devices.

3. **Diagrams:** Panel electrical wiring diagrams shall be secured to the inside of the panel door.

C. SEQUENCE OF OPERATION

1. **Pump Room**

   a. Winter Heating shall be provided by electric unit heaters EUH-1 to EUH-6 and each controlled by its own built-in thermostat set at 65 degrees F. (adjustable).

   b. Summer ventilation shall be provided by exhaust fans EF-1 and EF-2 and each controlled by a H-O-A switch and ventilation high-low controller. In the "H" (hand or manual) position, and ventilation controller in low, each fan shall start on low and run continuously and louvers L-1 to L-3 shall open. If the controller is in high position, the fan shall go to high speed and run continuously and Louvers L-1 to L-3 shall open. In the "O" (off) position, the fans shall stop and the louvers shall spring close. In the "A" (automatic) position the fans shall be controlled by its own remote, two-stage thermostat. When the room's temperature reaches 80 degrees F, the fans shall start in low speed and run continuously and Louvers L-1 to L-3 shall open. When the rooms temperature rises to 85 degrees F, the fans shall go to high speed and run continuously. When the room's temperature falls to 75 degrees F, the fans shall stop and the Louvers L-1 to L-3 shall spring close.

c. Ventilation shall also be provided by ceiling paddle fans CPF-1 through CPF-8 and each shall be controlled by a variable speed solid state motor speed controller mounted in a control panel.

d. If either of the two smoke detectors located on the ceiling is activated, exhaust fan EF-1&2, and ceiling paddle fans CPF-1 through 8 shall stop, louver L-1,2 and 3 shall spring close, electric unit heaters EUH-1 through EUH-6 shall be deactivated, a local alarm shall sound and a signal shall be sent to the RTU.

2. **Electrical Room**

a. The heating, cooling and ventilation shall be provided by Air Conditioning Unit AC-1 and controlled by an adjustable remote thermostat with automatic summer winter change over set at 70 degrees for the winter and 75 degrees for the summer. In-line Fan SF-1 shall work in conjunction with the circulating fan at AC-1.

b. If the smoke detector located on the ceiling is activated, Air conditioning Unit, AC-1 and inline supply fan SF-1 shall stop, louver L-4 shall spring close, a local alarm shall sound and a signal shall be sent to the RTU.

2.25 PAINTING

A. Painting of the equipment and materials shall comply with Section 09900 Painting.

B. The CONTRACTOR shall include the painting of factory paint surfaces that are rusted and/or scratched. These finishes shall be cleaned to bright metal, primed with a corrosion inhibitor and finished with a paint and/or enamel to match original finish.

PART 3 — EXECUTION

3.1 GENERAL

A. **Openings - New Construction:** The CONTRACTOR shall provide all necessary openings in walls, floors and roofs for the passage of heating and ventilating equipment in the buildings. All openings shall be as indicated on the Contract Drawings, or as required to provide passage for heating and ventilating work.

1. No extra compensation shall be given for defective or ill-timed work.

2. The CONTRACTOR shall provide all hanger and support inserts into masonry or structural steel as required for proper completion of the work.

3.2 INSTALLATION OF PIPING

A. **Drain Piping:**

1. Install valve-drain piping where valves are equipped with drain connection, fabrication from type L copper tube and solder-joint drainage fittings.

2. Install piping system and equipment drains fabricated from copper tube with solder-joint fittings, or from black steel piping with fittings as indicated.

3. Install drain piping at the low points of supply and return piping, at abrupt changes in vertical offsets in horizontal runs, and in piping at mechanical equipment including pumps.

4. Extend drain piping to nearest drain.

3.3 BALANCING AND TESTING

A. **General:** After the installation work is complete, the CONTRACTOR shall make all necessary adjustments of volume controllers, exhaust blowers, exhaust fans, supply blowers, supply and return registers, air conditioning units and heating units. The CONTRACTOR shall provide all labor, tools, testing equipment and appliances for the necessary testing and adjustment required.

1. The CONTRACTOR shall use the services of an independent BALANCING SUBCONTRACTOR to perform the work of balancing the system.

2. The BALANCING SUBCONTRACTOR shall be one who has at least five years of balancing experience with experience in at least five projects of this type. The CONTRACTOR shall forward to the ENGINEER an experience resume and project resume for approval of the BALANCING SUBCONTRACTOR.

3. The BALANCING SUBCONTRACTOR shall not be associated with any firms doing engineering and/or construction work in HVAC and/or Plumbing.

4. The BALANCING SUBCONTRACTOR shall use the balancing methods approved by the Associated Air Balance Council.

5. The BALANCING SUBCONTRACTOR shall send a copy of all correspondence and reports, as they are written, pertaining to this project, directly to the ENGINEER.

B. The CONTRACTOR shall demonstrate to the OWNER, in an extensive operating test covering every component of the installation, that the entire heating, ventilating and air conditioning system meets the requirements of the Contract Drawings and Specifications and is in first class condition and ready for continuous, satisfactory operation. Any repairs and revisions necessary to make the system operative shall be done by the CONTRACTOR at no additional cost to the OWNER.

- END OF SECTION –

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide electrical work, complete and operable, in accordance with the Contract Documents.

B. All equipment and systems shall be Year 2000 compliant and shall be able to accurately process date data (including but not limited to calculating, comparing, and sequencing) from, into, and between the 20th and 21st centuries; the years 1999 and 2000, and leap year calculations. Successful operation and calculation shall be demonstrated during factory testing and facility startup and testing. Any system failing such testing will be considered defective and shall be upgraded, re-programmed, or replaced until it passes the test, at no increased cost to the OWNER.

C. The provisions of this Section apply to all sections in Division 16, except as indicated otherwise.

D. The WORK of this Section is required for operation of electrically-driven equipment provided under specifications in other Divisions. The CONTRACTOR's attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment specifications, the WORK of instrumentation sections, and the WORK of Section 16460-Electric Motors.

E. All concrete, excavation, backfill, and steel reinforcement work required for encasement, installation, or construction of the work of the various sections of Division 16 is included as a part of the work under the respective sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

1.2 REFERENCE STANDARDS

A. The WORK of this Section and all sections in Division 16 shall comply with the following as applicable:

NEC (NFPA 70)	National Electrical Code
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)

B. All electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 FR 1926, as applicable), state building standards, and applicable local codes and regulations.

D. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1.3 PERMITS AND INSPECTION

A. Permits shall be obtained and inspection fees shall be paid according to Section 00700 - General Conditions.

1.4 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop drawings shall include the following:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for all grounding work not specifically indicated.
3. Front, side, rear elevations and top views with dimensional data.
4. Location of conduit entrances and access plates.
5. Component data.
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers.
7. Method of anchoring, seismic requirements; weight.
8. Types of materials and finish.
9. Nameplates.
10. Temperature limitations, as applicable.
11. Voltage requirement, phase, and current, as applicable.
12. Front and rear access requirements.
13. Test reports
14. Grounding requirements
15. Catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material. Catalog data sheets shall be stamped to indicate the project name, applicable Section and paragraph, model number, and options. This information shall be marked in spaces designated for such data in the ENGINEER's stamp.

C. Shop drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from shop drawings.

D. **Materials and Equipment Schedules:** The CONTRACTOR shall deliver to the

ENGINEER within 30 days, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

E. **Owner's Manuals:** Complete information in accordance with Section 01300.

F. **Record Drawings:** The CONTRACTOR shall show invert and top elevations and routing of all duct banks and concealed below-grade electrical installations. Record drawings shall be prepared, be available to the ENGINEER, and be submitted according to Section 01300.

1.5 AREA DESIGNATIONS

A. General

1. Raceway system enclosures shall comply with Section 16110 - Electrical Raceway Systems.

2. Electric WORK specifically indicated in sections within any Division of the Specifications shall comply with those requirements.

3. Other electrical WORK not included in 1.5A1 and 1.5A2 shall comply with this Paragraph 1.5A3.

AREA	NEMA ENCLOSURE CLASSIFICATION					
	1	3R	7	9	12	Notes
Electric Room	X					

4. Installations in hazardous locations shall conform strictly to the requirements of the Class, Group, and Division indicated.

B. Material Requirements

1. In chlorine and hydrofluosilicic (HFS) acid areas, sealing fittings shall be provided.

2. NEMA 4X enclosures shall be 304 stainless steel except in chlorine and HFS areas where non-metallic enclosures shall be provided.

3. NEMA 7 enclosures shall be cast aluminum where used with aluminum conduit; cast iron when used with galvanized steel conduit.

4. NEMA 1, 3R, and 12 enclosures shall be steel coated with ANSI 61 grey paint. NEMA 4X, 7 and 9 shall not be coated.

1.6 TESTS

A. The CONTRACTOR shall be responsible for all factory and field tests required by specifications in Division 16 and by the ENGINEER or other authorities having jurisdiction. The CONTRACTOR shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.

B. Where test reports are indicated, proof of design test reports for mass-produced equipment shall be submitted with the shop drawings, and factory performance test reports for custom-manufactured equipment shall be submitted and be approved prior to shipment. Field test reports shall be submitted for review prior to Substantial Completion.

C. Any equipment or material which fails a test shall be removed and replaced at no additional cost to the OWNER.

1.7 DEMOLITION AND RELATED WORK

A. The CONTRACTOR shall perform all electrical demolition work as indicated. The CONTRACTOR is cautioned that demolition work may also be indicated on non-electrical drawings. Coordinate electrical de-energization, disconnection, and removal with all trades and the overall sequence of construction.

B. Electrical requirements associated with removed equipment shall be:

1. Remove dedicated wiring and exposed conduits back to the source.

2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Power wiring shall be removed from the power source to the first pullbox or manhole remote from the panel. The remainder shall be abandoned in place.

3. Abandon in place wiring routed through encased conduits. Encased conduits shall be cut flush to the floor and be grouted.

4. Remove remote mounted starters, disconnect switches, circuit breakers, sensors, and transmitters.

C. Where new lighting and receptacles are installed, old lighting, receptacles, switches, wiring, and conduits shall be removed.

D. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips. The junction box shall have a NEMA rating in accordance with the area in which it is located, and shall be sized as required. Wires and terminals shall be properly identified before disconnection.

E. Materials and equipment not indicated to be removed and returned to the OWNER shall, upon removal, become the CONTRACTOR's property and shall be disposed of off the site.

F. Material and equipment indicated to be relocated or reused shall be removed and relocated, and reinstalled with care to prevent damage thereto.

G. Materials indicated to be returned to the OWNER shall be placed in boxes with the contents clearly marked and be stored at a location determined by the ENGINEER.

H. Where motor control centers or panelboards are indicated to have circuits removed and reconnected, the MCC shall have a new engraved phenolic nameplate worded as indicated or the panelboard schedule shall be modified to indicate the revised circuits. Pencil or magic marker markings directly on the MCC or panelboard breaker are not permitted.

1.8 CONSTRUCTION SEQUENCING

A. Continuance of plant operation during demolition and construction is critical. Therefore, CONTRACTOR shall carefully examine all work to be done in, on, or adjacent to existing equipment. Work shall be scheduled, subject to OWNER's approval, to minimize required plant shutdown time. The CONTRACTOR shall submit a written request, including sequence and duration of activities to be performed during plant shutdown.

B. All switching, safety tagging, etc., required for plant shutdown or to isolate existing equipment shall be performed by the CONTRACTOR. In no case shall the CONTRACTOR begin any work in, on, or adjacent to existing equipment without written authorization by the ENGINEER.

C. The CONTRACTOR shall make all modifications or alterations to existing electrical facilities required to successfully install and integrate the new electrical equipment as indicated. All modifications to existing equipment, panels, or cabinets shall be made in a professional manner with all coatings repaired to match existing. The costs for all modifications to existing electrical facilities required for a complete and operating system shall be included in the CONTRACTOR's original bid amount and no additional payment for this work shall be authorized. Extreme caution shall be exercised by the CONTRACTOR in digging trenches in order not to damage existing underground utilities. Cost of repairs of damages caused during construction shall be the CONTRACTOR's responsibility without any additional compensation from the OWNER.

D. The CONTRACTOR shall be responsible for identifying all available existing circuit breakers in lighting panels for the intended use as required by the Drawings. CONTRACTOR shall also be responsible for field verifying the available space in substation switchboards to integrate new power circuit breakers. Costs for this WORK shall be included in the CONTRACTOR's original bid amount.

E. The CONTRACTOR shall visit the site before submitting a bid to better acquaint itself with the WORK of this Contract. Lack of knowledge will not be accepted as a reason for granting extra compensation to perform the WORK.

PART 2 – PRODUCTS

2.1 GENERAL

A. All equipment and materials shall be new, shall be listed by UL, and shall bear the UL label where UL requirements apply. All equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar items in the WORK shall be products of the same manufacturer. All equipment and materials shall be of industrial grade standard of construction.

B. Where a NEMA enclosure type is indicated in a non-hazardous location, the CONTRACTOR shall utilize that type of enclosure, despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.

C. On all devices indicated to display dates, the year shall be displayed as 4 digits.

2.2 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. All nuts, bolts, and washers shall be stainless steel.

2. Threaded rods for trapeze supports shall be continuous threaded, galvanized steel, 3/8" diameter minimum.

3. Strut for mounting of conduits and equipment shall be galvanized steel. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion. Aluminum strut shall not be utilized for free standing support frames. Strut for free standing support frames shall be stainless steel. Strut shall be as manufactured by **Unistrut, B-Line.**

4. Anchors for attaching equipment to concrete walls, floors and ceilings shall be stainless steel expansion anchors, such as **"Rawl-Bolt," "Rawl-Stud" or "Lok-Bolt" as manufactured by Rawl; or similar by Star.** Wood plugs shall not be permitted.

2.3 ELECTRICAL IDENTIFICATION

A. **Nameplates:** Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock, **Formica type ES-1.** Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style with no characters smaller than 1/8-inch high.

B. **Conductor and Equipment Identification:** Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices such as manufactured by **Brady, Thomas & Betts,** or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place.

PART 3 – EXECUTION

3.1 GENERAL

A. **Incidentals:** The CONTRACTOR shall provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the Specifications or the Drawings. Typical incidentals are terminal lugs not furnished with vendor supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor furnished equipment to connect with other equipment indicated in the Contract Documents.

B. **Field Control of Location and Arrangement:** The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined by the CONTRACTOR in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions.

Locations shown on the Drawings, however, shall be followed as closely as possible.

1. Where conduit development drawings or "home runs" are shown, the CONTRACTOR shall route the conduits in accordance with the indicated installation requirements. Routings shall be exposed or encased as indicated. Conduits encased in a slab shall be sized for conduit OD to not exceed one-third of the slab thickness and be laid out and spaced to not impede concrete flow.

2. All conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated. Where the Drawings do not indicate exact locations, such locations shall be determined by the ENGINEER. If equipment is installed without instruction and must be moved, it shall be moved without additional cost to the OWNER. Lighting fixture locations shall be adjusted slightly to avoid obstructions and to minimize shadows.

C. **Workmanship:** All materials and equipment shall be installed in strict accordance with printed recommendations of the manufacturer. Installation shall be accomplished by workers skilled in the work. Installation shall be coordinated in the field with other trades to avoid interferences.

D. **Protection of Equipment and Materials:** The CONTRACTOR shall fully protect all materials and equipment against damage from any cause. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts shall be kept clean and dry. The CONTRACTOR shall replace or refinish all damaged materials or equipment, including face plates of panels and switchboard sections, at no additional expense to the OWNER.

E. The CONTRACTOR shall provide power wiring in conduit for the HVAC equipment in accordance with Section 15500 - Heating, Ventilating, and Air Conditioning. Starters shall be in accordance with Section 16480 - Low Voltage Motor Control Center, for starters in MCC's and Section 16485 - Local Control Stations and Miscellaneous Electrical Devices, for starters not in MCC's, except for starters in HVAC equipment which are indicated in Section 15500. Control wiring operating at 120 volts and less shall be as indicated in Section 15500.

3.2 CORE DRILLING

A. The CONTRACTOR shall perform core drilling required for installation of raceways through concrete walls and floors. Locations of floor penetrations are approximate. Verify all exact core drilling locations based on equipment actually furnished as well as exact field placement. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities. Damage to any encased conduits, wiring, and piping shall be repaired at no extra cost to the OWNER.

3.3 CONCRETE HOUSEKEEPING PADS

A. Concrete housekeeping pads shall be provided for all indoor floor standing electrical equipment. Housekeeping pads for all equipment, including future units, shall be 4 inches above surrounding finished floor or grade and 2 inches larger in both dimensions than the equipment, unless otherwise indicated.

B. Concrete housekeeping curb shall be provided for all conduit stub-up in indoor locations that are not concealed by equipment enclosures. Such curb shall be 3 inches above finished floor or grade.

3.4 EQUIPMENT ANCHORING

A. Wall-mounted panels that weigh more than 500 pounds or which are within 18 inches of the floor shall be provided with fabricated steel support pedestals. If the supported equipment is a panel or cabinet enclosed within removable side plates, it shall match supported equipment in physical appearance and dimensions. Transformers hung from 4-inch stud walls and weighing more than 300 pounds shall have auxiliary floor supports.

B. Leveling channels anchored to the concrete pad shall be provided for all switchgear and pad-mounted transformer installations.

C. Anchoring methods and leveling criteria specified in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract. Such recommendations shall be submitted as shop drawings in Section 01300.

3.5 EQUIPMENT IDENTIFICATION

A. **General:** Equipment and devices shall be identified as follows:

1. Nameplates shall be provided for all panelboards, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to name plates, control devices shall be equipped with standard collar-type legend plates.

2. Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.

3. Toggle switches which control loads out of sight of switch and all multi-switch locations of more than 2 switches shall have suitable inscribed finish plates.

4. Empty conduits shall be tagged at both ends to indicate the destination at the far end. Where it is not possible to tag the conduit, destination shall be identified by marking an adjacent surface.

5. Equipment names and tag numbers, where indicated on the Drawings, shall be utilized on all nameplates.

6. The CONTRACTOR shall furnish typewritten circuit directories for panelboards; circuit directory shall accurately reflect the outlets connected to each circuit.

3.6 CLEANING

A. Before final acceptance, all parts of the WORK shall be thoroughly cleaned. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. All oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Paint touch-up shall be applied to all scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum-cleaned.

- END OF SECTION -

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide electrical raceway systems, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Sections 01300 - Contractor Submittals, and 16050 - Electrical Work, General.

B. Shop Drawings

1. Complete catalog cuts of all raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.

2. Dimensioned layout drawings of all cable tray routings, including elevations.

PART 2 – PRODUCTS

2.1 GENERAL

A. Pull and junction boxes, fittings, and other indicated enclosures which are dedicated to the raceway system, shall comply with the requirements of this Section.

2.2 CONDUIT

A. Rigid Galvanized Steel (RGS) Conduit

1. Rigid steel conduit shall be mild steel, hot-dip galvanized inside and out.

2. Rigid steel conduit shall be manufactured in accordance with ANSI C80.1 - Rigid Steel Conduit, Zinc Coated, and UL-6.

3. **Manufacturers:**

   a. **LTV Steel**
   b. **Triangle**
   c. **Wheatland Tube**

B. Rigid Non-Metallic Conduit

1. Rigid non-metallic conduit shall be Schedule 40 PVC, sunlight resistant.

2. Rigid PVC conduit shall be manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit standards.

3. **Manufacturers:**

   a. **Carlon**
   b. **Condux**

C. Rigid PVC Coated Galvanized Steel (RPGS) Conduit

1. The conduit, prior to PVC coating, shall meet the requirements for RGS conduit above.

2. A PVC coating shall be bonded to the outer surface of the galvanized conduit. The bond between the coating and the conduit surface shall be greater than the tensile strength of the coating.

3. PVC coating thickness shall be not less than 40 mils.

4. PVC coated RGS shall be manufactured in accordance with the following standards:

   a. UL-6
   b. ANSI C80.1
   c. NEMA RN1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

5. **Manufacturers:**

   a. **Robroy**
   b. **Ocal**

D. Liquidtight Flexible Conduit

1. Liquidtight flexible conduit shall be constructed of a flexible galvanized metal core with a sunlight resistant thermoplastic outer jacket.

2. Liquidtight flexible conduit shall be manufactured in accordance with UL-360 - Steel Conduits, Liquid-Tight Flexible.

3. **Manufacturers:**

   a. **Anaconda, "Sealtite"**
   b. **Electriflex, "Liquatite"**

E. Electrical Metallic Tubing (EMT) or Intermediate (IMC) conduit will not be accepted.

2.3 FITTINGS AND BOXES

A. General

1. All cast and malleable iron fittings for use with metallic conduit shall be the threaded type with five full threads.

2. All fittings and boxes shall have neoprene gaskets and non-magnetic stainless steel screws. All covers shall be attached by means of holes tapped into the body of the fitting. Covers for fittings attached by means of clips or clamps will not be

acceptable.

3. Boxes larger than standard cast or malleable types shall be 304 stainless steel, NEMA 4X.

4. In outdoor areas, conduit shall be terminated in raintight hubs as manufactured by **Myers, or O.Z. Gedney.** In other than outdoor areas, sealed locknuts and bushings shall be used.

5. Conduit, fittings, and boxes in hazardous locations shall be suitable for the Class and Division indicated.

B. Malleable Iron Fittings and Boxes

1. All fittings and boxes for use with galvanized steel conduit shall be of malleable iron or gray-iron alloy with zinc plating.

2. **Manufacturers:**

   a. **O.Z. Gedney**
   b. **Crouse-Hinds**
   c. **Appleton**

C. PVC Fittings and Boxes

1. All fittings for use with rigid non-metallic conduit shall be PVC, solvent welded type.

2. Boxes shall be PVC or fiberglass reinforced polyester (FRP).

3. **Manufacturers:**

   a. **Carlon**
   b. **Crouse-Hinds**
   c. **Hoffman**

4. Provide all welding solvent as required for installation of non-metallic conduit and fittings.

D. PVC Coated Fittings

1. All fittings for use with PVC coated RGS shall be PVC coated and shall be products of the same manufacturer as the conduit.

E. Stainless Steel Boxes

1. Stainless steel boxes shall be used with PVC coated RGS conduit and where indicated.

2. Stainless steel boxes shall be NEMA 4X, Type 304.

3. Stainless steel shall be minimum 14-gauge thickness, with a brushed finish.

4. Doors shall have full length stainless steel piano hinges. Non-hinged boxes are not

acceptable.

5. **Manufacturers:**

   a. **Hoffman**
   b. **Rohn**
   c. **Hammond**

F. Sheet Steel Boxes

1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.

2. **Manufacturers:**

   a. **Raco**
   b. **Steel City**

PART 3 – EXECUTION

3.1 GENERAL

A. Raceways shall be installed between equipment as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for this purpose. Factory elbows shall be utilized wherever possible.

B. Where raceway routings are indicated on plan views, the CONTRACTOR shall follow those routings to the extent possible.

C. Where raceways are indicated but routing is not shown, such as home runs or on conduit developments and schedules, raceway routings shall be the CONTRACTOR's choice and in strict accordance with the NEC, customary installation practice. Raceway shall be encased, exposed, concealed, or under floor as indicated.

D. Routings shall be adjusted to avoid obstructions. Coordinate with all other trades prior to installation of raceways. Lack of such coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be at no extra cost to the OWNER.

E. Exposed raceways shall be installed parallel or perpendicular to structural beams.

F. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.

G. All exposed raceways shall be installed at least 1/2-inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, exposed raceways shall be installed 1/4-inch minimum from the face of walls or ceilings by the use of clamp backs or struts.

H. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, suitable insulating means shall be provided to prevent such corrosion.

3.2 CONDUIT

A. All exposed conduit shall be galvanized steel.

B. All conduit concealed, buried, or encased in concrete shall be Schedule 40 PVC. Where conduit emerges from concrete encasement, a PVC coated RGS elbow shall be utilized for transition from the concrete. Conduit shall emerge from the concrete perpendicular to the surface whenever possible.

C. Exposed conduit shall be 3/4-inch minimum trade size. Encased conduit shall one-inch minimum trade size. Supports shall be installed at distances required by the NEC.

D. Conduit shall not be encased in the bottom floor slab below grade.

E. Encased conduit shall have outer diameters not exceeding 1/3 of the concrete slab thickness. Encased conduit shall be routed between reinforcing bars.

F. All threads shall be coated with a conductive lubricant before assembly.

G. Joints shall be tight, thoroughly grounded, secure, and free of obstructions in the pipe. All conduit shall be adequately reamed to prevent damage to the wires and cables inside. Strap wrenches and vises shall be used to install conduit to prevent wrench marks on conduit. Conduit with wrench marks shall be replaced at no additional cost to the OWNER.

H. Wherever possible, conduit runs shall slope to drain at one or both ends of run. Wherever conduit enters substructures below grade, the conduit shall be sloped to drain water away from the structure. Extreme care shall be taken to avoid pockets or depressions in conduit.

I. Connections to lay-in type grid lighting fixtures shall be made using flexible metal conduit not exceeding 4 feet in length. Connections to motors and other equipment subject to vibration shall be made with liquid-tight flexible conduit not exceeding 3 feet in length. Equipment subject to vibration which is normally provided with wiring leads shall be provided with a cast junction box for the make-up of connections.

J. Conduit passing through walls or floors shall have plastic sleeves. Core drilling shall be performed in accordance with Section 16050 - Electrical General Provisions.

K. Provide conduit seal fittings at the following locations:

1. In hazardous classified locations, in strict accordance with the NEC.

2. In chlorine, ammonia, sulfur dioxide, and HFS areas to prevent passage of gases to other areas.

L. All conduit, fittings, and boxes required in hazardous classified areas shall be suitably rated for the area and shall be provided in strict accordance with NEC requirements.

- END OF SECTION -

SECTION 16111 - UNDERGROUND RACEWAY SYSTEMS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide underground raceway systems, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Sections 01300 - Contractor Submittals, and 16050 - Electrical Work, General.

B. Shop Drawings

1. Complete catalog cuts of all raceways, fittings, pullboxes, manholes, handholes, marked where applicable to show proposed materials and finishes.

2. Dimensioned layout drawings of all cable tray routings, including elevations.

PART 2 – PRODUCTS

2.1 GENERAL:

A. Manholes, handholes, pullboxes and fittings which are dedicated to the underground raceway system shall comply with the requirements of this section.

2.2 MANHOLES AND HANDHOLES

A. Manholes and pullboxes shall be cast in place with construction and size as indicated. Precast manholes and handholes of similar size and loading may be accepted, subject to approval by the ENGINEER.

1. Covers shall be traffic type, H-20 loading, except as indicated otherwise. Manhole and pullbox covers shall be identified as "Electric" by raised letters cast into the covers. Manhole frames and covers shall be **Neenah Foundry No. R-1755-G.**

2. Manholes shall have frost-proof and water-tight grey iron frames and covers with solid lids and inner lids with 28-inch clear openings. All covers and lids shall be bolted to cast-in-place steel frames with corrosion resistant hardware. Frames shall be factory-primed; covers shall be cast-iron and shall have pick-holes.

3. The concrete envelope shall have a compression strength of 3,000 psi in accordance with the requirements of Section 03300 - Cast-in-Place Concrete.

B. Manholes and pullboxes shall be equipped with pulling-in irons opposite and below each ductway entrance.

C. PVC ductbank conduits shall be provided with end bells. Brackets, **Unistrut Cat. No. P2515** and 60-inch concrete inserts, **Unistrut Cat. NO. P3261**, shall be provided in manholes as required for racking wiring through manholes.

D. Precast manholes and pullboxes shall be **Brooks Mack, Quikset or U.S. Precast.** Cast-iron covers shall be by **U.S. Foundry.**

2.3 DUCTBANKS

A. Underground ducts shall be Schedule 40 PVC.

B. Ducts shall be encased in concrete with steel reinforcing bars. Concrete shall have 3,000 psi compressive strength conforming to Section 03300 - Cast-In-Place Concrete. Colorant shall be applied as a red-oxide dye, applied as a surface treatment to the ducts.

C. Ductbanks shall contain a No. 4/0 base stranded copper ground wire. The ground wire shall be continuous through the ductbank and terminate at power distribution equipment and grounding grid.

D. **Identification Tape:** Continuous lengths of underground warning tapes shall be installed 12 inches above and parallel to all ductbanks. Tape shall be 6 inches wide polyethylene film imprinted "CAUTION - ELECTRIC UTILITIES BELOW." Tapes shall be as manufactured by **Brady.**

PART 3 – EXECUTION

3.1 GENERAL

A. Underground raceways shall be installed between manholes, handholes and pullboxes as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be fabricated with tools designed for this purpose. Factory elbows shall be utilized wherever possible.

B. Raceway routings on plan views shall be followed to the extent possible.

C. Routings shall be adjusted to avoid obstructions. Coordinate with all other trades prior to installation of raceways. Lack of coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be at no extra cost to the OWNER.

3.2 DUCTBANKS

A. Ductbanks shall be installed in accordance with the criteria below:

1. Duct shall be assembled using high impact non-metallic spacers and saddles to provide conduits with vertical and horizontal separation. Plastic spacers shall be set every 5 feet. The duct array shall be anchored every 5 feet to prevent movement during placement of concrete.

2. The duct shall be laid on a grade line of at least 3 inches per 100 feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the concrete envelope is a minimum of 18 inches below grade and a minimum of 24 inches below roadways.

3. Changes in direction of the duct envelope by more than 10 degrees horizontally or vertically shall be accomplished using bends with a minimum radius 24 times the duct diameter.

4. Duct couplings shall be staggered a minimum of 6 inches.

5. The bottom of trench shall be of select backfill or sand.

6. Each bore of the completed ductbank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct. After passing of the mandrel, a wire brush and swab shall be drawn through.

7. Spare raceways which are not indicated to contain conductors shall have a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.

B. Duct entrances shall be grouted smooth; ducts shall be terminated with flush end bells. Sections of pre-fabricated manholes and pullboxes shall be assembled with waterproof mastic and shall be set on a 12-inch bed of gravel as recommended by the manufacturer or as required by field conditions.

C. Ductbank penetration through walls of manholes, pullboxes, and building walls below grade shall be watertight.

D. Concrete encased ductbank shall terminate at building foundations. When duct enters the building on a concrete slab on grade, duct shall not be encased, but shall transition to rigid steel PVC-coated conduits on all stub-ups.

- END OF SECTION -

SECTION 16120 - WIRES AND CABLES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide wires and cable, complete and operable, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit Shop Drawings in accordance with Sections 01300 - Contractor Submittals and 16050 - Electrical Work, General.

PART 2 – PRODUCTS

2.1 GENERAL

A. All conductors, include grounding conductors, shall be copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. All conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400 and fixture wires shall conform to Article 402. All wiring shall have wire markers at each end.

2.2 LOW VOLTAGE WIRE AND CABLE

A. Power and Lighting Wire

1. All wire rated for 600 volts in duct or conduit for all power and lighting circuits shall be Class B Type XHHW cross-linked polyethylene conforming to UL-44-UL Standard for Safety Rubber Insulated Wires and Cables. THHN wire will be permitted to be used in dry and damp locations, for any power or control wiring in this project. THNWN wire may be used in dry and wet locations.

2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

3. Conductors for branch circuits as defined in Article 100 of the NEC, shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

4. Wiring for 600 volt class power and lighting shall be as manufactured by **BICC Cables or Okonite.**

B. Control Wire

1. Control wire in duct or conduit shall be the same type as power and lighting wire indicated above.

2. Control wiring shall be No.14 AWG.

3. Control wires at panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American or Carol Cable**.

C. Instrumentation Cable

1. Instrumentation cable shall be rated at 600 volts.

2. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded polyethylene: black-red for two-conductor cable and black-red-white for three-conductor cable.

3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 18 AWG stranded tinned copper drain wire, and a PVC outer jacket with a thickness of 0.048 inches.

4. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 9342.**

5. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 1119A.**

2.3 MEDIUM VOLTAGE CABLE

A. General

1. Individual conductors shall be copper, Class B, stranded.

B. 5 KV Cable

1. Cable used in conduit or duct shall be composed of a single conductor, ethylene-propylene rubber (EPR) insulation rated at 90 degrees C, shield, and black chlorosulfonated polyethylene (CPE). Insulation level shall be 133%, 115 mil. Shield shall be copper tape type, corrogated drain wire type (**Unishield** as manufactured by **BICC Cables**). Cable shall be UL Type MV-90 in accordance with UL 1072 - UL Standard for Safety - Medium Voltage Power Cables, as manufactured by **BICC Cables or Okonite.**

2.4 CABLE TERMINATIONS

A. Only compression connectors may be used. Compression connectors shall be **Burndy "Hi Lug" or Thomas & Betts "Sta-Kon."**

B. Pre-insulated fork tongue lugs shall be **Thomas & Betts or Burndy.**

C. All insulating tape shall be **Scotch No. 88,** as manufactured by **CM.**

D. Labels for coding all 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M.**

E. Stress cone material for make-up of medium voltage shielded cable shall be as manufactured by **Raychem or 3M.**

PART 3 – EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall provide and terminate all power, control, and instrumentation conductors except where indicated.

3.2 INSTALLATION

A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.

B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

3.3 SPLICES AND TERMINATIONS

A. General

1. All wire taps and splices shall be properly taped and insulated according to their respective classes.

2. In general, there shall be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables shall be brought aboveground and terminated in a NEMA 4X, stainless steel terminal or splice cabinet on a concrete pad. Splices in underground manholes and pullboxes may be made only with the approval of the ENGINEER.

3. Stranded conductors shall be terminated directly on equipment box lugs making sure that all conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

4. Excess control and instrumentation wire shall be properly taped and terminated as spares.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.

2. In junction boxes, motor control centers, and control panels, all control wire and spare wire shall be terminated to terminal strips.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4-20 mA system.

2. Two- and three-conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes. Such cable runs shall have only one splice per conductor.

D. Power Wire and Cable

1. All 120/208-volt and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR. All cables rated above 2,000 volt shall be spliced or terminated only at equipment terminals indicated.

2. Splices to motor leads in motor terminal loops shall be wrapped with 2 layers of cambric cloth, then shall be wrapped with mastic material, and overtaped with a minimum of two layers of high temperature type.

3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as described for shop drawings.

3.4 CABLE IDENTIFICATION

A. **General:** Wires and cables shall be identified for proper control of circuits and equipment and to reduce maintenance effort.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to all conductors having common terminals and shall be shown on all "as built" drawings. Identification numbers shall appear within 3 inches of conductor terminals. "Control" shall be defined as any conductor used for alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. All individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.

2. All 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A-black, Phase B-red, Phase C-blue, and Neutral-white. The 480/277-volt system conductors shall be color coded as follows: Phase A-Brown, Phase B-Orange, Phase C-Yellow, and Neutral-Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to

bottom, or left to right, facing connecting lugs.

3. General purpose AC control cables shall be red. General purpose DC control cables shall be blue.

4. All spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

3.5 TESTING

A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-68-516 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Section 01300 prior to shipment of cable. The following field tests shall be the minimum requirements:

1. High potential DC test shall be performed on all cables operating at more than 2,000 volts to ground. Time-resistance readings shall be taken and recorded at intervals of 30 seconds and one minute. Time-resistance voltage levels shall be per the cable manufacturer's recommendations.

2. All cables rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmeter.

3. All field testing shall be done after cables are installed in the raceways.

4. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.

5. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

B. **Continuity Test:** All control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cables in service.

- END OF SECTION -

SECTION 16140 - WIRING DEVICES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide wiring devices, complete and operable, in accordance with the Contract Documents.

B. **Single Manufacturer:** Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Contract submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings

1. Complete catalog cuts of switches, receptacles, enclosures, covers, and appurtenances, marked to clearly identify proposed materials.

2. Documentation showing that proposed materials comply with the requirements of NEC and U.L.

3. Documentation of the Manufacturer's qualifications.

PART 2 – PRODUCTS

2.1 GENERAL

A. All devices shall carry the U.L. label.

B. General purpose duplex receptacles and toggle switch handles shall be brown everywhere except in finished rooms where they shall be ivory. Special purpose receptacles shall have a body color as indicated. Receptacles and switches shall conform to Federal Specifications W-C-596E and W-S-896E, respectively.

2.2 LIGHTING SWITCHES

A. Local branch switches shall be toggle type, rated at 20 amperes, 120-277 VAC, and shall be **General Electric Cat. No. GE-5951-1** for single pole, **GE-5953-1** for three-way and **GE-5954-1** for four-way, or similar types as manufactured by **Hubbell.**

2.3 GENERAL PURPOSE RECEPTACLES

A. Duplex receptacles rated 120 V, 20 amperes shall be polarized 3 wire type for use with 3 wire cord with grounded lead and 1 designated stud shall be permanently grounded to the conduit system (NEMA 5-20R). Duplex 120 V receptacles shall be **G.E. 5362, Hubbell 5362.** Single receptacles shall be **G.E. 4102, Hubbell 4102.**

B. Ground-fault circuit interrupting receptacles (GFCI's) shall be installed at the locations indicated. GFCI's shall be rated 125V, 20A and shall be **Hubbell GF-5362.**

2.4 ENCLOSURES AND COVERS

A. All surface mounted switches and receptacles shall be in FS or FD type weatherproof conduit fittings.

B. All switch and receptacle covers on surface mounted boxes shall be die cast copper-free aluminum.

C. In finished areas, switch and receptacle boxes shall be provided with SUPER STAINLESS STEEL COVERS as manufactured by **Harvey Hubbell, Arrow Hart, Bryant.**

D. In areas where cast boxes are used, switch and receptacle covers shall be **Crouse-Hinds Catalogue No. DS185 and WLRD-1, or Adalet No. WSL and WRD.**

E. Receptacles in wet locations shall be with a hinged cover/enclosure marked "Suitable for Wet Locations when in use" and "UL Listed." There shall be a gasket between the enclosure and the mounting surface and between the hinged cover and mounting plate/base. The cover shall be **TayMac Specification Grade.**

2.5 NAMEPLATES

A. Provide nameplates or equivalent markings on switch enclosures to indicate ON and OFF positions of each switch. ON and OFF for 3-way or 4-way switches is not acceptable. Provide receptacles for special purposes with nameplates indicating their use. Conform to requirements of Section 16050 - Electrical Work, General.

PART 3 – EXECUTION

3.1 GENERAL

A. Perform work in accordance with the National Electrical Code.

3.2 CONNECTION

A. Rigidly attach wiring devices in accordance with National Electrical Code, and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device, unless otherwise indicated.

3.3 GROUNDING

A. Ground all devices, including switches and receptacles, in accordance with NEC, ART.250, and Section 16450 - Grounding.

B. Ground switches and associated metal plates through switch mounting yoke, outlet box, and raceway system.

C. Ground flush receptacles and their metal plates through positive ground connections to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw or by grounding jumper, each making positive connection to outlet box and grounding system at all times.

3.4 FIELD TESTING

A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 16050.

B. Test each receptacle for polarity and ground integrity with a standard receptacle tester.

- END OF SECTION -

SECTION 16310 - SECONDARY UNIT SUBSTATION

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide the unit substation, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 16050 - Electrical Work, General, apply to the WORK of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Reference Codes:** All work specified herein shall conform to or exceed the applicable requirements of the National Electric Code (NEC); provided, that where a local code or ordinance is in conflict with the NEC, the provisions of said local code or ordinance shall take precedence. For additional requirements, see paragraph "Applicable Publications" of Section 16050.

B. **Commercial Standards:**

NFPA 70	National Electrical Code
UL 1558	Low Voltage Switchgear
ANSI C37.20	Switchgear Assemblies
ANSI Z55.1	Gray Finishes for Industrial Apparatus, and Equipment
ANSI C57.12.00	Transformers

1.3 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit shop drawings of all secondary unit substations, and components in accordance with the requirements of Section 01300 - Contractor Submittals, and the additional requirements below:

1. Certified outline drawings complete with dimensions, weights, space for conduits, cable terminations, and bus terminations.

2. Engineering data to include voltage, continuous current, withstand interrupting kVA, and temperature.

3. Material list, and catalog data.

4. Submit spare parts data listing source and current prices of recommended replacement parts and supplies; recommended maintenance procedures and intervals.

5. Certified factory design test report.

6. Complete list of tools for the operation and maintenance of the unit.

1.4 QUALITY ASSURANCE

A. **General:** All materials shall be tested and inspected in accordance with Section 16050 and the following requirements.

B. Unit substation shall be stored in a clean, dry space. Factory wrapping shall be maintained, or a heavy plastic cover shall be provided to protect units from dirt, water, construction debris, and traffic. Storage space shall be heated, or space heaters shall be energized.

C. **Factory Tests:**

1. Medium Voltage Load Break Switch: A certificate of design tests previously conducted on one medium voltage load break switch, and switch assembly of rating essentially similar to that specified herein shall be submitted. The design testing program shall conform to ANSI C37.20.3, and shall include, but not be limited to, the following tests:

    a. Basic impulse level.

    b. Momentary withstand capability.

    c. Short time withstand capability.

    d. Fault closing.

    e. Mechanical life tests.

    f. Rigidity.

    g. Bus bracing.

    h. Venting.

2. Production tests shall be conducted on each medium voltage load break switch supplied herein, and certificates for each test shall be submitted. The production testing program shall conform to ANSI Standard C37.20.3, and shall include but not be limited to the following tests:

    a. Dielectric test at power frequency for 1-minute.

    b. Contact resistance measurement for all the three phase.

    c. A check of safety interlocks.

    d. Visual and mechanical inspection.

3. **Step-down Transformer**: A certificate of design tests previously conducted on one step-down transformer of each rating essentially similar to that specified herein shall be submitted. The design testing program shall conform to ANSI Standard C57.12.00 with the exception of Paragraphs 9.1 and 9.2, and shall include but not be

limited to the basic impulse level test.

4. Production tests shall be conducted on each step-down transformer supplied herein, and certificates for each test shall be submitted. The production testing program shall conform to ANSI Standard C57.12.00, and shall include but not be limited to the following tests:

   a. Sound level measurements.

   b. Resistance measurements.

   c. Ratio tests on all tap connections.

   d. Polarity and phase relation check.

   e. No-load loss.

   f. Exciting current measurement.

   g. Impedance, and load loss measurements.

   h. Applied potential test.

   i. Induced potential test.

   j. Temperature tests at OA and FA ratings. Temperature tests shall be made only on one unit of each rating. Temperature tests previously performed on a duplicate unit will be acceptable in lieu of the temperature test on the units to be supplied.

5. Low Voltage Switchgear

   a. A certificate of design tests previously conducted on one air-break circuit breaker, and switchgear assembly of each rating essentially similar to that specified herein shall be submitted. The design testing program shall conform to ANSI Standard C37.20.1, and shall include, but not be limited to, the following tests: Dielectric, continuous current, withstand, and endurance.

   b. The low voltage switchgear sections, including the transition section, if required, shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchgear shall be tested for operation under simulated service conditions, to assure the accuracy of the wiring, and the functioning of all equipment.

   c. Production tests shall be conducted on each low voltage switchgear assembly, and a certificate of each test shall be submitted.

   d. The production testing program shall conform to ANSI Standard C37.20.1, and shall include, but not be limited to, the following tests: contact resistance measurement of all the three phases; operation of each electrically operated breaker with the control power supply voltage adjusted to the limits specified; check of safety interlocks, and interchangeability of circuit breakers of the same ratings in various cubicles.

D. **Environmental Conditions:** Secondary Unit substation(s) shall be designed for continuous duty service in the environmental conditions specified in Section 16050.

1.5 MAINTENANCE, AND GUARANTEE

A. CONTRACTOR shall submit a recommended spare part list.

B. CONTRACTOR shall guarantee that the equipment shall meet the requirements specified herein and Section 16050.

PART 2 – PRODUCTS

2.1 DESIGN REQUIREMENTS

A. The secondary unit substation shall be designed to meet the requirements of NEMA.

B. The phase-sequence of the assembled 3-phase buses, and primary conductors shall be A, B, C starting from front-to-back, top-to-bottom, or left-to-right as viewed from the front of the switchgear. The protective relays shall be mounted in the same order.

C. The Secondary unit substation assembly shall consist of the following equipment:

1-medium voltage fused, metal-enclosed, load break switch, located outdoor, remote from the transformer and low-voltage switchgear.

1-transformer to step the power down, located indoor, including incoming air-terminal compartment and coupled to the low-voltage switchgear.

1-low voltage transition with flexible bus, if required.

1-low voltage switchgear

The low voltage switchgear section shall include a main breaker outgoing feeder breakers and provisions for future breakers, as shown.

2.2 SERVICE

A. The secondary unit substation shall be suitable for operation:

1. primary voltage
   4.6 KV 3Ø, 3W, 60 Hz incoming

2. transformer
   4.16 KV - 480 Y/277 V

3. secondary (low voltage) outgoing 480 Y/277 V, 3Ø, 4W, solidly grounded

2.3 CONSTRUCTION FEATURES

A. The incoming line and outgoing switchgear sections shall consist of one or more groups of vertical sections containing the switchgear equipment, power fuses, circuit breakers, buses, instrumentation, relays, controls, and other required devices shown.

B. Vertical sections shall be fabricated, rigidly braced, structural steel framework, with interior barriers, and breaker module side sheets of not less than 11 gauge sheet steel, and external panels and covers of not less than 14 gauge sheet steel. Compartment doors shall be hinged flanged dead-front panels. Hinged flanged doors shall also be provided on the rear of those sections having external power connections, and on sections in which the rear cover plates exceed 60 pounds in weight. Panels shall be reinforced with stiffening members to minimize vibration. All steel shall be select quality, free of dents, and true to level after forming.

C. Vertical sections containing current-interrupting devices shall have provision for ventilation of ionized gases to the outside of the switchgear. Ventilating openings shall be rodent-proofed by covering with wire mesh securely held in place. All openings shall have removable dust filters.

D. Outgoing switchgear sections shall be manufactured so that future expansion is possible.

E. Space heaters shall have mechanical guards and be provided in each vertical section. Heaters shall be of the low temperature type, rated (nominally) at 120 volts, with a single pole circuit breaker. The heaters shall be sized to keep the air inside the enclosure above the dew point. Heaters shall be thermostatically controlled.

F. The incoming line switch(es), main fuse(s), metering equipment, and all circuit breakers shall be housed in separate sections or compartments within the vertical sections, and shall be isolated from adjacent elements by steel or appropriate insulated barriers.

G. Bus compartments shall be provided to fully enclose the incoming line and main bus from the cable termination area.

H. Isolating barriers shall be provided between the incoming line, and main bus systems to prevent fault communication. Insulating sleeves shall be provided in feeder run-back conductor in the bus compartment to prevent fault communication in that area.

I. The incoming and main bus shall be welded or bolted copper. All bolted or pressure joints for buses, interconnections, disconnecting devices, and external connections to the equipment shall be copper with silver-to-silver torqued contacts. Insulated bus supports shall be flame retardant polyester glass, designed and tested to withstand the mechanical stress produced by fault currents, as required.

J. Cable compartments shall be isolated from the bus compartments and have ample space for cables or busways entry from above or below and shall be easily accessible from the hinged rear door.

K. Switchgear shall be provided with removable steel plates on the top and sides. A hinged rear door shall be provided for each cable compartment. A front hinged panel shall be provided for each breaker and metering compartment.

L. Each low-voltage circuit breaker compartment shall have a drawout mechanism consisting of an integral racking device to lock the removable element in the connected position and to overcome the mechanical resistance of making and breaking the contacts of the disconnecting devices. Positive mechanical interlocks of rugged design shall prevent the breaker from being racked in or out unless the breaker is tripped and shall prevent the breaker from being closed while it is being racked in or out. The breaker drawout mechanism shall be of a design that permits the breaker to be racked from the connected to the test and disconnected positions with the door closed or a metal breaker cover in place. Manual release shall be provided to hold the breaker in the test and disconnected positions. A limit stop shall be provided in the fully withdrawn position. In this position, there shall be provisions for easy maintenance and inspection or removal.

M. **External Connections:** Primary cable compartments shall include connectors, and cable supports. Where connections are to be made to bus ducts, all necessary bus adapters, bolting, insulating supports, and metal flanges shall be provided. Ground sensing current transformers, when required, shall be mounted in the respective cable compartments or at the breakers cell.

N. Cable compartments for cables rated at 5 KV shall be large enough to accommodate cable stress cones or potheads and shall have termination points for drainage shield wires.

O. Primary and secondary cables or bus duct shall enter the equipment from above or below as shown or as dictated by field conditions.

P. **Control Wiring:**

1. Control wiring shall be provided to all auxiliary relays, and devices indicated to be furnished with the equipment. Control buses and wiring for each vertical section shall be enclosed in conduit or in compartments isolated from the primary circuits.

2. All control wiring shall be brought to identified terminal blocks. Connection made on terminal blocks, and on internal devices shall be by means of locking spade type pre-insulated terminals.

3. Terminal blocks, wired to outgoing control circuits, shall be mounted inside of each compartment.

4. Control and secondary wiring shall be 600-volt flame-retardant switchboard type, minimum size No. 14 AWG, stranded tinned copper. Hinge wiring shall be extra-flexible stranding. Wire shall be SIS, gray color. Both ends of the wire shall be identified with labels approved by the OWNER.

Q. **Equipment Enclosure:**

1. Enclosure for the 5 KV fused load interrputer switch shall be weather-proof type as specified herein, or shown. The dry-type step-down transformer and low voltage switchgear shall be indoor type.

2. Indoor type shall be NEMA 1 gasketed. Outdoor type shall be NEMA Type 3R.

2.4 COMPONENTS

A. The 480-volt secondary unit substation and switchgear shall include remote, outdoor primary switch transformer, air breakers, metering, and associated standard and optional accessories as specified herein, and as shown. BIL rating shall be NEMA standard for the service. Equipment shall be for indoor or outdoor service as specified herein or shown.

B. **Incoming Section:**

1. Incoming section shall be furnished with single air-interrupter switch and fuse as shown. Switch shall be 2-position, 3-pole, manually gang operated, having stored-energy mechanism for quick-make, quick-break operation.

2. Switch shall be rated as follows:

Voltage:	5,000 volts
Continuous current:	600 amperes
Interrupting Current:	600 amperes
Momentary withstand:	40,000 amperes asymmetrical (10 cycles)
Fault close:	40,000 amperes asymmetrical
BIL:	60 kV

3. All poles shall be suitably barriered and provided with arcing chutes and arcing contacts.

4. Each switch shall be key interlocked with the main secondary circuit breaker.

5. Mechanical interlock shall be provided to prevent opening of the switch access door unless the switch is open and to prevent closing of the switch unless the door is closed.

6. Potheads or stress cone kits shall be provided in each cable entrance compartment for terminating three-single conductor 5 kV, shielded cables.

7. Power fuse(s) shall be mounted in switch, or in a separate compartment with hinged door interlocked mechanically, or by key interlock, with the switch compartment door(s) to prevent opening of the fuse compartment when either switch is closed. Power fuse(s) shall be coordinated with the main secondary circuit breaker and transformer rating.

C. **Transformer Section (Dry):**

1. Transformer shall be of the type, voltage, and rating as shown.

2. Transformer shall conform to NEMA and ANSI C57.12.00, and shall have all applicable standard accessories.

3. Dry-type transformer(s) shall be provided with one single-pole double-throw alarm for contact a temperature indicator mounted on the unit. Taps shall be brought to terminals provided with accessible panels. Ventilation openings shall be screened and vibration pads provided.

4. All transformers shall have the following:

   a. Low voltage neutral terminal.

   b. Accessible solid grounded pad.

c. Pulling eyes, jacking provisions, instruction nameplates, and lifting lugs.

5. The transformer(s) shall have the following ratings:

kVA rating	As shown
Type	AA/(Future FA)
Phase	3
Temperature rise	As shown
Frequency	60-Hz
Primary voltage	4.16 kV Delta
Secondary voltage	480Y/277 V Solidly grounded
Impedance	NEMA standard
Taps	Four (4) 2-12 percent taps, 2 above, and 2 below rated high voltage.
BIL	NEMA standard

D. **Outgoing Section - Switchgear:** The outgoing section of the secondary unit substation(s) shall consist of low voltage switchgear. Components for outgoing unit substation sections, and separate switchgear sections shall conform to the requirements herein.

1. Low-voltage main, and feeder power circuit breakers

   a. Breakers shall conform to ANSI, UL, and NEMA Standards.

   b. Low-voltage power circuit breakers shall be five cycle oilless type, three-pole, single-throw, draw-out with frame size and trip setting as shown. All circuit breakers shall be 100% rated.

   c. Trip units shall be RMS microprocessor based type providing adjustable long time, short time, instantaneous and ground fault protection. Instantaneous trips shall not be provided on main breakers, and where deletion is recommended by the coordination study. Short time, and ground fault trip functions shall include I^2t slopes as part of the trip unit programming functions. Provide trip indicators for long time, short time, instantaneous, and ground fault trip indication.

   d. All circuit breakers shall have mechanically trip-free operating mechanisms of the stored energy type, and shall be provided with self-aligning primary, and secondary disconnecting devices, trip button, position indicator, mechanically operated devices as listed hereinafter and other specified accessories. Electrically-operated circuit breakers shall also be equipped with electrically trip-free operating mechanisms. Provide bell alarm and form "C" auxiliary contacts wired to an identified terminal strip.

e. Manually operated breakers shall be charged from the handle. Electrically operated breakers shall operate at 120 v or 240 vac.

f. Short circuit interrupting rating of the breakers shall be not less than 42,000 amperes symmetrical but no less than required by Section 16431 - Short Circuit and Protective Device Coordination Study. Include current limiters, integrally mounted or on a drawout truck where necessary to meet the short circuit rating. Limiters shall be coordinated with the breaker trips to avoid unnecessary blowing of the limiters. Provide anti-single phase protection and blown fuse indication interlocked with the breakers.

g. Mechanical interlocks shall be provided to prevent the removable element from being moved to or from the operating position with the circuit breaker closed, and to prevent the circuit breaker being closed unless primary disconnecting devices are fully engaged or separated a safe distance.

h. Where hazardous, it shall not be possible to open the compartment door with the breaker in the closed position.

i. The breaker shall be equipped for mounting on the draw-out mechanism in the breaker compartment.

j. Breaker elements of the same size, rating, and type shall be completely interchangeable within and between secondary unit substations and switchgear.

k. A 120 VAC static trip calibration and portable test unit shall be furnished per switchgear. The unit shall be as designed and built specifically for the type of circuit breakers being furnished and shall contain all necessary cables, plugs, and instruction manuals required for operating it. Test sets will not be necessary when the circuit breakers trip units include internal test capabilities by an operator.

l. Each cubicle shall have protection shutters to automatically cover primary line and secondary load studs when the circuit breaker is withdrawn from the cubicle.

m. Feeder and main circuit breakers shall be manually operated. Charging or energy storage springs shall be capable of being manually charged from an operating handle.

E. **Control Power Transformers**

1. Control power transformers shall be provided in the main circuit breaker section, as required, to supply power for switchgear control, space heaters, and transformer cooling system. For weatherproof enclosures, include capacity for the lights, switches, and receptacles.

2. The transformer shall be protected by current limiting fuses in a dead front holder on both the primary, and secondary.

3. Distribution control power shall be through use of panel mounted fusible type

switches or circuit breakers, properly coordinated.

F. **Busses and Bus Duct Ties**

1. Busses shall be of high conductivity copper, sized for the rated continuous and momentary currents within allowable temperature rise and shall not be tapered. A half capacity neutral bus shall be provided.

2. Busses shall be braced to withstand a short circuit current of 65,000 amperes symmetrical minimum.

3. Bus joints shall be welded, brazed, or bolted. Bolted joints shall have silver surfaces. Bolts and associated hardware shall be corrosion-resistant and shall be rear accessible.

4. Insulating barriers shall be provided where primary busses pass from one compartment to another, whether the bus is insulated, or not.

5. A copper ground bus extending the entire length of each unit substation switchgear assembly, and incoming line compartment shall be provided, and it shall have clamp type terminal lugs adjustable between 4/0 AWG, and 500 MCM at each end for external cable connections. All the metal parts of the structure shall be effectively connected to this bus. Ground bus shall be of rectangular cross section, not less than 1/4-inch by 1-1/2 inches.

G. **Terminal Blocks**

1. Terminal blocks for all external control connections shall be 600-volt, barrier type, having a minimum rating of 20 amperes with marker strips identifying all internal and external wiring. Terminal blocks shall have at least 20 percent unused spare connections after completion of wiring.

2. Terminal blocks for current transformer secondary connections shall be of the short-circuiting type. One 4-pole block shall be used for each current transformer set.

H. **Meters and Instruments**

1. Meters and instruments shall be provided as shown. These shall be installed and wired on the hinged front panels. Arrangement of these devices on the hinged panels is subject to approval by the ENGINEER.

2. Instruments, and meters shall be suitable for operating from instrument transformers with nominal 5 ampere and 120-volt secondaries. Scale ranges, and dial constants shall be provided to match the primary current and voltage ratings.

3. Multi-function microprocessor based electronic metering panels shall be provided as shown on the Contract Drawings.

I. **Instrument Transformers**

1. **Current Transformers:** The quantity and ratio of current transformers shall be as shown. Current transformers shall have thermal and mechanical ratings and insulation class not less than those of the associated circuit breakers. Current

transformers shall be mounted in such a way as to provide easy access for inspection and maintenance.

2. Provide test blocks and plugs for current and potential circuits for the main breaker(s).

J. **Spare and Space Cubicles**

1. Circuit breaker compartments when specified "future," shall be completely equipped with draw-out rails for future addition circuit breakers including all electrical connections. Insulating sleeves shall be furnished over the main stationary disconnect studs.

2. Circuit breaker compartments where shown as spares, shall have spare circuit breaker of the rating shown installed and wired.

K. **Lifting Device**

1. Provide a top of switchgear rail mounted overhead lifting device and transport dolly for removing circuit breakers.

2.5 NAMEPLATES

A. Nameplates shall be provided for front and rear face of each cubicle and for major devices thereon, such as meters, instruments, control switches, and relays. Nameplates shall also be provided for major internal devices such as relays, instrument, and control power transformers, fuse blocks, switches, and transducers. Nameplates shall be three-layer laminated phenolic plastic, black front, and back, white case, engraved to show white lettering. Lettering shall be upper case as follows:

1. 1-inch high for switchgear identification

2. 7/16-inch high for compartment identification

3. 1/8-inch high for component nameplate

B. Nameplates 1-1/2 inches tall and smaller shall be 1/16-inch thick. Nameplates larger than 1-1/2-inches tall shall be 1/8-inch thick. Nameplates shall be fastened by black anodized screws.

2.6 SURFACE PREPARATION, PAINTING AND CLEANLINESS

A. Metal surfaces shall be smooth and free of all foreign matter such as scale, sand, blisters, weld splatter, metal chips and shavings, oil, grease, organic matter, and rust, and shall be chemically cleaned and treated in a process which provides a phosphate coating. Immediately after the treatment process, the surfaces shall be sprayed with coatings of primer and finish paint, and both shall be baked. Electrostatically deposited powder coated epoxy finish, oven baked, 1 mill minimum thickness indoor, and 2 mills minimum thickness outdoor, are acceptable.

1. All surfaces shall be finished painted light gray ANSI 61 according to ANSI Z55.1 standard. The manufacturer's standard practice of double-tone finish on the low voltage switchgear section is acceptable.

2. Two spray cans of air-drying paint of each color tone shall be furnished for field use.

2.7 DESIGN BASIS

A. The CONTRACTOR shall assign to the designated medium-voltage load break switch manufacturer the responsibility to select and supply secondary unit substation(s).

B. Manufacturers:

1. Medium voltage load break switch: **Cutler-Hammer Type WLI, General Electric, Square D Type HVL**

2. Transformer: **Cutler-Hammer/Asea Brown Boveri, General Electric, Square D**

3. Low Voltage Switchgear: **Cutler-Hammer Type DS, General Electric Type AKR, Square D Type Power-Zone III**

PART 3 – EXECUTION

3.1 INSTALLATION

A. The CONTRACTOR shall install the secondary unit substation(s) in accordance with the manufacturer's installation instructions and as shown. The CONTRACTOR shall furnish, and install the floor channels, and shall secure the unit substation elements to the channels by bolting or tack welding at the front and the rest.

B. Prior to energizing, all equipment shall be cleaned, inspected for loose connections, checked out for electrical and mechanical operations and phase-sequence, and all circuits made free of any shorts or ground connections following field testing.

C. CONTRACTOR shall anchor substation in conformance with "Anchoring" criteria stated in Section 16050.

3.2 MANUFACTURER'S REPRESENTATIVE

A. The CONTRACTOR shall arrange for a technical representative of the manufacturer for pre-commissioning checkout of the equipment, and to instruct the operating personnel in the operation, shutdown, startup, and maintenance of the equipment.

3.3 FIELD TESTING

A. The CONTRACTOR shall perform all testing required by Section 16950 - Electrical Testing.

- END OF SECTION -

SECTION 16431 - PROTECTIVE DEVICE STUDIES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall perform short circuit and protective device studies for the electrical power system in accordance with the Contract Documents.

B. The study shall include all portions of the electrical distribution system included in the work under this Contract, down to and including the 480 V distribution system. The Contractor may utilize existing studies as they relate to the power distribution system feeding the point of connection to the work under this Contract, as may be available from the Owner.

C. The WORK of this Section shall include protection studies for motors with solid state overload and overcurrent protection devices.

D. It is the responsibility of the CONTRACTOR to obtain from the Owner, the electric utility and appropriate vendors the information required to perform the study.

1.2 QUALIFICATIONS

A. Short circuit studies, protective device evaluation studies, and protective device coordination studies shall be performed by a manufacturer who has been regularly engaged in short circuit and protective device coordination services for a period of at least 15 years.

B. Studies shall utilize proven computer programs for making three-phase fault duty calculations.

1.3 CONTRACTOR SUBMITTALS

A. The Report shall be submitted and approved prior to final approval of the distribution equipment shop drawings and release of equipment for manufacture. Approval from the ENGINEER shall be obtained to ensure that equipment withstand and interruption ratings will be adequate.

B. The Report shall be approved by the ENGINEER prior to releasing all distribution equipment for manufacture.

1.4 SERVICES OF MANUFACTURERS

A. The low voltage switchgear manufacturer shall furnish the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system coordination study.

B. The motor control center manufacturer shall furnish the services of a qualified field engineer to calibrate all MCPs as recommended in the power system study.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 GENERAL

A. The study shall include single-line and impedance diagrams of the power system. This diagram shall identify all components considered in the study and the ratings of all power devices, including transformers, circuit breakers, relays, fuses, busses, and cables. The resistances, and reactances of all cables shall be identified in the impedance diagram. The study shall contain all written data from the electric utility company regarding maximum available short circuit current, voltage, and X/R ratio of the utility power system.

B. The study shall include all protective devices and feeders included and/or modified under this CONTRACT. The first upstream overcurrent device outside this CONTRACT shall be used as a fixed reference.

3.2 SHORT CIRCUIT STUDY

A. The short circuit study shall be performed with the aid of a digital computer program, and shall be in accordance with:

1.	ANSI/IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
2.	ANSI/IEEE 242	Recommended Practice for Protection, and Coordination of Industrial, and Commercial Power Systems
3.	ANSI/IEEE C 37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4.	ANSI/IEEE C 37.13	Low-Voltage AC Power Circuit Breakers Used in Enclosures

3.3 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, molded case switches, and fuses. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the ENGINEER's attention.

3.4 PROTECTIVE DEVICE COORDINATION STUDY

A. A protective device coordination study shall be performed to provide the necessary calculations required to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.

3.5 TIME/CURRENT COORDINATION CURVES

A. As a minimum, the time/current coordination curves for the power distribution system shall include the following on 5-cycle log-log graph paper:

1. Time/current curves for each protective relay, circuit breaker, or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and tap and time dial settings shall be specified. Provide individual curves for each feeder unless identical to others.

2. Time/current curves for each device shall be positioned to provide the maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause. Recommendations shall be included for alternate methods that would improve selectivity.

3. Time/current curves and points for cable and equipment damage.

4. Circuit interrupting device operating and interrupting times.

5. Indicate maximum fault values on the graph.

6. Sketch of bus and breaker arrangement.

7. Magnetizing inrush points of transformers.

8. Thermal limits of dry type and liquid insulated transformers. (ANSI damage curve).

9. All restrictions of the ANSI and National Electrical Code shall be followed, and proper coordination intervals and separation of characteristics curves shall be maintained.

3.6 REPORT

A. The results of the power system studies shall be summarized in a final Report. Eight bound copies of the Report shall be submitted. The Report shall include the following:

1. Single-line diagram

2. Impedance diagram

3. Tabulation of all protective devices, which shall be identified on the single line diagram

4. Time/current coordination curves

5. Computerized fault current calculations

6. Specific recommendations, if any

7. Test instrumentation, condition, and connections, as applicable, for each study.

B. The Report shall include information concerning the computer program used for the study and also shall include a general discussion of the procedure, items, and data considered in preparing the study.

C. The CONTRACTOR shall indicate in the Report suggested changes to the protection scheme or equipment selection that will result in improved system reliability, and safety.

3.7 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. Test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system coordination study.

B. Calibrate all MCPs as recommended in the power system study.

C. All adjustments shall be made prior to energization of any electrical equipment.

- END OF SECTION -

SECTION 16450 - GROUNDING

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide the electrical grounding system, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 16050 - Electrical Work, General apply to this Section.

C. **Single Manufacturer:** Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with the requirements of Section 01300 - Contractor Submittals and Section 16050.

B. **Shop Drawings:** Manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

PART 2 – PRODUCTS

2.1 GENERAL

A. All components of the grounding electrode system shall be manufactured in accordance with ANSI/UL 467 - Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

2.2 GROUNDING ELECTRODE SYSTEM

A. Grounding loop conductors shall be bare annealed copper conductors suitable for direct burial. Conductors shall be #4/0 unless indicated otherwise.

B. Ground rods shall be copper-clad steel conforming to ANSI/UL 467.

1. Ground rods shall be 3/4-inch diameter and 10 feet long unless indicated otherwise.

2. Where ground rod lengths indicated on the Contract Drawings are unavailable, ground rods shall be coupled together using threaded copper alloy couplings.

C. Cable-to-cable and cable-to-ground rod connections shall be made using exothermic welds. Exothermic welds shall be by **Cadweld or Enrico Products.**

D. Grounding clamps shall be used to bond each separately derived system to the grounding electrode conductors.

E. Manufacturers of grounding materials shall be **Copperweld, Blackburn or Burndy.**

PART 3 – EXECUTION

3.1 GROUNDING

A. **General:** When sizes are not specifically indicated on the Drawings, grounding cable shall be sized by the CONTRACTOR in accordance with all applicable code requirements. The location of ground rods shall be as indicated. The lengths of rods forming an individual ground array shall be equal and shall be of the quantity required to obtain a ground resistance of no more than 5 ohms. Resistance may be less where specific code or utility requirements apply. The grounding system shall be in strict accordance with Article 250 of the N.E.C.

B. **Equipment Ground:** Ground continuity throughout the facility shall be maintained by means of a ground conductor run in all conduits. Grounding conductors run in conduit shall be insulated copper conductors, sized in accordance with the N.E.C. and the Drawings. Conductors shall meet the requirements of Section 16120 - Wire and Cables.

1. Metal equipment platforms which support any electrical equipment shall be bonded to the nearest ground bus or to the nearest switchgear ground bus. This grounding requirement is in addition to the raceway grounding required in the preceding paragraph. If not indicated otherwise, provide #6 AWG conductor in 3/4-inch conduit.

2. Copper bonding jumpers shall be used to obtain a continuous metallic ground for equipment such as expansion joints, cable trays, switchgear, and motor control centers.

C. **Grounding Electrode System:** The CONTRACTOR shall install the grounding electrode system with all required components in strict accordance with National Electrical Code Article 250.

1. Connection to ground electrodes and ground conductors shall be exothermic welded where concealed and shall be bolted pressure type where exposed. Bolted connectors shall be assembled wrench tight to manufacturer's requirements.

2. Insulated grounding bushings shall be employed for all grounding connections to steel conduits in switchboards, in motor control centers, in pullboxes, and elsewhere where conduits do not terminate at a hub or a sheet metal enclosure. Where insulated bushings are required, fasten with double locknuts.

3. Copper bonding jumpers shall be used to obtain a continuous metallic ground across non-conductive structural members.

4. Within buildings, the grounding cable shall, where possible, be embedded in or installed beneath the slabs.

D. Shield Grounding

1. Shields on power cable shall be grounded at each termination in a manner recommended by the cable manufacturer.

2. Shielded instrumentation cable shall be grounded at one end only; this shall typically

be at the "receiving" end of the signal carried by the cable.

3. Termination of each shield drain wire shall be on its own terminal screw. All of these terminal screws in one rack shall be jumpered with No. 16 solid tinned bare copper wire; connection to ground shall be accomplished with a No. 12 green insulated conductor to the main ground bus.

- END OF SECTION -

SECTION 16455 - VARIABLE FREQUENCY DRIVE UNITS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide all variable frequency drive (VFD) units, complete and operable, in accordance with the Contract Documents. It is the intent of this Section to require complete, reliable, fully tested variable frequency drive systems suitable for attended or unattended operation.

B. The requirements of Section 16050 - Electrical Work, General, apply to the WORK of this Section.

C. **Single Manufacturer:** Like products shall be the end product of one Manufacturer in order to standardize appearance, operation, maintenance, spare parts, and Manufacturer's services. This requirement, however, does not relieve the CONTRACTOR of overall responsibility for the WORK.

D. **Coordination:** The equipment provided under this Section shall operate the electric motor driver with the driven equipment as indicated under other equipment specifications. The CONTRACTOR'S attention is specifically directed to the need for proper coordination of the WORK under this Section and the WORK under the equipment section with the WORK under Section 16460 - Electric Motors.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals, except that shop drawing information for the drives shall be submitted as part of the drawing information for the driven equipment.

B. **Shop Drawings:** Shop Drawings shall include the following information:

1. Equipment information:

    a. Name of drive Manufacturer

    b. Type and model

    c. Assembly drawing and nomenclature

    d. Maximum heat dissipation capacity in KW

2. Written description of ladder diagram operation, system operation, and analog signal processing.

3. System block diagram, system schematic diagram, and interconnection diagrams.

4. Factory test data certifying compliance with requirements of similar equipment from the same Manufacturer.

C. **Owner's Manual:** The Owner's Manual shall contain the following documentation:

1. Manufacturer's two year warranty

2. Harmonic analysis report

3. Field test report

D. **Spare Parts List:** Spare parts information for parts required by this Section plus any other spare parts recommended by the controller Manufacturer.

PART 2 – PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall provide a total of 2 variable frequency drives, provided as a part of Motor Control Center, MCC-1 and MCC-2. Equipment to be operated through variable frequency drives include the following:

Qty	Equipment	HP	Constant or Variable Torque (C/V)	RPM	Enclosure Type
2	Sludge Feed Pumps	20	C	1800	NEMA 1

2.2 EQUIPMENT

A. The adjustable frequency power supply shall be an adjustable frequency inverter designed to convert incoming 3 phase, 480 volt, 60 Hertz power to a DC voltage and then to adjustable frequency AC by use of a 3 phase inverter. The inverter shall be a voltage source design producing a pulse-width-modulated type output. The inverters shall be designed to operate 460 volt, 3 phase, 60 Hertz, NEMA-B, TEFC (1.15 SF), squirrel-cage high efficiency inverter duty induction motors over the range of 50-100 percent of base speed without derating or requiring any motor modifications, inverters shall be capable of delivering nameplate horsepower exclusive of service factor without the need for mandatory thermostats or feedback tachometers. The VFD shall vary both the AC voltage and frequency simultaneously to operate the motor at required speeds. Current source inverters will not be acceptable. Inverters shall be sized to match the KVA and inrush characteristics of the motors actually furnished. The Contractor shall be responsible for matching the controller to the load (constant torque) as well as the speed and current of the actual motor being controlled.

B. The minimum VFD inverter efficiency shall be 95 percent at 100 percent speed and load, and 85 percent at 50 percent speed and load.

C. The VFD shall shut down in an orderly manner when a power outage occurs on one or more phases. Upon restoration of power and a "start" signal, the motor shall restart and run at the speed corresponding to the current process input signal.

D. The VFD shall be provided with additional features described below:

1. Inrush current adjustment between 50 and 110 percent of motor full load current

(factory set at 100 percent).

2. Overload capability at 110 percent for 60 seconds for variable torque loads and 150 percent for constant torque loads.

3. Adjustable acceleration and deceleration.

4. Input signal of 4 - 20 mA from process.

5. Output speed signal of 4 - 20 mA. Signals other than 4 - 20 mA are not acceptable.

6. On loss of input signal, the VFD shall operate at a preset speed.

7. A minimum of two selectable frequency jump points to avoid critical resonance frequency of the driven system.

8. The VFD's shall have the ability to re-start into a spinning motor in any direction and resume operation without tripping.

9. Additional devices and functions as indicated.

E. **Protection:** The VFD shall have, as a minimum, the following protection features:

1. Input line protection shall be provided with metal oxide varistor (MOV) and RC network.

2. Protection against single phasing

3. Instantaneous overcurrent protection.

4. Electronic overcurrent protection.

5. Ground fault protection.

6. Overtemperature protection for electronics.

7. Protection against internal faults.

8. Ability to start into rotating motor (forward or reverse rotation).

9. Additional protection and control as indicated and as required by the motor and driven equipment.

F. **Service Conditions:** The VFD shall be designed and constructed to satisfactorily operate within the following service conditions.

1. Elevation to 3300 feet

2. Ambient temperature - 0 degree C to 40 degrees C

3. Humidity: 0 to 95 percent, non-condensing

4. AC line voltage variation: plus 10 percent to minus 10 percent, exclusive of voltage drop in the isolation transformer

5. AC line frequency variation: plus and minus 2 hertz

G. **Enclosure:** The enclosure shall be NEMA type 1, for mounting in the MCC's provided under this Contract.

H. Electrical equipment provided in addition to the adjustable frequency inverter for each drive, shall include:

1. Isolation Transformer, specifically designed for use with 3-phase AC adjustable speed drives to provide isolation between the incoming line and the drive circuitry. Line reactors, in lieu of isolation transformers will not be acceptable. The isolation transformers shall be **Cutler-Hammer Type MD or G.E., Type DIT.**

2. Fused 480-120 volt control transformer to provide system control power for the logic and pilot lamps.

3. Input fused disconnect.

4. Provide overload heaters with auxiliary contacts to protect the motors. Refer to Elementary Schematics on the Contract Drawings for details. Heaters shall be sized for the motor actually furnished.

I. The inverter signal circuits shall be isolated from the power circuits and designed to accept an isolated 4-20 mA signal in the automatic mode of operation. The inverter shall follow the setting of a remote or local potentiometer control when in the manual mode. Refer to the Electrical Elementary Schematic drawings for speed control and start/stop methods. The following operator devices for the inverter shall be mounted and wired at locations as indicated:

1. Auto/Hand selection from a remote logic relay or switch. In "Auto", the inverter shall operate from the remote 4-20 mA input, where applicable, and in "Hand" control, shall be from a local or remote manually operated speed potentiometer. Speed pot ratings shall be coordinated with the supplier of the Local Control Station.

2. Speed meter, calibrated in percent speed

3. Inverter fault trip pilot light and output alarm contacts

4. Trip reset pushbutton

5. Run indicating light

6. Other controls and readouts normally furnished as standard equipment, or as otherwise indicated on the Electrical Contract Drawing Elementary Schematics

J. Screw type terminal boards, properly identified, shall be provided for interconnection to remote controls and instrumentation including: Hand-Off-Automatic Switch, remote start/stop control, On-Off Lights, 4-20 mA speed control input, potentiometer speed control input, and 4-20 mA speed output.

2.3 HARMONIC ANALYSIS FOR DRIVES

A. Harmonic analysis shall be performed in accordance with IEEE 519-Harmonic Control and Reactive Compensation of Static Power Converters at unit full load using a harmonic analyzer by Hewlett Packard.

B. The following assumptions shall be utilized:

1. The distribution system is a "general" system as classified by IEEE 519 under low voltage systems.

2. Assume 90 percent of total plant operating load is motor load (10 percent resistive).

3. Assume a 70 percent plant diversity factor (70 percent of total plant load is operating). Motors other than VFD's shall operate at 90 percent of name plate horsepower.

4. Assume all VFD's are operating.

5. Results shall be submitted prior to VFD shipment. Excessive harmonic distortion shall be specifically denoted and recommended corrective measures shall be submitted for action by the ENGINEER.

2.4 SPARE PARTS

A. The CONTRACTOR shall furnish the spare parts listed below, suitably packaged and labeled with the corresponding equipment number.

B. During the term of this Contract, the CONTRACTOR shall notify the ENGINEER in writing about any Manufacturer's modification of spare part numbers, interchangeabilities, or model changes. If the ENGINEER determines that the modified parts no longer apply to the equipment provided, the CONTRACTOR shall furnish other applicable parts at no increase in cost to the OWNER.

C. The following spare parts shall be furnished:

1. One set of spare fuses of each size

2. Two lamp lenses of each color

3. Two dozen pilot lamps

4. One of each type of circuit board

   a. Control board

   b. Power board

   c. Diode bridge

   d. Transistor module

5. One set of tools for maintenance of all VFD units

2.5 MANUFACTURERS

A. The variable frequency drive units shall be **Cutler-Hammer or General Electric**, and shall be of the same manufacturer as the associated MCC in which they are mounted.

PART 3 – EXECUTION

3.1 SERVICES OF MANUFACTURER

A. **General:** An authorized service representative of the Manufacturer shall be present at the site for 3 work days to furnish the services listed below. A minimum of 2 days shall be allowed for startup and one additional day for operating and maintenance instructions. For the purpose of this paragraph, a work day is defined as an 8-hour period excluding travel time.

B. **Inspection, Startup, Field Adjustment:** The authorized service representative shall supervise the following and certify the equipment and controls have been properly installed, aligned, and readied for operation.

1. Installation of the equipment
2. Inspection, checking, and adjusting the equipment
3. Startup and field testing for proper operation
4. Performing field adjustments to insure that the equipment installation and operation comply with requirements

C. **Instruction of OWNER's Personnel:** The authorized representative shall instruct the OWNER's personnel in the operation and maintenance of the equipment, including step by step troubleshooting with test equipment. Instruction shall be specific to the VFD models provided. Training shall be scheduled for one day, at the conclusion of equipment startups.

3.2 INSTALLATION

A. Conduit stub-ups for interconnected cables and remote cables shall be located and terminated in accordance with the drive manufacturer's recommendation.

3.3 FIELD TESTING

A. Testing, checkout, and startup of the variable frequency drive equipment in the field shall be performed under the technical direction of the Manufacturer's service engineer. Under no circumstances are any portions of the drive system to be energized without authorization from the Manufacturer's representative.

B. Tests shall prove that the harmonic voltage distortion at the 480 volt distribution bus of the panelboard, motor control center, or switchgear serving the VFD is limited to a magnitude of 5 percent of the fundamental with the isolation transformer in the circuit as indicated and with the maximum number of drives, as permitted by the process, in operation. The report shall include the following:

1. Expected harmonic voltage (THD) through the 35th harmonic, calculated with isolation transformers

2. Actual RMS value and measured percentage of the THD in the field.

- END OF SECTION -

SECTION 16460 - ELECTRIC MOTORS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide electric motors, accessories, and appurtenances complete and operable, in conformance with the individual driven equipment specifications and the Contract Documents.

B. The provisions of this Section apply to all low voltage AC squirrel cage induction motors except as indicated otherwise.

C. The CONTRACTOR shall assign to the equipment supplier the responsibility to select suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review by the ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 01300-Contractor Submittals.

B. Complete motor data shall be submitted with the driven machinery shop drawings. Motor data shall include:

1. Machine name and specification number of driven machine
2. Motor manufacturer
3. Motor type or model and dimension drawing. Include motor weight.
4. Nominal horsepower
5. NEMA Design
6. Enclosure
7. Frame Size
8. Winding insulation class and temperature rise class
9. Voltage, phase and frequency ratings
10. Service factor
11. Full load current at rated horsepower for application voltage
12. Full load speed
13. Guaranteed minimum full load efficiency. Also nominal efficiencies at 1/2 and 3/4 load.

14. Type of thermal protection or overtemperature protection, if included

15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable

16. Bearing data. Include recommendation for lubricants of relubricatable type bearings.

17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery.

18. Power factor at 1/2, 3/4 and full load

19. Recommended size for power factor correction capacitors to improve power factor to 0.95 (lagging) when operated at full load.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall in all cases be equal to nameplate horsepower rating or less, exclusive of service factor and be verifiable from the submittal data of the driven machinery.

C. **Minimum motor HP:** The CONTRACTOR shall size motors to continuously carry the maximum load imposed through the full range for driven equipment operation; however, power ratings shall not be less than the specified values, when indicated in the specification. If the specified values are less than those required from the first criterion above, then the CONTRACTOR shall provide greater capacity motors at no additional cost to the OWNER. In addition, increases in circuit breaker, magnetic starter, conductor, and conduit size capacities related to increased motor size shall also be provided at no additional cost to the OWNER.

D. **Exempt Motors:** Motors which are for valve operators, submersible pumps, or motors which are an integral part of standard manufactured equipment, i.e., non-NEMA mounting, common shaft with driven element, or part of domestic or commercial use apparatus may be excepted from these specifications to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.2 DESIGN REQUIREMENTS

A. **General:** All electric motors shall comply with ANSI/NEMA MG-1 - Motor and Generator. All motors used with adjustable frequency drives shall comply with ANSI/NEMA MG-1, Part 31.

B. **NEMA Design:** Electric motors shall be NEMA Design B, (except motors controlled for variable speed operation and other special motors) and constant speed squirrel-cage induction motors having normal starting torque with low starting current. In no case shall starting torque or breakdown torque be less than the value specified in said ANSI/NEMA MG 1. Motors shall be suitable for the indicated starting method.

C. **Motor Voltage Ratings:** Motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

20. Motors below 1/2-HP shall be rated 115 volts, single-phase, 60-Hz. Dual voltage motors rated 115/230-volts, 115/208-volts, or 120-240 volts are acceptable, provided all leads are brought out to the conduit box.

21. Motors 1/2-HP and larger shall be rated 230 volts, 460 volts, or 4160 volts, 3-phase, 60-Hz. Dual voltage motors rated 230/460 volts or 208/230/460 volts are acceptable, provided all loads are brought out to the conduit box.

D. **Insulation:** All 3-phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in ANSI/NEMA MG 1-12.42. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class. Motors to be operated from adjustable frequency drives shall be provided with insulation systems to withstand 1600 volt spikes, with dV/dt as defined in NEMA MG 1-31.

E. All motors 50 HP or smaller located in non-hazardous areas shall be totally enclosed, fan cooled (TEFC) with a Service Factor of 1.15 unless otherwise indicated.

F. All motors 50 HP and greater located in non-hazardous areas shall be with a service factor of 1.15.

G. Motors for use in hazardous locations shall have enclosures suitable for the classification indicated. Such motors shall be U.L. listed and be stamped as such.

H. Motors larger than 50 HP used outdoors shall have 120-volt AC space heaters and temperature sensors.

I. **High Efficiency Motors:**

1. Motors with a nameplate rating of 1 HP and larger shall be "high efficiency" units. Motors shall be stamped with the efficiency on the nameplate with the caption "NEMA Nominal Efficiency" or "NEMA Nom. Eff." Such motors shall have efficiencies determined by the test as set forth in ANSI/IEEE 112 -Standard Test Procedure for Polyphase Induction Motors and Generators, Method B.

2. Efficiency Index: Efficiency index, nominal efficiency, and minimum efficiency shall be defined in accordance with ANSI/NEMA MG 1-12.59 - Efficiency Levels of Energy Efficient Polyphase Squirrel-Cage Induction Motors: these three values shall be stated in the Shop Drawing submittal.

3. High Efficiency motors shall conform to the following guaranteed minimum efficiency requirements which are full load values:

OPEN DRIP-PROOF (ODP)								
FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS								
OPEN MOTORS								
	2 POLE		4 POLE		6 POLE		8 POLE	
HP	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.
1.0	--	--	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	84.0	81.5	75.5	72.0
2.0	84.0	81.5	84.0	81.5	85.5	82.5	85.5	82.5
3.0	84.0	81.5	86.5	84.0	86.5	84.0	86.5	84.0
5.0	85.5	82.5	87.5	85.5	87.5	85.5	87.5	85.5
7.5	87.5	85.5	88.5	86.5	88.5	86.5	88.5	86.5
10.0	88.5	86.5	89.5	87.5	90.2	88.5	89.5	87.5
15.0	89.5	87.5	91.0	89.5	90.2	88.5	89.5	87.5
20.0	90.2	88.5	91.0	89.5	91.0	89.5	90.2	88.5
25.0	91.0	89.5	91.7	90.2	91.7	90.2	90.2	88.5
30.0	91.0	89.5	92.4	91.0	92.4	91.0	91.0	89.5
40.0	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50.0	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60.0	93.0	91.7	93.6	92.4	93.6	92.4	92.4	91.0
75.0	93.0	91.7	94.1	93.0	93.6	92.4	93.6	92.4
100.0	93.0	91.7	94.1	93.0	94.1	93.0	93.6	92.4
125.0	93.6	92.4	94.5	93.6	94.1	93.0	93.6	92.4
150.0	93.6	92.4	95.0	94.1	94.5	93.6	93.6	92.4
200.0	94.5	93.6	95.0	94.1	94.5	93.6	93.6	92.4
250.0	94.5	93.6	95.4	94.5	95.4	94.5	94.5	93.6
300.0	95.0	94.1	95.4	94.5	95.4	94.5	--	--
350.0	95.0	94.1	95.4	94.5	95.4	94.5	--	--
400.0	95.4	94.5	95.4	94.5	--	--	--	--
450.0	95.8	95.0	95.8	95.0	--	--	--	--
500.0	95.8	95.0	95.8	95.0	--	--	--	--

TOTALLY ENCLOSED - FAN COOLED (TEFC)								
ENCLOSED MOTORS								
	2 POLE		4 POLE		6 POLE		8 POLE	
HP	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.
1.0	75.5	72.0	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	85.5	82.5	77.0	74.0
2.0	84.0	81.5	84.0	81.5	86.5	84.0	82.5	80.0
3.0	85.5	82.5	87.5	85.5	87.5	85.5	84.0	81.5
5.0	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10.0	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15.0	90.2	88.5	91.0	89.5	90.2	88.5	88.5	86.5
20.0	90.2	88.5	91.0	89.5	90.2	88.5	89.5	87.5
25.0	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
30.0	91.0	89.5	92.4	91.0	91.7	90.2	91.0	89.5
40.0	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50.0	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60.0	93.0	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75.0	93.0	91.7	94.1	93.0	93.6	92.4	93.0	91.7
100.0	93.6	92.4	94.5	93.6	94.1	93.0	93.0	91.7
125.0	94.5	93.6	94.5	93.6	94.1	93.0	93.6	92.4
150.0	94.5	93.6	95.0	94.1	95.0	94.1	93.6	92.4
200.0	95.0	94.1	95.0	94.1	95.0	94.1	94.1	93.0
250.0	95.4	94.5	95.0	94.1	95.0	94.1	94.5	93.6
300.0	95.4	94.5	95.4	94.5	95.0	94.1	--	--
350.0	95.4	94.5	95.4	94.5	95.0	94.1	--	--
400.0	95.4	94.5	95.4	94.5	--	--	--	--
450.0	95.4	94.5	95.4	94.5	--	--	--	--
500.0	95.4	94.5	95.8	95.0	--	--	--	--

J. All two-speed motors shall be the two-winding type.

2.3 ACCESSORY REQUIREMENTS

A. **General:** Horizontal motors 3 HP and larger, and all vertical motors, shall have split-type cast metal conduit boxes. Motors less than 3 HP shall have the manufacturer's standard conduit boxes. Motors other than open drip-proof shall be gasketed.

B. **Lifting Devices:** All motors weighing 265 lb (120 Kg) or more shall have suitable lifting eyes for installation and removal.

C. **Special Requirements:** The CONTRACTOR shall refer to individual equipment specifications for special requirements such as motor winding thermal protection or multi-speed windings.

D. **Grounding Lugs:** Provide motor grounding lug suitable to terminate ground wire, sized as indicated.

E. **Nameplate:** All motors shall be fitted with permanent stainless steel nameplates indelibly stamped or engraved with NEMA Standard motor data, in conformance with NEMA MG-1-10.40.

F. The motor manufacturer shall furnish for installation by the CONTRACTOR power factor correction capacitors for each motor 10 HP and larger that is started with FVNR, starters only. Motors started with solid state starters or VFDs shall not have capacitors. The capacitors shall be fused, with internal resistors, suitably enclosed for mounting adjacent to the starter, MCC, or the motor, and sized to improve power factor to not less than 95 percent at full load. Size shall be as recommended by the motor manufacturer. The capacitors shall be wired to the motor starter output terminals. Dielectric fluid shall be non-PCB type, non-flammable and biodegradable.

G. Where motors are indicated by elementary schematics or specifications to have zero speed switches, the switches shall be factory mounted integral to the motors. Switches shall close contact when the motor is at zero speed.

2.4 MOTOR THERMAL PROTECTION

A. **Single Phase Motors:** All single phase 120, 208, or 230 volt motors shall have integral thermal overload protection or shall be inherently current limited.

B. **Thermostats:** Winding thermostats shall be snap action, bi-metallic, temperature-actuated switch. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be precalibrated by the manufacturer.

C. **RTDs**: Bearing RTDs and/or winding RTDs (two per phase) shall be provided where indicated. RTDs shall be 10 ohm copper.

2.5 MOTOR BEARINGS

A. **General:** Bearings shall conform to Section 11000 - Equipment General Provisions, except as indicated herein.

B. All motors greater than 2 HP shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.

C. **Fractional Horsepower:** Motors with fractional horsepower through 2 HP shall be provided with Lubricated-for-Life ball bearings.

D. **Horizontal Motors Over 2 HP:** Motors larger than 2 HP shall be provided with relubricatable ball bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

E. **Vertical Motors Over 2 HP:** Vertical motors larger than 2 HP shall be provided with relubricatable ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

2.6 **Manufacturers:**

A. **U.S. Motors;**

B. **Reliance Electric.**

PART 3 – EXECUTION

3.1 INSTALLATION

A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment.

B. Related electrical work involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 16.

C. Capacitors shall be connected to the motor branch circuit conductors on the load side of the starter contactor. Motor overload elements shall be adjusted downwards to reflect the reduction in line current resulting from power factor correction.

3.2 FACTORY TESTING

A. Motors rated 100 HP and larger shall be factory tested in conformance with ANSI/IEEE 112, IEEE 43 - Recommended Practice for Testing Resistance of Rotating Machinery, and NEMA MG-2. Except where specific testing or witnessed shop tests are required by the specifications for driven equipment, factory test reports may be copies of routine test reports of electrically duplicate motors. Test report shall indicate test procedure and instrumentation used to measure and record data. Test report shall be certified by the motor manufacturer's test personnel and be submitted to the ENGINEER.

3.3 FIELD TESTING

A. The CONTRACTOR shall perform the following field tests:

1. Inspect each motor installation for any deviation from rated voltage, phase, or frequency and improper installation.

2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage.

3. Check winding and bearing temperature detectors and space heaters for functional operation.

4. Test for proper rotation prior to connection to the driven equipment.

5. Test insulation (megger test) of all new and re-used motors in accordance with NEMA MG-1. Test voltage shall be 1000 VAC plus twice the rated voltage of the motor.

- END OF SECTION -

SECTION 16470 - PANELBOARDS AND GENERAL PURPOSE DRY-TYPE TRANSFORMERS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide panelboards and general purpose dry-type transformers, complete and operable, in accordance with the Contract Documents.

B. **Single Manufacturer:** Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals and Section 16050 - Electrical Work, General.

B. Shop Drawings

1. Transformers

a. Dimension drawings
b. Technical certification sheets
c. Drawing of conduit entry/exit locations
d. Transformer ratings, including:
(1) Voltage
(2) Continuous current
(3) Basic impulse level for equipment over 600 volts
(4) kVA
e. Descriptive bulletins
f. Product sheets

2. Panelboards

a. Breaker layout drawings with dimensions and nameplate designations
b. Component list
c. Drawings of conduit entry/exit locations
d. Assembly ratings including:
(1) Short circuit rating
(2) Voltage
(3) Continuous current
e. Cable terminal sizes
f. Descriptive bulletins
g. Product sheets
h. Installation information
i. Seismic certification and equipment anchorage details

PART 2 – PRODUCTS

2.1 GENERAL

A. Transformers

1. The transformers shall be dry-type, designed, manufactured, and tested in accordance with the latest applicable standards of ANSI and NEMA.

2. All transformers shall be UL-listed and bear the UL label.

B. Panelboards

1. Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Safety Panelboards. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208-volt, 3-phase operation or 120/240-volt for single phase operation as indicated. Power panelboards shall be rated for 480 volts, 3-phase, 3-wire operation.

2. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

2.2 TRANSFORMERS

A. Ratings

1. KVA and voltage ratings shall be as indicated.

2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96 - Guide for Loading Dry Type Distribution and Power Transformers.

3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Up	to	9 kVA; 40 db
10	to	50 kVA; 45 db
51	to	150 kVA; 50 db

B. Construction

1. Insulation Systems

a. Transformers shall be insulated as follows:

(1) 2 kVA and below: 150 degrees C insulation system based upon 80 degree C rise.

(2) 3 to 15 kVA: 185 degrees C insulation system based upon 115 degree C rise.

(3) 15 kVA and above: 220 degrees C insulation system based upon 150 degree C rise.

b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient.

c. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

C. Manufacturers:

1. Transformers shall have four 2-1/2 percent taps, two above and two below 480 volts. Transformers shall be floor or wall-mounted type by **General Electric, Cutler-Hammer or Square D.**

2.3 PANELBOARDS

A. Ratings

1. Panelboards rated 240 VAC or less shall have short circuit ratings not less than 10,000 amperes RMS symmetrical or as indicated, whichever is greater.

2. Panelboards rated 480 VAC shall have short circuit ratings not less than 25,000 amperes RMS symmetrical or as indicated, whichever is greater.

3. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

B. Construction

1. All lighting and power distribution panels shall have copper busbars.

2. Breakers shall be one, two, or three pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse time trip characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position.

3. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall be inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.

4. All panelboards shall be rated for the intended voltage.

5. All circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. No plug-in circuit breakers will be acceptable.

6. Lighting and power distribution panels which are not part of a motor control center shall be mounted in code gauge galvanized steel cabinets. Panels shall have the

necessary barriers, supports, and liberal wiring gutters. Trim screws shall be galvanized or cadmium plated steel. All panelboard parts of metal other than copper, aluminum, or galvanized steel shall be cadmium plated. Panelboards shall be as manufactured by **General Electric or Cutler-Hammer (Cutler-Hammer).**

7. Panelboards shall be UL listed except for special enclosures which are not available with UL listing.

8. Panelboards shall be suitable for use as service entrance as indicated or as otherwise required by the N.E.C.

9. The new 30 KVA, 120/208 volt, 3-phase, 4-wire Mini-Powercenter, to be furnished as part of this Contract shall be provided in a weatherproof stainless steel enclosure.

10. Outdoor panelboards, rated 480 volts shall be provided in weatherproof, Type 304 stainless steel enclosures.

PART 3 – EXECUTION

3.1 GENERAL

A. All WORK of this Section shall be installed as indicated in Section 16050.

- END OF SECTION -

SECTION 16480 - LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide motor control centers (MCC's), complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 16050 - Electrical Work, General, apply to the WORK of this Section.

C. In the event that motors provided are larger horsepower than motors indicated, raceways, conductors, starters, overload elements, and branch circuit protectors shall be revised as necessary to control and protect the increased motor horsepower according to Section 16460-Electric Motors. Adjustments shall be made at no increase in cost to the OWNER.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Sections 01300-Contractor Submittals and 16050.

B. Shop Drawings

1. Enclosure NEMA rating and color
2. Horizontal and vertical bus ampacities, voltage rating and interrupting capacity. Include materials of construction
3. Ground bus size and material of construction
4. Conduit entrance provisions
5. Main incoming line entry provision (top or bottom)
6. Control unit nameplate schedule
7. All circuit breaker types, frames and settings
8. All starter NEMA sizes, auxiliary contact provisions, coil voltage
9. Relays, timers, pilot devices, control transformer VA and fuse sizes
10. Elementary schematic ladder diagrams for each compartment. Custom schematics shall be furnished. Diagrams shall include all remote devices. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED".
11. Short circuit rating of the complete assembly
12. Replacement parts lists and operation and maintenance procedures

PART 2 – PRODUCTS

2.1 GENERAL

A. The manufacturer of the low voltage motor control center shall also be the manufacturer of at least the following:

1. Molded case circuit breakers up to and including 225 ampere frame size
2. Disconnect switches
3. Magnetic motor starters
4. Control and timing relays rated at 600 volts AC
5. Pushbuttons, lights, and selector switches, including remote mounted control stations
6. Meters, including ammeter, voltmeter, and solid-state metering devices
7. VFD's provided as part of the MCC's.

B. Devices of the same type shall be products of the same manufacturer. This requirement applies to all control devices, and insofar as practical, to equipment manufactured on a production basis. It also applies without exception to equipment custom fabricated for this project.

C. Motor control centers shall conform to the standards for NEMA Class IIS, type B diagrams and wiring.

D. MCC Schedule

MCC DESIGNATION	LOCATION
MCC-1,2	Residuals Bldg. – Electric Room

2.2 DESIGN, CONSTRUCTION, AND MATERIAL REQUIREMENTS

A. The motor control centers shall be 600-volt class suitable for operation on a three-phase, 60-Hz system. The system operating voltage and number of wires shall be as indicated.

B. The motor control center shall receive power from a three phase, wye connected 277/480 volt transformer with a grounded neutral. Power distribution from the MCC shall be 480 volt, three-phase, three-wire, however the MCC shall include provision for termination of an incoming neutral conductor in conformance to NEC requirements for service entrance.

C. Enclosure shall be NEMA Type 1 enclosure. Compartment doors shall be interlocked with compartment circuit breakers. The interlock shall be fitted with a maintenance override.

D. Size and Arrangement

1. Motor control centers shall be of mechanical groupings of control center units, assembled into a lineup of control center sections. Each control section shall be nominally 90 inches tall by minimum 20 inches deep.

2. MCC's shall be designed to not exceed the space requirements as indicated on the Contract Drawings, including spaces, spares and future compartments. MCC's shall be subject to rejection for exceeding the lengths shown where allotted space is

critical.

3. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing the MCC provides the spares, space and future provisions indicated.

E. Components

1. Busses

a. A continuous copper ground bus shall be provided with full width of the motor control center line-up.

b. The main horizontal bus shall be copper, tin, or silver-plated copper located within an isolated compartment. The bus shall be rated 600 amperes minimum, but in no instance less than the main lug or main breaker frame size.

c. The vertical bus in each section shall consist of a single silver-plated copper conductor per phase with a current capacity of not less than 300 amps. The vertical bus shall be completely isolated and insulated, and shall extend the full height of the section wherever possible.

d. Fully rated continuous copper neutral bus shall be provided through the control center. Lugs of appropriate capacity shall also be furnished.

e. All power buses shall be braced to withstand 65,000 amperes.

2. Wireways: A separate vertical wireway shall be provided adjacent to each vertical unit, and shall be covered by a hinged door. Each individual unit compartment shall be provided with a side barrier to permit pulling wire in the vertical wireway without disturbing adjacent unit components.

F. Cabinet

1. Structural members shall be fabricated of not less than 12 gauge steel and side and top panels and doors shall be not less than 14 gauge steel.

2. Spaces designated as "SPACE" or "BLANK" shall include blank hinged doors and vertical bus bars.

3. Control units inside compartments shall be clearly identified with tags or stencil markings.

4. Each control unit including spares, spaces, and blanks, lights and devices shall be identified by an engraved nameplate. Identification shall include circuit number as indicated.

5. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including sales order number, date of manufacturer, and place of manufacture.

6. Where "L" or "U" shaped MCC layouts are indicated, corner compartments shall have similar current and short circuit ratings as functional compartments.

7. Finish for motor control center shall be light grey, ANSI 61. The panels shall be given two coats of primer inside and out and two coats of enamel finish. External colors other than ANSI 61 will not be acceptable.

2.3 MOTOR STARTERS

A. Motor starters shall be mounted in standard motor control center assemblies, arranged as indicated.

B. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device, mounted in a completely enclosed cubicle. Short circuit protective device shall be an instantaneous, magnetic only circuit breaker, **Cutler-Hammer Type HMCP or G.E. Mag-Break Motor Circuit Protector**. All circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the open position. Reset of thermal overload elements shall be possible with unit door closed. Three phase overload trip units shall be furnished to suit the full load current of the equipment installed. Overload trip unit shall be adjusted as required for power factor correction capacitors.

C. Magnetic starters shall have auxiliary contacts as required by electrical motor control diagrams including N-O and N-C contacts as indicated, plus one each spare N-O and N-C contact. The combination motor starters shall be drawout-type for size 5 and below. The fixed-type unit assembly shall be constructed so that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

D. Each starter unit shall have its own control power transformer. It shall have a 115-volt grounded secondary. One secondary fuse and 2 primary fuses shall be provided. Control power transformers shall be sized to accommodate the control devices indicated. Local control devices shall be mounted independently of the cover door. All starters shall have a local red "running" lamp and a green "off" light to indicate the presence of control power when the motor is not running. Starters shall be provided with elapsed time meters, hand/off/auto selector switches, and other devices as indicated. All cubicle control wires shall be terminated at a pull apart disconnecting terminal block at the cubicle.

E. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers. Each control wire shall be identified at both ends.

F. Full voltage motor starter units shall be NEMA Size 1 or larger. The combination starters shall be rated for a minimum 65,000 RMS symmetrical amperes.

G. Motor starters shall be designed to NEMA ratings. Starters designed to IEC ratings or with dual IEC/NEMA ratings will not be acceptable, either as part of any MCC, as remote starters, or as part of any equipment package.

H. Two speed starters shall be of the two-winding type.

2.4 MAIN AND FEEDER CIRCUIT BREAKERS (480 V)

A. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units.

B. Circuit breakers with a frame size of 225 amperes to 1,200 amperes shall be molded case with interchangeable thermal, and adjustable magnetic trip.

C. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes.

D. Circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "open" position.

2.5 CONTROL DEVICES

A. All control devices shall conform to the requirements of Section 16485-Local Control Panels.

2.6 FACTORY TESTS

A. All motor control centers and their components shall be given Manufacturer's standard electrical and mechanical production tests and inspections. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of all components including controls, protective devices, metering, and alarm devices.

2.7 SPARE PARTS

A. The CONTRACTOR shall furnish the following for each MCC:

1. One unit control transformer of each size furnished in magnetic starters installed

2. Three bezels of each color installed for pilot indicators

3. One dozen panel lamps

4. One dozen control fuses of each size installed

B. Spare parts shall be identified by MCC number, type, size, and manufacturer.

2.8 MANUFACTURERS, OR EQUAL

A. Motor control centers shall be **Cutler-Hammer "2100" or General Electric "8000 Line,"**.

PART 3 – EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall install motor control centers in accordance with Manufacturer's published instructions. Conduit installation shall be coordinated with Manufacturer's-as-fabricated drawings so that all conduit stub-ups are within the area allotted for conduit. Conduit shall be stubbed up in the section that contains the devices to which conductors are terminated.

B. If stored at the site, motor control centers shall be stored in a clean, dry space. Factory wrapping shall be maintained or an additional heavy plastic cover shall be provided to protect units from dirt, water, construction debris, and traffic. Storage space shall be heated or MCC space heaters shall be energized.

C. Motor control centers shall be handled carefully to avoid damage to motor control center components, enclosure, and finish. Damage shall be repaired before installation.

3.2 INSTALLATION

A. Motor control centers shall be installed on 4-inch concrete pads. After leveling and shimming, the CONTRACTOR shall anchor motor control centers to concrete pads, and shall grout so that no space exists between the pad and support beams.

B. The CONTRACTOR shall:

1. Torque all bus bar bolts to Manufacturer's recommendations; tighten all sheet metal and structure assembly bolts.

2. Adjust all Motor Circuit Protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor. Verify that overload devices are proper for equipment installed; make necessary changes in overload devices as required for motors having power factor correcting capacitors.

3. After equipment is installed, touch up scratches, and verify that nameplate, and other identification is accurate.

4. Furnish and install high voltage switchboard matting in front of the MCC. The mat shall be 1/4 inch thick and 36 inches wide and shall be **Model M36** as manufactured by **W.H. Salisbury & Co.**

3.3 FIELD TESTS

A. Visual and mechanical inspection after installation

1. Inspect for physical damage, proper anchorage and grounding.

2. Verify that the ratings of the thermal overload heaters match the motor full-load current nameplate data.

3. Check tightness of bolted connections.

B. Electrical tests

1. Insulation tests

a. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute. Test voltage and minimum acceptable resistance shall be in accordance with Manufacturer's recommendations.

b. Measure insulation resistance of each starter section phase to phase and phase to ground with the starter contacts closed and the protective device open. Test voltage and minimum acceptable resistance shall be in accordance with the Manufacturer's recommendations.

c. Measure insulation resistance of each control circuit with respect to ground.

2. Verify proper operation of control logic in all modes of control.

- END OF SECTION -

SECTION 16485 - LOCAL CONTROL STATIONS AND MISCELLANEOUS ELECTRICAL DEVICES

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide complete local control stations as shown and as specified herein or in other Sections of the Specification.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Local control panels shall comply with the requirements of NEC, NEMA, and UL.

1.3 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit shop drawings in accordance with the requirements specified in Sections 01300 - Contractor Submittals, and 16050 - Electrical Work, General.

B. Ladder diagrams and written descriptions explaining ladder diagrams operation and system operation shall be provided with shop drawings.

C. Provide catalog cuts of all control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

PART 2 – PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall provide the stations to satisfy the functional requirements specified in the relevant mechanical equipment, and Instrumentation & Control specification sections and as shown on the Electrical Elementary Schematics. Each station shall be fabricated with UL labelled components. Stations not specifically specified as being provided in other Sections of the Specification shall be furnished and installed under this Section. All stations shall be wired under this Section.

B. The controls shall be 120 volt maximum. Where the electrical power supply is 240 volt single phase, or 480 volt, 3-phase, as shown on the electrical drawings, the station shall be provided with a fused control power transformer. Control conductors shall be provided in accordance with the requirements specified in Section 16050.

C. Each station shall be provided with identified terminal strips for the connection of all external conductors. The CONTRACTOR shall provide sufficient terminal blocks to connect 25 percent additional conductors for future use. Termination points shall be identified in accordance with accepted shop drawings. The stations shall be the source of power for all 120 VAC solenoid valves interconnected with the stations. All equipment associated with the stations shall be ready for service after connection of conductors to equipment, controls, and stations.

D. All internal wiring shall be factory-installed and shall be contained in plastic raceways or troughs having removable covers. Wiring to door-mounted devices shall be extra flexible and anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

E. Enclosures

1. Enclosures shall be NEMA-1 in the Electric Room, NEMA-12 in indoor process area, and weatherproof NEMA-3R outdoors, painted steel enclosures with ANSI 61 exterior and white interior.

2. Enclosures shall be either freestanding, pedestal-mounted, or equipment skid-mounted, as specified or shown. Internal control components shall be mounted on a removable mounting pan. Mounting pan shall be finished white.

F. The main feeder disconnect shall have a door-mounted handle unless otherwise specified or shown.

G. Identification of panel-mounted devices, conductors, and electrical components shall meet the requirements specified in Section 16050.

H. All panel-mounted devices shall be mounted a minimum of 3 feet above finished floor elevation.

2.2 STATION COMPONENTS

A. Pushbuttons, selector switches, and pilot lights shall be of the heavy-duty, oil-tight type sized to 30 mm. Miniature style devices are not acceptable. Devices shall be as manufactured by **G.E. or Cutler-Hammer.**

1. Lens colors shall be red for "run," "open," or "on"; green for "stopped," "closed," or "off;" amber for alarm.

2. Pilot lights shall be transformer type, push-to-test.

3. Provide hazardous location type pilot devices in classified locations.

B. Relays shall be 3 PDT with 10 amp contacts, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Relays shall be as manufactured by **Square D or Potter Brumfield.**

C. Elapsed time meters shall be non-resettable type, read to a maximum of 99999.9 hours and shall be as manufactured by **G.E. or Cutler-Hammer.**

D. Magnetic starters shall meet the following requirements:

1. NEMA rated: IEC or dual NEMA/IEC rated type are not acceptable.

2. FVNR type unless specified otherwise.

3. Combination starters with magnetic only instantaneous trip circuit breakers such a **Cutler-Hammer "MCP" or G.E., "Mag-Break."**

4. Control transformers shall be provided, with primary and secondary fuses, 120 VAC

maximum control voltage.

E. Terminal strips shall be provided for all panels and shall be of the flanged fork or ring lug type suitable for No. 12 A.W.G. stranded wire minimum. Provide 25 percent spare terminals in each panel.

F. Current-to-current converter/isolators shall be 4-20 mA input, 4-20 mA output for operation from 120 volt AC power, and shall be by **Moore or A.G.M.**

G. Process alarm relays shall have a 4-20 mA input and two (2) independent SPST contact outputs as manufactured by **A.G.M.** Power input shall be 120 VAC.

H. Digital indicators shall have 4-20 mA input and shall display the signal in process units. 0-100% as a displayed signal shall only be acceptable to indicate speed. Indicators shall be as manufactured by Newport or Red Lion, for operation from 120 VAC. Provide splash-proof covers in NEMA 4X panels, and viewing windows in NEMA 7 panels.

I. Time delay relays shall be combination on delay and off delay (selectable) with adjustable timing ranges. Time delay relays shall be **Square D JCK70.** Provide socket with screw terminal connections and retaining strap. Similar shall be by **ATC.**

J. Reset Timers: Reset timers shall be synchronous motor driven with a solenoid operated clutch. Timer shall be on-delay for semi-flush panel-mounting. The timers shall be rated 120-volt, 60 Hz, with 10-amp rated contacts, and with time range as shown, and shall be **Eagle Signal Division E.W. Bliss Company Bulletic 125 or Automatic Timing and Controls, Inc., Type 305.**

2.3 FACTORY TESTING

A. Each LCS shall be factory assembled, and tested for sequence of operation prior to jobsite delivery.

2.4 SPARE PARTS

A. Provide a minimum of 10% spare lamps (minimum 2) and one spare lens for each color pilot lamp in each panel.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Stations shall be installed in accordance with the requirements specified in Section 16050 and in accordance with the Manufacturer's recommendations.

B. Stations shall be protected at the jobsite from loss, damage, and the effects of weather. Stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion, and humidity.

C. Stations interiors, and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the work.

D. Conduit, conductors, and terminations shall be installed in accordance with the requirements specified in Section 16050.

3.2 FIELD TESTING

A. Each station shall be tested again for functional operation in the field after the connection of external conductors, and prior to equipment startup.

- END OF SECTION -

SECTION 16500 - LIGHTING

PART 1 – GENERAL.

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide lighting fixtures, and accessories for all lighting systems, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

National Electric Code

Underwriters Laboratories

ANSI C82.1	Specifications for Fluorescent Lamp Ballasts
ANSI C84.4	Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type)

Standards of the Certified Ballast Manufacturer's Association

1.3 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit the following in accordance with the requirements of Section 01300 - Contractor Submittals.

1. Shop drawings and catalog data.
2. Catalog literature for each fixture.
    a. Materials of construction, type of diffusers, hardware, gasketing, reflector and chassis, finish, and ballast.
    b. Photometric data, including coefficient of utilization, average brightness, candle power distribution curve, and lumen output chart.
3. Pole-mounted fixtures, including complete data on the pole material, finish, handpoles, anchoring, and fixture attachment. Support method shall be submitted for interior fixtures weighing more than 50 pounds.
4. Ballast catalog data indicating lamp wattage, input watts, sound rating, power factor, and type of ballast. Data for outdoor ballast shall be include low temperature starting characteristics.
5. Photocell data submittal shall indicate switching capacity, the means of adjusting the lighting pickup level, and enclosure.

B. Substitutions for specified fixtures shall be based upon quality of construction, light distribution, appearance, and maintenance.

1.4 QUALITY ASSURANCE

A. Exterior lighting system operation shall be demonstrated during the hours of darkness to indicate that fixtures are properly focussed, photo-cell operation is correct, and that fixture switching functions as intended. Similar requirements shall apply to interior lighting. Through demonstration, the CONTRACTOR shall also verify that panel schedules properly indicate the lighting outlets connected to each circuit.

B. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

C. Lighting fixtures shall be stored in their original cartons from the manufacturers until the time of installation. Fixtures poles shall be stored on blocks above grade until the time of installation.

1.5 CLEANUP

A. Fixture lenses, diffusers, and reflectors shall be cleaned just prior to the time specified for the system demonstrations.

B. Fixture trim, including poles and support brackets, where finish has been damaged, shall be refinished.

PART 2 – PRODUCTS

2.1 FIXTURES - GENERAL

A. All fixtures shall be pre-wired with leads of 18-AWG, minimum, for connection to building circuits.

2.2 EXTERIOR FIXTURES

A. Exterior fixtures in combination with their mounting pole and bracket shall be capable of withstanding 100 MPH winds without damage. Exterior fixtures shall have corrosion-resistant hardware and hinged doors or lens retainer. Fixtures specified to be furnished with integral photo-electrical control shall be of the fixture manufacturer's standard design.

2.3 INTERIOR FIXTURES

A. Interior fluorescent fixtures without diffusers shall be furnished with end plates. Where diffusers are required, they shall be of high molecular strength acrylic. Minimum thickness of the acrylic shall be 0.125 inches for all diffusers, except that those on 4-foot square fixtures shall be 0.187 inches thick.

2.4 LAMPS

A. Lamps shall be first-line **General Electric or Sylvania.**

B. Fluorescent lamps shall be T-8, energy-efficient, cool/white. Incandescent lamps shall be frosted unless a specified fixture lighting control system requires clear globe lamps. High-pressure sodium lamps shall be "color corrected." Unless otherwise indicated in the

Contract Documents, lamps shall be suitable for operation in any burning position.

2.5 PHOTO-ELECTRIC CELLS

A. Photoelectric cells for control of multiple fixtures shall be self-contained, weatherproof type and shall be provided with time-delay features.

2.6 LIGHT FIXTURE CONTROL RELAYS

A. Relays for light fixtures control shall be mechanically held. Such relays shall be based-mounted, single-purpose units, i.e., not attachments to a multi-purpose solenoid operator.

B. If not indicated otherwise, coil voltage shall be 115 volts ac with contacts rated at 20 amps. Relays shall be **ASCO Series 166 or Zenith Series MSC.**

2.7 BALLASTS

A. Ballasts for fluorescent fixtures in office areas shall have a Class "A" sound rating. Such ballasts shall be of the electronic, low loss type. All ballasts shall be high power factor, Class P. Primary ballast voltage shall be suitable for use in the branch circuits indicated in the Contract Documents.

2.8 LIGHT FIXTURE SCHEDULE

See Schedule below.

Fixture Type	Lamp Type	Lamps/ Fixture	Lamp Wattage	Primary Mfg. Cat. Number	Secondary Mfg. Cat. Number	Description
A	FL	2	32	Holophane HWSM4DSH71O42EP11	Daybrite HW 232-1/2-EB-120	4' ceiling or pendant mount fixture with wrap around lens. White painted steel housing and reflector. Holophane 7100(A) acrylic lens. T8 lamps and electronic ballast.
B	HPS	1	150	Holophane BA15DHP12PA	Daybrite LLB15HS12LRA	Pendant mount enclosed and gasketed fixture with glass or acrylic lens. White painted cast aluminum housing and aluminum reflector.
C	LED	1	2	Holophane MLNWP1R	Emergi-Lite ECLXN-1-R	Wall mount exit fixture with emergency battery backup.
D	INC	2	18	Holophane C16N18WWTB2	Emergi-Lite EC-2	Wall mount emergency lighting unit with incandescent emergency lamps, and battery pack with minimum 10 year life expectancy.

Fixture Type	Lamp Type	Lamps/ Fixture	Lamp Wattage	Primary Mfg. Cat. Number	Secondary Mfg. Cat. Number	Description
E	HPS	1	150	Holophane MW15AHP12Z		Wall mount exterior fixture with bronze die-cast aluminum housing and prismatic borosilicate glass refractor.
E1	HPS	1	100	Holophane MW10AHP12Z		Wall mount exterior fixture with bronze die-cast aluminum housing and prismatic borosilicate glass refractor.
F	HPS	1	50	Holophane WP1A50DHP12BZ		Wall mount exterior fixture with bronze die-cast aluminum housing and prismatic borosilicate glass refractor.
G	HPS	1	50	SGRT10J/1/ PTA050HP12545BZPETLWGA		Bronze Petrolux PTA Series with Symetrical Distribution & Wet Location – Round tapered galvanized steel 10 ft. pole. Pole to have festoon boxes for switch and receptacle.
H	INC	1	150	Crouse-Hinds VXHF25GP		Vaporgard Series Incandescent Lighting Fixture – Enclosed and Gasketed – Ceiling and Junction Box with Globe and Gard.

PART 3 – EXECUTION

3.1 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished complete at each outlet in accordance with the Fixture Schedule.

B. Lighting fixtures shall be installed plumb and square with building and wall intersections. Pendant-mounted fixtures which are mounted from sloping ceilings shall be suspended by ball hangers. Fixtures installed in machinery rooms shall be located after machines have been installed. In all cases, fixture locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures. Fixtures shall be installed in accordance with the architectural reflected ceiling Drawings. Unless otherwise indicated, fixtures shall be centered on ceiling tiles. Fixtures weighing more than 25 pounds shall be supported independently of the fixture outlet box.

C. Recessed fixtures shall be installed light-tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure. Said safety supports shall consist of #12 AWG soft drawn galvanized wire or #10 Aluminum wire.

3.2 FIXTURE POLES

A. Fixture poles shall be set on anchor bolts and secured with double nuts on each bolt. After fixture has been leveled and plumbed, the fixture base shall be dry-packed with grout.

- END OF SECTION -

SECTION 16850 - ELECTRIC HEAT TRACING

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide electric heat tracing systems for pipes, valves, fittings, and appurtenances subject to freezing, as shown and required for trouble-free operation, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced documents to the extent that the requirements therein are not in conflict with the provisions of this Section; provided, that for Building Codes, the latest edition of the codes, as adopted as of the date of award by the agency having jurisdiction, shall apply to the WORK.

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** The CONTRACTOR shall submit complete shop drawings of all heat tracing systems, showing the location of interface with electric power supply, in accordance with Section 01300 - Contractor Submittals.

B. **Manufacturer's Data:** With the shop drawings, the CONTRACTOR shall also furnish complete manufacturer's data of the electric heating cables and the thermostats.

PART 2 – PRODUCTS

2.1 GENERAL

A. All pipes, valves, equipment and appurtenances shall be provided with heat tracing where shown; or, where not shown, heat tracing shall be provided in all cases where such items could be endangered by freezing. Such heat tracing shall consist of spiral wrapping with electrical heating cables as recommended by manufacturer to maintain an operating temperature of 55°F with subsequent insulation with polyurethane foam, sealed and weatherproofed with outer aluminum jacket. The heating cables shall be the dual line self limiting type. The heat tracing systems shall be installed complete, including heating elements, power connections, end seals, and in accordance with the manufacturer's printed installation instructions.

B. All heat trace shall be 120 VAC.

2.2 BASIC MATERIALS

A. **Heating Cable:** Provide dual line self limiting heat tracing, **Auto-Trace 8BTV-CT series**, as manufactured by **Chemelex**.

PART 3 – EXECUTION

3.1 INSTALLATION

A. **General:** The CONTRACTOR shall assemble and install equipment in strict accordance with the manufacturer's published instructions, under the supervision of the manufacturer's representative, under the general review of the ENGINEER. All installations shall be accomplished by competent craftsmen in a workmanlike manner. All heating strips shall be cut in the field and wrapped on the pipelines as required.

B. **Contractor Coordination:** The CONTRACTOR shall coordinate the installation with the electrical work, to ascertain the correct location of all electrical interface.

3.2 TESTING

A. After completion of its work, the CONTRACTOR shall prepare the equipment for operational use in accordance with the manufacturer's printed instructions. Each system shall be tested for proper operation.

3.3 ACCEPTANCE BY OWNER

A. Final acceptance of the equipment is contingent on satisfactory appearance and operation after installation.

- END OF SECTION -

SECTION 17100
PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide all Process Control and Instrumentation Systems (PCIS) complete and operable, in accordance with the Contract Documents. Three preferred instrument integrators are Integrity Engineering, Bristol Babcock, and Industrial Control Systems.

B. The requirements of this Section apply to all components of the PCIS unless indicated otherwise.

C. Year 2000 compliance: All information technology components, including, but not limited to hardware, software, accessories and peripherals, tools and utilities (collectively, "components") shall be Year 2000 compliant. "Year 2000 compliant" means that such components will accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, and the years 1999 and 2000, and leap year calculations. Furthermore, Year 2000 compliant components, when used in combination with other components, shall accurately process date/time data if the other components properly exchange date/time data with it. Successful operation and calculation shall be demonstrated during factory testing and facility startup and testing. Any system or component failing such testing will be considered defective and shall be upgraded, re-programmed, or replaced until it passes the test, at no increased cost to the OWNER.

D. **Responsibilities**

1. The CONTRACTOR, through the use of a qualified Instrumentation Supplier and qualified electrical and mechanical installers, shall be responsible to the OWNER for the implementation of the PCIS and the integration of the PCIS with other required instrumentation and control devices.

2. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the Instrumentation Supplier be responsible to the CONTRACTOR for the integration of the PCIS with existing devices and devices provided under other sections with the objective of providing a completely integrated control system free of signal incompatibilities.

3. As a minimum, the Instrumentation Supplier shall perform the following work:

   a. Implementation of the PCIS

      (1) prepare analog hardware submittals

      (2) design, develop, and electronically draft RTU interconnect diagram drawings and control panel designs

(3) prepare the test plan, and the spare parts submittals

(4) procure hardware

(5) fabricate panels

(6) perform factory tests on panels using the Instrumentation Supplier's test RTU

(7) perform bench calibration and verify calibration after installation

(8) oversee and certify installation of equipment furnished and/or installed under this contract

(9) oversee, document, and certify RTU interconnect diagram testing

(10) oversee, document, and certify system commissioning for equipment furnished and/or installed under this contract

(11) conduct the performance test

(12) prepare Owner's Manuals

(13) prepare training classes

(14) prepare record drawings

b. Integration of the PCIS with instrumentation and control devices being provided under other sections:

(1) It should be noted that the Instrumentation Supplier's scope is limited, in general, to equipment furnished and/or installed under this contract, as well as other scope items specifically identified in the Division 17 Specifications.

(2) Develop all requisite RTU interconnect diagram drawings and record RTU interconnect diagram drawings associated with equipment provided under other Divisions of these Specifications and Owner furnished and existing equipment.

(3) Resolve signal, power, or functional incompatibilities between the PCIS and interfacing devices.

(4) The intended general scope of services for the Instrumentation Supplier for this contract is identified below. Other specific scope requirements are defined in the various sections of Division 17.

a. Where equipment and/or instruments are installed by the Owner and/or others, they are identified as such. Additionally, existing equipment and/or instruments which are required to be interfaced to under this contract, and which are included in the Instrumentation Supplier's scope of integration, will also be identified as such.

Documentation required for the Instrumentation Supplier to complete its scope of work will be provided upon reasonable request, but in no case will delay the Instrumentation Supplier, provided that adequate advance notice is given.

b. Where instrumentation is supplied by the Instrumentation Supplier, the Instrumentation Supplier shall furnish and completely install this equipment in accordance with the Division 17 Specifications.

c. Where instrumentation is indicated to be existing, the Instrumentation Supplier shall recalibrate the instrument, develop RTU interconnect diagram drawings, terminate or check terminations completed by others, perform loop checks, and recommission the instrument loop as detailed in Division 17 Specification.

4. Any Instrumentation Supplier responsibilities in addition to the list above are at the discretion of the CONTRACTOR and the Instrumentation Supplier. Additional requirements in this Section and throughout Division 17 which are stated to be the CONTRACTOR's responsibility may be performed by the qualified Instrumentation Supplier if the CONTRACTOR and Instrumentation Supplier so agree.

E. **Certification of Intent**

1. Each bidder shall include with the bid the following Certification from the selected Instrumentation Supplier:

a. The Certification shall be typed on the Instrumentation Supplier's firm letterhead.

b. It shall be signed by an authorized representative of the Instrumentation Supplier's firm.

c. It shall include the following statements:

(1) (Corporate name of Instrumentation Supplier) "hereby certifies intent to assume and execute full responsibility to the CONTRACTOR to perform all tasks defined under Section 17100 - Paragraph 1.1C3 in full compliance with the requirements of the Contract Documents."

(2) "It is certified that the quotation to the CONTRACTOR includes full and complete compliance with the requirements of the Contract Documents without exception."

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals and the following:

1. The CONTRACTOR shall coordinate the instrumentation work so that the complete instrumentation and control system will be provided and will be supported by accurate shop drawings and record drawings.

2. Exchange of Technical Information: During the period of preparation of these submittals, the CONTRACTOR shall authorize a direct, informal liaison with the ENGINEER for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as indicated may be authorized informally by the ENGINEER, but will not alter the scope of work or cause increase or decrease in the Contract Price. During this informal exchange, no oral statement by the ENGINEER shall be construed to give approval of any component or method, nor shall any statement be construed to grant exception to or variation from these Contract Documents.

3. Symbology and Nomenclature: In these Contract Documents, all systems, all meters, all instruments, and all other elements are represented schematically, and are designated by symbology as derived from Instrument Society of America Standard ANSI/ISA S5.1 - Instrumentation Symbols and Identification. The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout shop drawings, and similar materials. No other symbols, designations, or nomenclature unique to the manufacturer's standard methods shall replace those prescribed above, used herein, or on the Drawings.

B. **Shop Drawings**

1. General:

   a. All shop drawings shall include the letter head or title block of the Instrumentation Supplier. The title block shall include, as a minimum, the Instrumentation Supplier's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing. The quantity of submittal sets shall be as indicated in Section 01300 - Contractor Submittals.

   b. Organization of the shop drawing submittals shall be compatible with eventual submittals for later inclusion in the Owner's Manual. Submittals not so organized and incomplete submittals for a given RTU interconnect diagram will not be accepted.

   c. Shop drawing information shall be bound in standard size, 3 ring, loose-leaf, vinyl plastic, hard cover binders suitable for bookshelf storage. Binder ring size shall not exceed 3 inches.

   d. Interfaces between instruments, motor starters, control valves, variable speed drives and other equipment related to the PCIS shall be included in the shop drawing submittal.

2. Analog Hardware Submittal: The CONTRACTOR shall submit an analog hardware submittal as a complete bound package at one time within 20 calendar days after the commencement date stated in the Notice to Proceed, including:

   a. A complete index which lists each device by tag number, type, and Manufacturer. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or RTU interconnect diagrams, as a separate group for each system or RTU interconnect diagram. If, within a single system or RTU interconnect diagram, a single instrument is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that instrument in that system. Each brochure or bulletin shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags.

b. Fully executed data sheets according to ISA-S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves, for each component, together with a technical product brochure or bulletin. The technical product brochures shall be complete enough to verify conformance to all Contract Document requirements. The data sheets, as a minimum, shall show:

(1) Component functional description used in the Contract Documents

(2) Manufacturer's model number or other product designation

(3) Project tag number used in the Contract Documents

(4) Project system or RTU interconnect diagram of which the component is a part

(5) Project location or assembly at which the component is to be installed

(6) Input and output characteristics

(7) Scale, range, units, and multiplier (if any)

(8) Requirements for electric supply (if any)

(9) Requirements for air supply (if any)

(10) Materials of component parts to be in contact with or otherwise exposed to process media and corrosive ambient air

(11) Special requirements or features

c. Priced list of all spare parts for all devices

d. Instrument installation, mounting, and anchoring details shall be submitted in an electronic AUTOCAD and hard copy format. Each instrument shall have a dedicated 8 1/2" X 11" detail which only pertains to the specific instrument by tag number. Each detail shall be certified by the instrument manufacturer that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable. These certifications shall be embedded in the CAD files and also appear as a stamp on the hard copies. As a minimum, each detail shall have the following contents:

(1) show all necessary sections and elevation views required to define instrument location by referencing tank, building or equipment names

and numbers, and geographical qualities such as north, south, east, west, basement, first floor.

(2) ambient temperature and humidity of the environment that the instrument is to be installed in.

(3) corrosive qualities of the environment that the instrument is to be installed in.

(4) hazardous rating of the environment that the instrument is to be installed in.

(5) process line pipe or tank size, service and material.

(6) process tap elevation and location

(7) upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves for in-line instruments

(8) routing of tubing and identification of supports.

(9) mounting brackets, stands, and anchoring devices.

(10) conduit entry size, number, location, and delineation between power and signal.

(11) NEMA ratings of enclosures and all components.

(12) clearances required for instrument servicing.

(13) list itemizing all manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.

3. Project-Wide RTU interconnect diagram Drawing Submittal: The CONTRACTOR shall furnish a Project-wide RTU interconnect diagram Drawing Submittal which completely defines and documents the contents of each monitoring, alarming, interlock, and control loop associated with equipment provided under Division 17 sections, equipment provided under sections in other Divisions, existing, and OWNER furnished equipment which is to be incorporated into the PCIS. The project-wide RTU interconnect diagram drawing submittal shall be a singular complete bound package electronically drafted in AUTOCAD, submitted within 120 days after contract award, and shall include the following:

a. A complete index in the front of each bound volume. The RTU interconnect diagram drawings shall be indexed by systems or process areas. All RTU interconnect diagrams shall be tagged in a manner consistent with the Contract Documents. RTU interconnect diagram drawings shall be submitted for all analog and discrete monitoring and control loops.
b. Drawings showing definitive diagrams for every instrumentation loop system. These diagrams shall show and identify each component of each loop or system using legend and symbols from ANSI/ISA S5.4 - Instrument loop

Drawings, extending the format as shown on Instrument Legend Sheet drawing and as defined by the most recent revision in ISA. RTU interconnect diagram drawings shall be developed for loops in equipment vendor supplied packages, equipment provided under Division 17, and OWNER furnished equipment. The RTU interconnect diagram drawings shall also show all software modules and linkages. In addition to the expanded ISA S5.4 requirements the RTU interconnect diagram shall also show the following details:

(1) Functional name of each RTU interconnect diagram.

(2) Reference name, drawing, and RTU interconnect diagram numbers for any signal continuing off the RTU interconnect diagram sheet.

(3) MCC panel, circuit, and breaker numbers for all power feeds to the RTU interconnect diagrams and instrumentation.

(4) Designation, and where utilized, terminal assignments associated with every manhole, pullbox, junction box, conduit, and panel through which the loop circuits pass. The contractor shall acknowledge compliance with this requirement in writing prior to bid acceptance.

(5) Vendor panel, instrument panel, conduit, junction boxes, equipment and PLC terminations, termination identification wire numbers and colors, power circuits, and ground identifications. The contractor shall acknowledge compliance with this requirement in writing prior to bid acceptance.

c. Itemized instrument summary: The summary shall be prepared with Microsoft Excel and shall be submitted on 3 1/2-inch floppy disks and hard copy. The instrument summary shall list all of the key attributes of each instrument provided under this Contract. As a minimum, attributes shall include:

(1) Tag number

(2) Manufacturer

(3) Model number

(4) Service

(5) Area location

(6) Calibrated range

(7) RTU interconnect diagram drawing number

(8) Associated LCP, PLC, PCM, or RTU

4. Test Procedure Submittals

a. The CONTRACTOR shall submit the proposed procedures to be followed during tests of the PCIS and its components.

b. Preliminary Submittal: Outlines of the specific proposed tests and examples of proposed forms and checklists.

c. Detailed Submittal: After approval of the Preliminary Submittal, the CONTRACTOR shall submit the proposed detailed test procedures, forms, and checklists. This submittal shall include a statement of test objectives with the test procedures.

C. **Owner's Manual**

1. General: Information in the Owner's Manual shall be based upon the approved shop drawing submittals as modified for conditions encountered in the field during the work.

2. The Owner's Manual shall have the following organization for each process:

   a. Section A - Process and Instrumentation Diagrams

   b. Section B - RTU interconnect diagram Descriptions

   c. Section C - RTU interconnect diagram Drawings

   d. Section D - Instrument Summary

   e. Section E - Instrument Data Sheets

   f. Section F - Sizing Calculations

   g. Section G - Instrument Installation Details

   h. Section H - Test Results

3. Signed results from RTU interconnect diagram Testing, Precommissioning, and Performance Testing shall be included in Section H.

4. Initially, 2 sets of draft Owner's Manuals shall be submitted for review after return of favorably reviewed shop drawings and data required herein. Following the ENGINEER's review, one set will be returned to the CONTRACTOR with comments. The Manuals shall be revised and amended as required and the final Manuals shall be submitted 15 days prior to start-up of systems.

D. **Record Drawings**

1. The CONTRACTOR shall keep current a set of complete RTU interconnect diagrams and schematic diagrams which shall include all field and panel wiring, piping and tubing runs, routing, mounting details, point-to-point diagrams with cable, wire, tube and termination numbers. These drawings shall include all instruments and instrument elements. One set of drawings electronically formatted in AUTOCAD and 2 hard copies shall be submitted prior to Performance Testing. All such

drawings shall be submitted for review prior to acceptance of the completed work by the OWNER.

1.3 EXTENDED PERIOD FOR CORRECTION OF DEFECTS

A. The CONTRACTOR shall correct all defects in the PCIS upon notification from the OWNER within one year from the date of Substantial Completion. Corrections shall be completed within 5 days after notification.

PART 2 – PRODUCTS

2.1 GENERAL

A. **Current Technology:** All meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise required to match existing equipment.

B. **Hardware Commonality:** All instruments which utilize a common measurement principle (for example, d/p cells, pressure transmitters, level transmitters which monitor hydrostatic head) shall be furnished by a single Manufacturer. All panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

C. **Loop Accuracy:** The accuracy of each instrumentation system or loop shall be determined as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracies" of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual instrument shall have a minimum accuracy of plus and minus 0.5 percent of full scale and a minimum repeatability of plus and minus 0.25 percent of full scale unless otherwise indicated. Instruments which do not conform to or improve upon these criteria are not acceptable.

D. **Instrument and RTU interconnect Power:** Power requirement and input/output connections for all components shall be verified. Power for transmitted signals shall, in general, originate in and be supplied by the control panel devices. The use of "2-wire" transmitters is preferred, and use of "4-wire" transmitters shall be minimized. Individual RTU or redundant power supplies shall be provided as required by the Manufacturer's instrument load characteristics to ensure sufficient power to each RTU interconnect diagram component. All power supplies shall be mounted within control panels or in the field at the point of application.

E. **Instrument Air:** Dry, filtered control air at 80-100 psig nominal pressure shall be piped to all field instruments and instrument panels requiring air. Each field instrument shall be provided with an integral, non-adjustable filter-regulator assembly to provide regulated air. Each instrument panel requiring air shall be provided with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments. All air shall be filtered to 5 micron maximum particle size. Pressure reducers and regulators shall be furnished with additional instrumentation as required.

F. **RTU interconnect diagram Isolators and Convertors:** Signal isolators shall be provided as required to ensure adjacent component impedance match where feedback paths may be generated, or to maintain RTU interconnect integrity during the removal of an RTU interconnect component. Dropping precision wirewound resistors shall be installed at all field side terminations in the control panels to ensure RTU interconnect integrity. Signal conditioners and converters shall be provided where required to resolve any signal level incompatibilities or provide required functions. The Instrumentation Supplier shall include dedicated RTU interconnect diagram isolators for 20% (2 minimum) of all analog inputs and analog outputs utilized on this project. Unused isolators shall be furnished loose to the owner.

G. **Environmental Suitability:** All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices 20% within the minimums and maximums of their rated environmental operating ranges. The CONTRACTOR shall provide all power wiring for these devices. Enclosures suitable for the environment shall be furnished. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

H. **Signal Levels:** Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable. Electrical signals outside control panels shall be 4 to 20 milliamperes dc except as indicated. Signals within enclosures may be 1-5 volts dc. All electric signals shall be electrically or optically isolated from other signals. All pneumatic signals shall be 3 to 15 psig with 3 psig equal to 0% and 15 psig equal to 100%.

I. **Control Panel Power Supplies:** All control panels shall be provided with redundant power supplies which are configured in a fault-tolerant manner to prevent interruption of service upon failure and interruption of service necessitated by the replacement of a power supply. All power supplies shall have an excess rated capacity of 40 percent. The failure of a power supply shall be annunciated to the main control room.

J. **Alternative Equipment and Methods:** Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the ENGINEER. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage and maintenance enhancement over the equipment or method indicated, or shall include evidence that an indicated component is not available.

2.2 OPERATING CONDITIONS

A. The PCIS shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:

1. Environment - a chemical facility
2. Temperature Range - 32 through 104 degrees F
3. Thermal Shock - 1 degree F per minute

4. Relative Humidity - 20 through 90 percent, non-condensing

2.3 SPARE PARTS AND SPECIAL TOOLS

A. The CONTRACTOR shall furnish the spare parts selected by the ENGINEER from the priced list of spare parts in the Analog Hardware and CPES Submittals.

B. The CONTRACTOR shall furnish a priced list of all special tools required to calibrate and maintain all of the instrumentation provided under the Contract Documents. After approval the CONTRACTOR shall furnish all listed tools.

C. All special tools and spare parts shall be submitted before startup commences, suitably wrapped and identified.

2.4 FACTORY TESTING

A. Factory witness testing is not required under this contract.

PART 3 – EXECUTION

3.1 PRODUCT HANDLING

A. **Shipping Precautions:** After completion of shop assembly, factory test, and approval, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. **Special Instructions:** Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. **Tagging:** Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package. Clearly readable, permanently engraved rigid plastic is an acceptable alternative.

D. **Storage:** Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the CONTRACTOR at no additional cost to the OWNER. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the ENGINEER. Such tests shall be at no additional cost to the OWNER, and if the equipment fails the tests, it shall be replaced at no additional cost to the OWNER.

3.2 INSTALLATION

A. **General**

1. All instrumentation, including instrumentation furnished under other Divisions, shall be installed under Division 17 and the manufacturers' instructions.

2. **Equipment Locations:** The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the OWNER exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the CONTRACTOR shall make such changes without additional cost to the OWNER.

B. **Conduit, Cables, and Field Wiring**

1. All conduit and field wiring shall be provided under Division 16 without delay to the WORK of Division 17.

2. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, RTU and RIO input and output wiring and other field wiring and cables shall be provided under Division 16.

3. All other wiring not mentioned above furnished under this or any other Division shall be provided under Division 17.

C. **Instrumentation Tie-Downs:** All instruments, control panels, and equipment shall be anchored by methods which comply with seismic requirements which apply to the site.

D. **Existing Instrumentation:** Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned and recalibrated by an authorized service facility of the instrument Manufacturer. The CONTRACTOR shall provide certification of this work prior to reinstallation of each instrument.

E. **Ancillary Devices:** The Contract Documents show all necessary conduit and instruments required to make a complete instrumentation system. The CONTRACTOR shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements at no additional cost to the OWNER. All such additions and all such changes, including the proposed method of installation, shall be submitted to the ENGINEER for approval prior to commencing the work. Such changes shall not be a basis of claims for extra work or delay.

F. **Installation Criteria and Validation:** All field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on installation requirements of the Contract Documents.

2. Technical assistance is available to installation personnel at least by telephone.

3. Installation personnel have at least one copy of the approved shop drawings and data.

4. Instrument process sensing lines shall be installed similar to conduit specified under Section 16050 - Electrical General Provisions. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3 feet of rigid tubing.

5. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.

6. All flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.

7. All power and signal wires shall be terminated with crimped type lugs.

8. All connectors shall be, as a minimum, water tight.

9. All wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature and shall be in accordance with the requirement of Section 16050 - Electrical Work, General.

10. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the ENGINEER. All wiring shall be protected from sharp edges and corners.

11. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.

12. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. The CONTRACTOR shall certify in writing that for each RTU interconnect diagram or system checked out, all discrepancies have been corrected.

13. The OWNER will not be responsible for any additional cost of rework attributable to actions of the CONTRACTOR or the Instrumentation Supplier.

3.4 CALIBRATION

A. **General:** All devices provided under Division 17 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. **Calibration Points:** Each instrument shall be calibrated at 20,40,60, 80 and 100% of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Testing Standards.

C. **Bench Calibration:** Instruments which have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the ENGINEER.

D. **Field Calibration:** Instruments which were not bench-calibrated shall be calibrated in the field to insure proper operation in accordance with the instrument RTU interconnect diagrams or specification data sheets.

E. **Calibration Sheets:** Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:

1. Project name
2. RTU interconnect diagram number
3. Tag number
4. Manufacturer
5. Model number
6. Serial number
7. Calibration range
8. Calibration data: Input, output, and error at 10 percent, 50 percent and 90 percent of span
9. Switch setting, contact action, and deadband for discrete elements
10. Space for comments
11. Space for sign-off by Instrumentation Supplier and date
12. Test equipment used and associated serial numbers

F. **Calibration Tags:** A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the ENGINEER. The CONTRACTOR shall have the Instrumentation Supplier sign the tag when calibration is complete. The ENGINEER will sign the tag when the calibration and testing has been accepted.

3.5 RTU INTERCONNECT DIAGRAM TESTING

A. **General:** Instrument RTU interconnect diagrams shall be submitted to the ENGINEER for review prior to the loop tests. The CONTRACTOR shall notify the ENGINEER of scheduled tests a minimum of 30 days prior to the estimated completion date of installation and wiring of the PCIS. After the ENGINEER'S review of the submitted RTU interconnect diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the ENGINEER.

B. **Control Valve Tests:** All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to insure that no changes have occurred since the bench calibration.

C. **Interlocks:** All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.

D. **Instrument and Instrument Component Validation:** Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance to Manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirement, or, in the absence of a Contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the ENGINEER at no additional cost to the OWNER.

E. **Loop Validation:** Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Specified accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks which incorporate analog elements, simulated sensor inputs corresponding to 20, 40, 60, 80 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated root-mean-square-summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. All analog loop test data shall be recorded on test forms attached at the end of this section which include calculated root-mean-square-summation system accuracy tolerance requirements for each output.

F. **RTU Interconnect Validation Sheets:** The CONTRACTOR shall prepare RTU interconnect confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. RTU interconnect diagram confirmation sheets shall form the basis for operational tests and documentation. Each RTU interconnect diagram confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the loop by the Instrumentation Supplier:

1. Project name
2. RTU interconnect diagram number
3. Tag number, description, manufacturer and model number for each element
4. Installation bulletin number
5. Specification sheet number
6. RTU interconnect diagram description number
7. Adjustment check
8. Space for comments
9. Space for RTU interconnect diagram sign-off by Instrumentation Supplier and date
10. Space for ENGINEER witness signature and date

G. **RTU interconnect diagram Certifications:** When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the ENGINEER or the ENGINEER's representative as a witness, with test data entered, shall be submitted to the ENGINEER together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

3.6 PRECOMMISSIONING

A. **General:** Precommissioning shall commence after acceptance of all wire test, calibration tests and RTU interconnect diagram tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contract requirements. Precommissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

B. **Precommissioning Procedures and Documentation:** All precommissioning and test activities shall follow detailed test procedures and check lists accepted by the ENGINEER. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the ENGINEER, which include calculated tolerance limits for each step. Completion of all system precommissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the ENGINEER with a clear and unequivocal statement that all system precommissioning and test requirements have been satisfied.

C. **Operational Validation:** Where feasible, system precommissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

D. **Loop Tuning:** All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 20, 40, 60, 80 and 100% of span and the results checked against indicated accuracy tolerances.

E. **Precommissioning Validation Sheets:** Precommissioning shall be documented on one of two types of test forms as follows:

1. For functions which can be demonstrated on an RTU interconnect diagram, the form shall include:

    a. Project name

    b. RTU interconnect diagram number

    c. RTU interconnect diagram description

    d. Tag number, description, manufacturer and data sheet number for each component.

    e. Space for sign-off and date by both the Instrumentation Supplier and ENGINEER.

2. For functions which cannot be demonstrated on a RTU interconnect diagram basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:

    a. Specification page and paragraph of function demonstrated

    b. Description of function

    c. Space for sign-off and date by both the Instrumentation Supplier and ENGINEER

F. **Precommissioning Certification:** The CONTRACTOR shall submit an instrumentation and control system precommissioning completion report which shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the precommissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the ENGINEER before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

3.7 ON-SITE SUPERVISION

A. The CONTRACTOR shall furnish the services of an on-site resident engineer to supervise and coordinate installation, adjustment, testing, and start-up of the PCIS. The resident engineer shall be present during the total period required to effect a complete operating system. A team of engineering personnel shall be on site to check all equipment, perform the tests indicated in this Section, and furnish startup services.

3.8 PERFORMANCE TEST

A. The entire PCIS shall operate for 30 days without failure.

B. The CONTRACTOR shall furnish all necessary support staff as required to operate the system and to satisfy the repair or replacement requirements.

C. If any component fails during the performance test, it shall be repaired or replaced and the PCIS shall be restarted on another 30 day period.

3.9 TRAINING

A. **General:** The CONTRACTOR shall train the OWNER'S personnel on the maintenance, calibration and repair of all instruments provided under this Contract.

B. **Instructions:** The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

C. **Duration:** Training shall be 10 weeks in duration, and shall cover, as a minimum, operational theory, maintenance, trouble shooting/repair, and calibration of the instrumentation.

D. **Schedule:** Training shall be performed during the precommissioning phase of the project. The training shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The ENGINEER will review the course outline for suitability and provide comments that shall be incorporated.

E. **Agenda:** The training shall include operation and maintenance procedures, trouble shooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment.

F. **Documentation:** Within 10 days after the completion of each session the contractor shall submit the following:

1. A list of all OWNER personnel that attended the session.

2. An evaluation of OWNER personnel via written testing or equivalent evaluation.

3. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

3.10 ACCEPTANCE

A. For the purpose of this Section, the following conditions shall be fulfilled before the WORK is considered substantially complete:

1. All submittals have been completed and approved.

2. The PCIS has been calibrated, RTU interconnect diagrams tested and precommissioned.

3. The OWNER training has been performed.

4. All required spare parts and expendable supplies and test equipment have been delivered to the ENGINEER.

5. The performance test has been successfully completed.

6. All punch-list items have been corrected.

7. All record drawings in both hard copy and electronic format have been submitted.

8. Revisions to the OWNER'S Manuals that may have resulted from the field tests have been made and reviewed.

9. All debris associated with installation of instrumentation has been removed.

10. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

- END OF SECTION -

SECTION 17220 - FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR through the use of an Instrumentation Supplier, shall furnish and install all field instruments specified.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Shop Drawings shall be submitted in conformance with the requirements of Section 17100 - Process Control and Instrumentation Systems, and Section 01300 - Contract Submittals.

1.3 QUALITY ASSURANCE

A. **General:** The accuracy of each instrumentation system or loop shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

1.4 MANUFACTURER'S REPRESENTATIVE SERVICES

A. **General:** Manufacturer's representative services shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

1.5 PRODUCT HANDLING

A. **General:** Product handling shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

1.6 GUARANTEE

A. **General:** Guarantees shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

PART 2 - PRODUCTS

2.1 DIAPHRAGM SEALS

A. Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, fusing connection, and a top housing. The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid. The space between the diaphragm and the instrument pressure element shall be completely filled with a suitable liquid. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge or switch. The diaphragm seal shall have a removable bottom housing to permit the servicing of the diaphragm capsule without the need to refill. All surfaces exposed to the chemical shall be PVC. Pressure diaphragm seals shall be **Ametek, Ashcroft, or U.S. Gauge.**

2.2 PRESSURE GAUGES

A. Pressure gauges shall be 4-1/2 inches in diameter; bottom connected with white laminated dials and black graduations. Gauges shall have a blowout disc and safety glass, encased in phenolic, steel or cast iron. Measuring element shall be a stainless steel bourdon tube with welded, stress-relieved joints. Socket shall have wrench flats. Movement shall be rotary geared, all stainless steel material. Accuracy shall be ± 0.5 percent range. Pressure gauges shall be **Ashcroft, Ametek, or U.S. Gauge.**

B. Pressure gauges shall be installed with ½" minimum, 316 stainless steel piping. All installation materials shall be 316 stainless steel. Furnish and install all pressure gauges with separate 316 stainless steel block and bleed valves.

C. The pressure gauge tagging shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems. The following pressure gauges shall be provided and installed:

Tag	Service	Diaphragm Seal	Range(psi)
PW.P-PI-10.01	Plant Water Booster Pump 1 Discharge Pressure	No	0-200
PW.P-PI-20.01	Plant Water Booster Pump 2 Discharge Pressure	No	0-200
TS.P-PI-10.02	Belt Filter Press Feed Pump 1 Discharge Pressure	Yes	0-50
TS.P-PI-20.02	Belt Filter Press Feed Pump 2 Discharge Pressure	Yes	0-50
PW.P-PI-10.02	Plant Water Booster Pumps Suction Pressure	No	0-100

2.3 MAGNETIC FLOWMETERS

A. Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC pulsed signal directly proportional to and linear with the liquid flow rate. Complete zero stability shall be an inherent characteristic of the flowmeter system. Each magnetic flow metering system shall include a metering tube, signal cable, transmitter and flow meter grounding rings.

B. The metering tube shall be constructed of 304 or 316 stainless steel with carbon steel flanged connections. The liner shall be teflon. The metering tube shall have a minimum of two stainless steel, self-cleaning, bullet-nosed electrodes. The tube shall have an epoxy coated finish. The housing shall be rated NEMA 4X and be capable of accidental submergence. Grounding rings shall be in conformance with the manufacturer's bore and material recommendation for the intended service. Grounding rings shall be designed to protect and shield the liners edge from process abrasion.

C. The transmitter shall utilize a DC pulse technique to drive the flux-producing coils and covert the DC pulse signal from the tube to a standardized 4-20mA signal into a minimum of 750 ohms. The transmitter shall have a LCD display for display of flow rate, percent of span and totalized flow. The transmitter shall have a keypad for operator interface. The transmitter shall have integral low flow cutoff, zero return, empty pipe detection, automatic range change, self-diagnostics and automatic data checking features. Programmable parameters shall include full scale Q, primary constant and time constant. The transmitter shall be capable of data retention for a period of ten years. The transmitter shall have a NEMA 4X enclosure and be capable of operating in ambient temperatures of –4 to 140 °F and 10-90% relative humidity, non-condensing. The transmitter shall be provided with a stainless steel pipe mounting bracket.

D. Each flowmeter system shall be hydraulically calibrated at a facility which is traceable to the National Institute of Standards and Technologies. The calibration procedure shall conform to the requirements of MIL-STD-45662A. The real time computer generated printout of the actual calibration data indicating apparent and actual flows of at least three rates shall be submitted to the Engineer prior to shipment of the meters to the project site. The flow metering system shall conform to the following: Time Constant 0.5 –1000 seconds, galvanic or optic isolation, accuracy ±.25%, rangeability 75:1. Power requirements shall be 120VAC. Flow metering system must be capable of measuring flows which contain between 0 to 15% solids.

E. The magnetic flowmeter tagging shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems. The following magnetic flowmeters shall be provided and installed. Magnetic flowmeters shall be **Bailey-Fischer&Porter, Rosemount, or Foxboro.**

Tag	Service	Range(gpm)
TS-FIT-10.01	Belt Filter Press 1 Thickened Sludge Discharge Flow	0-400
TS-FIT-20.01	Belt Filter Press 2 Thickened Sludge Discharge Flow	0-400

2.4 ULTRASONIC LEVEL TRANSMITTERS

A. Each ultrasonic level transmitter shall be a microprocessor-based electronic unit consisting of a separate sensor and transmitter. The sensor shall be suitable for operation over a temperature range of –20 to +150 degrees F and a relative humidity of 10 to 100 percent. Sensors mounted in areas subject to freezing shall be provided with special transducers or protected against icing by heaters. Sensors mounted in direct sunlight shall be provided with sunshades.

B. The ultrasonic level transmitter shall have automatic compensation for changes in air temperature at the sensor location. If separate temperature sensing probes are provided, they shall be mounted with or adjacent to the ultrasonic sensor, as recommended by the manufacturer. The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 0.5 inches. The transmitter shall be designed to ignore momentary level spikes or momentary loss-of-echo. A loss-of-echo condition shall be indicated on the unit and shall be available as an alarm contact output. The transmitter output shall be an isolated 4-20 mA DC signal linearly proportional to the measured level range. Some of the transmitters shall have relay outputs for hard-wired interlocks. Calibration parameters shall be entered through a keypad on the unit and shall be stored in nonvolatile EEPROM memory. Accuracy of the transmitted signal shall be ± 0.5 percent of the level range.

C. A sufficient length of sensor-to-transmitter signal cable shall be furnished with the instrument to locate the sensor 25 to 200 feet from the signal converter. The signal converter electronics shall be housed in a weatherproof NEMA 4 enclosure suitable for wall or pipestand mounting and for operating temperatures of –15 to +125 degrees F and a relative humidity of 10 to 100 percent. A thermostatically controlled strip heater shall be provided in the signal converter enclosure if necessary. The signal converter shall be of the AC powered type. The manufacturer shall provide a five-year warranty.

D. The ultrasonic level transmitter tagging shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems. The following ultrasonic level transmitters shall be provided and installed. Ultrasonic level sensors shall be **Endress and Hauser DU or FDU.** Ultrasonic level transmitters shall be **Endress and Hauser LTU675.**

Tag	Service	Range(feet)
BPOL.T-LE/LIT-00.01	2,500 Gallon Polymer Bulk Storage Tank Level	0-10
GWPOL.T-LE/LIT-00.01	5,000 Gallon Polymer Bulk Storage Tank Level	0-15
SS.SW-LE/LIT-00.01 (include relay output)	Sludge Well Level	0-9
TS.BFT1-LE/LIT-10.01	Batch Feed Tank 1 Level	0-16
TS.BFT2-LE/LIT-10.01	Batch Feed Tank 2 Level	0-16
LS.LAG1-LE/LIT-00.01	Lagoon 1 Supernatant Level	0-6
LS.LAG2-LE/LIT-00.02	Lagoon 2 Supernatant Level	0-6
LS.LAG3-LE/LIT-00.03	Lagoon 3 Supernatant Level	0-6
LS.LAG4-LE/LIT-00.04	Lagoon 4 Supernatant Level	0-6
LSR.LSRV2-LE/LIT-00.01 (include relay output)	Lagoon Supernatant Return Vault No. 2 Level	0-16

2.5 ULTRASONIC LEVEL SWITCHES

A. Ultrasonic point level switches shall be utilized for high, low, high-high, low-low level setpoints. Ultrasonic level switch enclosure to be NEMA 4X. Enclosure to have two ½" NPT connections. The level switch shall be suitable for operation on 120 VAC. Level switch output to be two SPDT contacts with a 5 amp rating. Level sensor material to be Kynar.

B. Ultrasonic level switch tagging shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems. The following ultrasonic level switches shall be provided and installed. Ultrasonic level switches shall be **Milltronics Pointek, or Endress and Hauser equivalent, or Drexelbrook equivalent.**

Tag	Service	Range/Setpoint(feet)
BPOL.T-LSH-00.01	2,500 Gallon Polymer Bulk Storage Tank Level High	0-10/10
GWPOL.T-LSH-00.01	5,000 Gallon Polymer Bulk Storage Tank Level High	0-15/15

2.6 TURBIDITY ANALYZERS

A. Analyzers will operate with a continuous flow of sample through the sample cell to drain. A strong light beam will be passed through the sample and the amount of light scattered by the turbidity particles will be measured. The analyzer will utilize a US EPA approved method of turbidity analysis.

B. The sample cell will utilize a lamp operated below rated voltage to extend operating life and a silicon photocell which detects the reflected light intensity. Sample flow rate will be approximately 5 gpm. The sample cell will be constructed of all corrosion-resistant materials and will have an integral bubble trap. Accessories will be provided as required to allow for a field calibration check of the analyzer. Calibration accessory to include a primary standard formazin calibration kit.

C. The analyzer will have a master indicator mounted near the sample cell and connected to the sample cell with a special cable. The unit will have an auto-ranging four or five digit display which indicates turbidity within a range of 0 to 9999 nephelometric turbidity units (NTU). The master indicator will be housed in a NEMA 12 enclosure and will be 120 Vac powered. The master indicator will have a linear 4-20 mA dc output signal which corresponds to a preselected turbidity range.

D. Turbidity analyzer tagging shall conform to the requirements of Section 17100 – Process Control and Instrumentation Systems. The following turbidity analyzers shall be provided and installed. Turbidity analyzers shall be a **Hach 45000, Rosemount Analytical equivalent, or Royce Instrument equivalent.**

Tag	Service	Range(NTU)
FP.BFP-TUR-10.01	Belt Filter Press 1 Pressate Turbidity	0-5000
FP.BFP-TUR-10.01	Belt Filter Press 2 Pressate Turbidity	0-5000

2.7 SLUDGE BLANKET LEVEL DETECTORS

A. The sensor shall be made of 316 stainless steel. It shall have at least 25 feet of attached cable. The cable shall be controlled via a hoisting drum and stepper motor. The sensor shall have two pulsed infrared LED's. It's temperature range shall be 32-122 degrees F. It shall have automatic temperature compensation over this range.

B. The transmitter shall be mounted in a NEMA 4 enclosure. Its sludge blanket level range shall be at least 3.3 to 25 feet and suspended solids concentration range 0 to 1.0%. The transmitter shall be powered by 120 Vac. It shall provide an LED display which shall indicate the measured values. The transmitter output is to be an isolated 4-20 mA signal and a SPDT relay. The transmitter synchronized input feature which automatically raises the sensor for sludge raker bridge passes. This should be utilized if necessary.

C. Sludge blanket level detector tagging shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems. The following sludge blanket level detectors shall be provided and installed. Sludge blanket level detectors shall be **GLI 7219MTS, Royce Instrument, or Drexelbrook equivalent.**

Tag	Service	Range(feet)
TS.GT1-DE/DIT-00.01	Gravity Thickener 1 Sludge Blanket Level	0-5
TS.GT2-DE/DIT-00.02	Gravity Thickener 2 Sludge Blanket Level	0-5

2.8 LEAK DETECTION SWITCH

A. Ultrasonic point level switch shall be utilized to detect a leak in the Polymer Containment Area. It shall have a 7/8" diameter sensor with a insertion length of no more than 16". Process wetted parts to be PFA. The switch shall be suitable for operation on 120 Vac. Output to be DPDT relay with a 5 amp contact rating. Switch housing to be NEMA 4X.

B. Ultrasonic point level switch shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems. The following ultrasonic point level switch shall be provided and installed. Ultrasonic point level switch shall be **Drexelbrook 504-1000-6, Milltronics equivalent, or Magnetrol equivalent.**

Tag	Service	Range/Setpoint(inches)
POLY.CONT-LSH-00.01	Polymer Containment Area Leak Detection	0-18"/16"

PART 3 - EXECUTION

3.1 **General:** Electrical interface and code compliance shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.2 **Installation:** The installation of all devices shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems and applicable details shown on the Contract Drawings.

3.3 **Calibration:** The calibration of all devices shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.4 **Loop Testing:** The loop testing of all devices shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.5 **On-Site Supervision:** On-site supervision shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.6 **Performance Testing:** On-site performance tests shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.7 **Record Drawings:** Record drawings shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.8 **Training:** Training shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.9 **Acceptance:** Acceptance shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

A. VALVE HOUSE - FLUSHING WATER AND SETTLED SOLIDS WITHDRAWAL SYSTEMS

Overview

a. There is one valve house per two purification units. The settled solids removal lines from a pair of purification units connect to a common settled solids header in the valve house.

b. The overall solids blowdown cycle consists of the flushing water cycle and the settled solids withdrawal cycle.

c. The valve house flushing cycle is used to flush the settled solids line before solids are removed from the purification units.

d. The flushing cycle can flush the sludge line to the purification unit, or to the sludge well. The selection of flushing direction is determined by valve position.

e. The settled solids from the purification units can be directed to either the sludge well or to a common 6-inch drain line. The selection of flow direction is determined by valve position.

f. Each purification unit also has a 12-inch drain line that connects to a common drain line in the valve house. The drain system is independent of the blowdown cycle.

g. The typical settled solids removal sequence begins with flushing the line into the purification unit for a pre-selected time period. Once time has elapsed, the flushing operation ceases, and the valves on the settled solids removal lines direct the solids to the sludge well.

h. The operation of each purification unit blowdown cycle is independent of the other units.

i. Each purification unit shall have independent control logic.

j. Each control valve local control station will have open/close pushbuttons, and a local/remote mode switch.

Local Manual Mode of Operation

a. The two components of the blowdown cycle, flushing water and settled solids withdrawal, can be independently operated in the local manual mode.

b. The direction of the flushing water flow (to either the purification unit or the sludge well) is determined by selecting the appropriate position of the settled solids valve on its local control station for the settled solids lines. Flushing water is initiated by opening the flushing water valve on its local control station. Flushing water remains on until the valve is closed at its local control station.

c. For settled solids removal, the direction of settled solids flow from the purification unit (to the sludge well or the 6-inch drain line) is determined by selecting the appropriate valve position (for the 4-inch valve on the line to the sludge well) on its local control station. If the operator desires to direct solids to the 6-inch drain line, the operator must also manually open the 4-inch hand valve on the settled solids line to the 6-inch drain line. There is no automatic control capability to direct settled solids to the 6-inch drain line. Solids removal occurs until the 3-inch valve on the solids line from the designated purification unit is closed on its local control station.

d. For draining the purification unit, the valve for the 12-inch drain line will be opened on its local control station.

e. A control valve's local control station must be in local mode in order to open and close the valve manually via pushbuttons.

Local Automatic Mode of Operation

a. Not used

Remote Manual Mode of Operation

a. Once in the remote manual mode, the operator has the capability to select the flushing direction (into the desired purification unit or to the sludge well) from the workstation. This is accomplished by opening the appropriate valve on the solids line.

b. Once the operator selects the flushing direction and indicates that flushing should start, the flushing water shall remain on until the operator selects stop.

c. From the workstation, the operator selects to remove settled solids from the desired purification unit, and opens the associated solids removal valve. The operator closes the valve (stopping the settled solids withdrawal cycle) when desired.

d. The operator may also open and close the 12-inch drain line valve from the workstation.

e. The control valve's local control station must be in remote mode in order to open and close valves from the workstation.

Remote Automatic Mode of Operation

a. Once in the remote automatic mode, the operator has the capability to designate the following three variables; the duration of each component of the blowdown cycle (flushing and solids removal), the direction of the flushing water flow and the frequency of the blowdown cycle. These variables are independently designated for each purification unit.

b. The operator has the capability to select the flushing direction (into the desired purification unit or sludge well) from the workstation

c. After the operator starts the flushing sequence, the flushing water shall remain on for an adjustable time period.

d. After the designated time has elapsed, the flushing water shall stop and the sludge withdrawal process shall commence.

e. The sludge withdrawal process shall remain on for an adjustable time period.

f. After the designated time has elapsed, the sludge withdrawal process stops (the valve closes.)

g. There is no remote automatic mode for the 12-inch drain line.

Common Control Features for All Modes of Operation

a. Flushing may occur in more than one purification unit at a time.

b. Only one flushing direction (into the purification unit or sludge well) may be selected at one time for a designated purification unit.

c. The ability to adjust the flushing water timer and the sludge withdrawal timer shall be provided.

Monitoring Requirements

a. The position (open/close) and local/remote status of the control valves associated with each purification unit shall be monitored.

B. SLUDGE WELL

Overview

a. There is one sludge well that receives the settled solids from all of the purification units.
b. The settled solids removal lines from a pair of purification units connect to a common settled solids header in the associated valve house.
c. The settled solids from valve houses No. 1 and No. 2 enter the sludge well from a common 4-inch line.
d. The settled solids from valve houses No. 3, No. 4 and No. 5 enter the sludge well from a common 4-inch line.
e. There are two vertical solids handling pumps in the sludge well.
f. Under normal operation, settled solids from the sludge well are directed to the gravity thickeners. Selection of the desired gravity thickener to receive the settled solids is made by electrically operated gravity thickener inlet valves.
g. Settled solids may also be directed to the lagoons during emergency conditions through the opening of manual valves. Under normal operation, these manual valves will be closed.
h. An overflow line from the sludge well connects into the plant 24-inch drain line.
i. Settled solids pumps operate in a lead-lag mode with alternating starts.
j. An ultrasonic level sensor is used to determine well level and automatic pump operation.
k. The pump local control panel will have start/stop pushbuttons, on/off lights, an elapsed time meter, and a local/remote switch per pump

Local Manual Mode of Operation

a. Once in the local mode, the settled solids pumps can be operated from the local control panel.
b. The pumps must be shut off manually, unless the hardwired ultrasonic level sensor settings shut the pump off on low-low level.
c. The desired gravity thickener will be selected by operating the gravity thickener inlet valves at their local control panels.

Local Automatic Mode of Operation

a. Not used

Remote Manual Mode of Operation

a. Once in the remote manual mode, the operator has the capability to select the desired settled solids pump to start and to select which gravity thickener the settled solids should be pumped to.

Remote Automatic Mode of Operation

a. Once in the remote automatic mode, the settled solids pumps operate on sludge well level. The lead pump turns on once the well reaches low level. At high level, the lag pump turns on . The operator can select which pump is lead and which pump is lag.
b. On high-high sludge well level, an alarm will be indicated.
c. The pumps will shut off on low-low level(same setpoint as local manual).
d. At the workstation, the operator will select the gravity thickener to receive settled solids. This selection will open the appropriate gravity thickener inlet valve.

Common Control Features for All Modes of Operation

a. Not applicable.

Monitoring Requirements

a. Pump run status, pump local/remote status and sludge well level shall be monitored in all operating modes.

b. The position (open/close) and local/remote status of the inlet valves to the gravity thickeners shall be monitored.

C. LAGOONS

Overview

a. There are four existing lagoons with capacities of 0.5 MG (Lagoon 4), 1.6 MG (Lagoon 3), 1.9 MG (Lagoon 2), and 1.4 MG (Lagoon 1).

b. There are two sets of inlet lines to the lagoons, a 30-inch wash water waste drain line, and a 6-inch sludge line.

c. The common 30-inch inlet line carries the influent flows to Lagoon 1, Lagoon 2 and Lagoon 3 by selection of lagoon inlet valve position. This inlet flow consists of wash water waste, gravity thickener supernatant and filter pressate.

d. The 6-inch sludge line carries settled solids from the sludge well to any of the four lagoons through manual valve operation. This lagoon inlet line will be used under emergency conditions, since under normal operation, settled solids will be directed to the gravity thickeners.

e. Due to its location, Lagoon 4 will not receive wash water waste, gravity thickener supernatant or filter pressate. It will be reserved as an emergency backup to receive settled solids.

f. Overflow from the gravity thickeners shall be sent only to Lagoon 3.

g. Selection of operational lagoons shall be by operation of motorized (on the 30-inch line) and manual (on the 6-inch line) isolation valves on the lagoon influent lines.

h. Lagoons in service shall be decanted continuously. The decanting rate will be directly proportional to the depth of submergence of the telescoping valve orifice. Under normal operation, this depth of submergence will be 0 - 1.0 FT.

i. Overflow from the lagoon supernatant vaults will be sent to Lagoon 1.

Local Manual Mode of Operation

a. All motorized inlet valves will be put in the local mode of operation at their respective local control station, which will lock out control from the remote operator station. The motorized valves are opened or closed locally by pushbutton. Selection of the operational lagoons will then be made by local operation of the appropriate manual isolation valves and motorized inlet valves.

b. Telescoping valves will be put in the local mode of operation at their respective local control station. Doing so will lock out control from the remote operator station. Telescoping valve depth of submergence will then be set by the open/close pushbuttons on the telescoping valve local control station.

Local Automatic Mode of Operation

a. Not used.

Remote Manual Mode of Operation

a. All motorized inlet valves will be put in remote mode of operation at their local control stations. The motorized valves are opened or closed remotely at the workstation. Selection of the operational lagoons will then be made by remote operation of the appropriate inlet valves on the 30-inch line.

b. Telescoping valves will be put in the remote mode of operation at the local control stations. Telescoping valve depth of submergence will then be set by the operator at the workstation.

Remote Automatic Mode of Operation

a. Not used

Common Control Features for All Modes of Operation

a. Not applicable.

Monitoring Requirements

a. The position (open/close) and local/remote status of the lagoon inlet control valves for each lagoon shall be monitored.
b. Lagoon levels shall be continuously monitored by ultrasonic level sensor.
c. The local/remote status of the lagoon telescoping control valves for each lagoon shall be monitored.

D. GRAVITY THICKENERS AND BATCH TANKS

Overview

a. There are two gravity thickeners that receive the settled solids from the sludge well.
b. There is an electrically operated valve at the inlet of each gravity thickener.
c. Each gravity thickener has a mechanical sludge collector rake arm.
d. Each gravity thickener has two vertical solids handling pumps, which pump the thickened solids to the batch tanks.
e. The pumps in each thickener will alternate starts after a remote belt filter press automatic cycle.
f. Thickened sludge can be pumped from only one gravity thickener at a time. Thickener sludge pumps cannot operate concurrently.
g. There are two batch tanks that receive the thickened solids from the gravity thickeners. The inlet valves to the batch tanks are electrically operated.
h. The batch feed tanks are equipped with mixers and ultrasonic level sensors.
i. The emptying of a batch tank is determined by the operation of the respective belt filter press feed pump.
j. The batch tanks are equipped with electrically operated drain valves. Drain valves shall be used to completely empty the tanks when required.
k. The supernatant from the gravity thickeners is collected in effluent troughs and discharges by gravity to the lagoons.
l. Each gravity thickener is equipped with a sludge probe that reads the depth of the thickened sludge.
m. Thickened sludge can be pumped back to the sludge well under emergency conditions by opening a manual valve on the line to the sludge well.
n. The thickened sludge pump local control panel will have start/stop pushbuttons, on/off lights, elapsed time meter, and local/remote switch for each pump.

Local Manual Mode of Operation

a. The thickened solids pumps can be operated from their local control panel.
b. The desired batch feed tank will be selected by operating the batch tank inlet control valves at their local control stations (located in the Dewatering Building).
c. The mechanical solids collectors in each gravity thickener will only have manual control from their local control panels. No automatic or remote control of the solids collectors will be provided.
d. The batch feed tank mixers can be operated from their local control panels in local mode.
e. The batch tank drain valves shall be operated at their local control station.

Local Automatic Mode of Operation

a. Not used

Remote Manual Mode of Operation

a. Once in the remote manual mode, the operator has the capability to select the desired thickened solids pump and the desired batch feed tank.
b. The operator may manually start and stop the thickened solids feed pumps.
c. The thickened solids pump remains on until the operator selects stop.
d. The operator has the capability to turn the batch tank mixers on and off.
e. The operator has the capability to open the batch tank drain valves.

Remote Automatic Mode of Operation

a. Once in the remote automatic mode, the thickened solids pump operate on an operator selectable sludge depth. The pump should turn off based on an operator selectable duration, provided that the batch tank is not full.
b. If both batch tanks are full, the thickened solids pump should turn off.
c. If one batch tank becomes full and the other is not in operation (i.e. not emptying), the thickened solids pump should turn off.
d. The emptying of a batch tank to the press is determined by the operation of the respective feed pump to the belt filter press.
e. The batch feed tank mixers turn on when high level is reached in the tank and turn off at low level.
f. The last step for a belt filter press cycle would be to drain out the remaining sludge from the batch feed tanks to the lagoons via motorized plug valves. The operator shall select the frequency (number of press cycles) which shall occur before the drain valve opens.

Common Control Features for All Modes of Operation

a. Only one thickened solids pump will operate at a time.
b. Only one batch tank will fill at one time.
c. The control of the mechanical solids collectors is only a local operation with no remote capabilities.
d. A thickened solids pump will shut down on low sludge blanket level.

Monitoring Requirements

a. Thickened solids pump run status and sludge level in each gravity thickener shall be monitored.
b. The position (open/close) of inlet valves to the batch feed tanks shall be monitored.
c. Level in the batch feed tanks shall be monitored.
d. Run status of the batch feed tank mixers shall be provided.
e. Local/remote status for the pumps, inlet valves, drain valves and mixers shall be provided.
f. The collector run status shall be provided.

E. BELT FILTER PRESS SYSTEM

Overview

a. The belt filter press system consists of two belt filter presses (BFP) supplied as a manufacturer's package. The main air solenoid, washwater valve, and main belt drive VFD are the major components of this manufacturer's package.

b. Ancillary systems associated with the belt filter press system include the plant water booster pumps, sludge feed pumps, polymer blending systems, air compressors and belt conveyors.
c. The air compressor shall operate independently by cycling on and off automatically, based on a tank mounted pressure switch when the air compressor switch is in the on position.
d. The belt filter press system has no control capabilities from the operator workstation.

<u>Local Manual Mode of Operation</u>
a. In the local manual mode at the belt filter press panel, only the main drive can be started or stopped.
b. In the local manual mode at their respective local control stations, individual system components can be started or stopped. These system components include the plant water booster pumps, the BPOL polymer blending systems, the sludge feed pumps, and the sludge cake conveyors.

<u>Local Automatic Mode of Operation</u>
a. Individual belt filter presses are put into local automatic mode at their local control panel.
b. Operating the automatic start mode for the filter presses will initiate the following sequence of events:
   1. Main air solenoid energizes (instantly)
   2. Open washwater valve (instantly)
   3. Start plant water booster pump if not already running (instantly).
   4. Start sludge cake conveyor (5 second delay from auto start initiate)
   5. Start main belt drive (20 second delay from auto start initiate)
   6. Start polymer blending system (5 minutes delay from auto start initiate)
   7. Start BFP feed pump (15 second delay from polymer blending system start)
c. While auto start is in progress, the auto start indicator light will flash. After start-up is complete, the indicator light will stay on steady.
d. Operating the auto stop pushbutton will initiate the following sequence of events:
   1. BFP sludge feed pump stops (instantly)
   2. Polymer blending system stops (instantly)
   3. Main belt drive, washwater valve, pneumatic valve and conveyor shuts down (10 minute delay from auto stop initiate)
   4. Plant water booster pump stops if not being used by either of the other two polymer blending systems.
e. While auto stop is in progress, the auto stop indicator light will flash. After stop sequence is complete, the indicator light will stay on steady.
f. The discharge belt conveyor will have two belt tracking switches, an Estop pullcord switch, and a zero speed switch which will stop the conveyor if any of them are tripped.

<u>Remote Manual Mode of Operation</u>
a. None

<u>Remote Automatic Mode of Operation</u>
a. None

<u>Common Control Features for All Modes of Operation</u>
a. The operator has manual control of feed pump speed and polymer blending system speed from the belt filter press (BFP) control panel.

b. The operator can select which plant water booster pump, sludge feed pump, and polymer blending system will feed into a belt filter press from the BFP1 control panel and by changing manual valve settings. The default setting for belt filter press 2 if the BFP1 control panel is down would be the original dedicated train of ancillary equipment for belt filter press 2.

Monitoring Requirements

a. Run and local/remote status of all BFP system equipment shall be monitored except for the air compressor at the operator workstation. This will be done via data highway.

b. Monitoring of filter pressate turbidity.

Note: Belt Filter Press vendor to provide detailed sequence of operations for the control of their equipment and its associated ancillary equipment.

F. SUPERNATANT RETURN VAULT

Overview

a. Under normal mode of operation both supematant retum vaults receive flow from the lagoon supematant lines. Each vault houses two vertical turbine supematant retum pumps. Each of the four pumps shall be set to energize at a different level. The fourth pump is a redundant unit.

b. Lagoon supematant will be conveyed from the lagoons to the vaults by one 12" diameter ductile iron pipeline.

c. The inlet valves to the vaults are manually operated.

d. Pump start/stop will be based on level in the supematant vaults.

e. An ultrasonic level sensor will be placed in the new supematant retum vaults. There will be low-low level, low level, high level, high-high level and overflow settings. All setpoints are operator selectable.

f. The supematant retum vaults will be hydraulically linked, meaning they will have the same level. This is contingent on the manual valve connecting the two vaults being open.

g. In the valve vaults there is a submersible sump pump, which removes water from the sump and pumps it back over into the wet well.

h. The lagoon supematant pump local control panel will have start/stop pushbuttons, on/off lights, elapsed time meter, and a local/remote switch for each pump.

Local Manual Mode of Operation

a. Supematant retum pumps will be put in the local mode of operation at the pump local control panel. The operator shall have the capability to operate the pumps manually from the local control panel via start/stop pushbuttons.

b. The pumps must be shut off manually unless the hardwired ultrasonic level sensor settings shut off the pump on low-low level.

Local Automatic Mode of Operation

a. Not used.

Remote Manual Mode of Operation

a. Supematant retum pumps will be put in the remote mode of operation at the pump local control panel.

b. Operator shall have the capability to manually operate the pumps from the workstation.

Remote Automatic Mode of Operation

a. Supernatant return pumps will be put in the remote mode of operation at the pump local control panel.

b. Pumps will operate in a lead/lag mode. The operator can select which pump is lead and which is lag.

c. There shall be a switch on the pump local control panel which will tell the control system which vaults are in operating service.

d. If vault 1 is selected its level transmitter and pumps are used for automatic control. If vault 2 is selected its level transmitter and pumps are used for automatic control. If both vaults are selected vault 2's level transmitter and pumps are used for control.

e. The vault level transmitter not being used for pump control will still be used for monitoring.

f. Pump shall start upon detection of supernatant at low level point in supernatant return vault.

g. Pumps shall operate until the low-low level(same setpoint as local manual) is reached.

h. Second (lag) pump turns on when level reaches the high level point.

i. There shall be an alarm upon detection of supernatant at high-high level point.

Common Control Features for All Modes of Operation

a. Not applicable.

Monitoring Requirements

a. Pump run status, and pump local/remote status and supernatant return vault levels shall be monitored in all operating modes.

G. PLANT WATER BOOSTER PUMPS

Overview

a. There are two booster pumps to increase the available plant water pressure.

b. The booster pumps will boost pressure for the water supply to wash stations at each belt filter press, and the water supply to the polymer blending systems.

c. The pumps will operate in an alternating start mode of operation. The pumps are redundant units and will not operate simultaneously.

Local Manual Mode of Operation

a. Once in local mode, the booster pumps can be operated from their local control stations.

Local Automatic Mode of Operation

a. Not used.

Remote Manual Mode of Operation

a. Once in the remote manual mode, the pumps can be operated from the operator workstation.

Remote Automatic Mode of Operation

a. Once in the remote automatic mode, the pumps will operate as required by the belt filter press or the plant control system.

b. Prior to a polymer blending system being automatically started it will need the plant water booster pump running.

c. The plant water booster pump hardwired start will come from the belt filter press control system (RTU).

d. The plant data highway will be utilized to start the plant water booster pump for the WPOL or GPOL polymer blending systems.

Common Control Features for all Modes of Operation

a. Not applicable.

Monitoring Requirements

a. Pump run status will be monitored at the operator workstation. This will be done via data highway.

H. BULK POLYMER TRANSFER

Overview

a. There are two truck fill panels with a high level alarm light, beacon light, horn and alarm acknowledge pushbutton.
b. There are two bulk polymer systems: one for the belt filter press polymer (BPOL) and one which feeds both the gravity thickner polymer (GPOL) and wash water waste polymer (WPOL). Since the same polymer is used for both the GPOL and the WPOL, only one bulk tank (GWPOL-T-00.01) is required for these two locations.
c. Polymer is transferred from the bulk storage tanks to the day tanks with transfer pumps.
d. There are no remote control capabilities for the bulk polymer transfer system.
e. Each day tank is equipped with a mixer.

Local Manual Mode of Operation

a. Local manual mode is the day tank mixer's only mode of operation.
b. Transfer pump will run continuously as long as start pushbutton is depressed.

Local Automatic Mode of Operation

a. None

Remote Manual Mode of Operation

a. None

Remote Automatic Mode of Operation

a. None

Common Control Features for all Modes of Operation

a. Day tank mixer can be run only in local manual.

Monitoring Requirements

a. Status of mixer.
b. High level alarm for bulk storage tanks.
c. Level for bulk storage tank.
d. Weight for day tank.

I. BELT FILTER PRESS POLYMER BLENDING SYSTEM

Overview

a. The belt filter press polymer feed system (BPOL) is a bulk liquid system consisting of one bulk tank, one day tank, two transfer pumps, and two polymer blending package systems (PBS).

b. The polymer blending systems' shall have built in progressing cavity metering pumps with speed adjustment capabilities, and manual stroke settings.
c. The BPOL polymer blending systems are piped to each belt filter press. Operators will have the ability to select which PBS feeds a particular press by changing manual valve settings and selecting which polymer blending system feeds into a belt filter press from the BFP1 control panel.
d. It is first necessary to define the operating capabilities of the BPOL PBS based on its internal metering pump manual stroke setting. As the speed of this metering pump is varied, the output will be unique for a specific stroke setting. This matrix shall be fully defined on the BFP control panel operator interface with the ability to update the information each time a metering pump is calibrated.
e. The specific stroke setting for the BPOL polymer blending system's metering pump is manually set, and as such must be entered by the operator on the BFP control panel operator interface from which the BPOL mix-feed systems are controlled. **It is imperative that this stroke setting entered in by the operator correctly match that of the PBS.** The control logic will then determine the output range (in gph) for the BPOL mix-feed system based on the metering pump's speed range and stroke setting, and display this information on the display such that the gph range for the BPOL polymer mix-feed system is clear to the operator. The operator can then set the desired output of the PBS (in gph) from the BFP control panel operator interface. The actual gph of a BPOL mix-feed system's metering pump shall be indicated on the operator interface.

<u>Local Manual Mode of Operation</u>
a. Individual BPOL polymer blending systems are put in local mode at their local control panel.
b. In local manual mode, the operator has the capability to turn the individual BPOL mix-feed systems on and off and control their output of polymer (in gallons per hour, gph) by varying the speed of the metering pump at the BPOL local control panels.
c. Controlling the output of the mix-feed system in terms of percentage is not acceptable.

<u>Local Automatic Mode of Operation</u>
a. The initiation of the belt filter press start cycle shall turn on the BPOL polymer blending system. The BPOL polymer system shall start at its previous setting, and will be manually adjusted by the operator from the BFP control panel as required.

<u>Remote Manual Mode of Operation</u>
a. None

<u>Remote Automatic Mode of Operation</u>
a. None

<u>Common Control Features for All Modes of Operation</u>
a. The operator workstation shall have monitoring capabilities only. Remote control of the polymer blending system shall be provided by the belt filter press control system.

<u>Monitoring Requirements</u>
a. It is necessary that the plant control system calculate polymer usage and average polymer dosage, over a 24-hour period, based on the day tank's weigh scale.
The inputs required would be as follows:
Polymer Density (lb/gal) [must be a constant for the 24-hour period]

Belt Filter Press Feed Pump No. 1 flow rate (gpm) and daily run time (min/day) presented in terms of MGD
Belt Filter Press Feed Pump No. 2 flow rate (gpm) and daily run time (min/day) presented in terms of MGD

The equation for daily polymer usage would be as follows:
Polymer Usage(gal/day) = total day tank weight reduction (lb/day) / polymer density (lb/gal)

The equation for daily average polymer dosage would be as follows:
Polymer Dosage (mg/l) = total day tank weight reduction (lb/day) / [Feed Pump No. 1 daily flow (MGD) + Feed Pump No. 2 daily flow rate (MGD)] X 8.34

b. The control system must recognize that the tank will be filled during the day, possibly more than once. This could be accomplished by monitoring the changes in the day tank's weight (rising or falling) and incorporating it into the logic.

c. Monitoring of the BPOL PBS' pump run status, pump mode status, pump speed, and pump system fault shall be available at the operator workstation. This will be done via data highway.

J. GRAVITY THICKENER AND WASH WATER WASTE POLYMER BLENDING SYSTEMS

Overview

a. The gravity thickener and wash water waste polymer feed system (GWPOL) is a bulk liquid system consisting of one bulk tank, one day tank, two transfer pumps, and four polymer blending package systems (PBS), two for the gravity thickeners (GPOL) and two for the wash water waste flow stream (WPOL).
b. The polymer blending systems' shall have built in progressing cavity metering pumps with speed adjustment capabilities, and manual stroke settings.
c. The GPOL polymer blending systems are piped into a common header, which is routed to the settled solids inlet line of the gravity thickeners.
d. The WPOL polymer blending systems are piped into a common header, which is routed to the new manhole in the 30-inch wash water waste pipe.
e. It is first necessary to define the operating capabilities of each PBS based on its internal progressing cavity pump manual stroke setting. As the speed of this pump is varied, the output will be unique for a specific stroke setting. This matrix shall be fully defined on a limited access supervisory screen with the ability to update the information each time a metering pump is calibrated.
f. The specific stroke setting for each polymer blending system's metering pump is manually set, and must be entered by the operator at the operator workstation. **It is imperative that the manual stroke setting for the PBS be correctly entered in by the operator.** The control logic will then determine the output range (in gph) for each PBS based on metering pump's speed range and stroke setting, and display this information on the screen such that the gph range for that specific PBS are clear to the operator. The operator can then set the desired output of the PBS (in gph) from the operator workstation. The actual speed of each mix-feed system's metering pump shall be indicated at the operator workstation.

Local Manual Mode of Operation

a. Individual polymer blending systems are put in local mode at their local control panel.

b. In local manual mode, the operator has the capability to turn individual mix-feed systems on and off and control their output of polymer (in gallons per hour, gph) by varying the speed of the metering pumps at their local control panels.
c. Controlling the output of the mix-feed system in terms of percentage is not acceptable.

<u>Local Automatic Mode of Operation</u>
a. None

<u>Remote Manual Mode of Operation</u>
a. None

<u>Remote Automatic Mode of Operation</u>
a. Prior to the WPOL or GPOL polymer blending system starting up in remote automatic mode, the plant water booster pump is checked to see if it is running. If it is not it will be started up.
b. In the remote automatic mode, the GPOL polymer blending system shall respond to the operation of the sludge well pumps. The GPOL system shall be flow paced based on the capacity of one or both of the sludge well pumps.
c. The WPOL polymer blending system shall begin feeding in response to the opening of any of the filter influent wash valves. Feed rate setting shall be entered in manually by the operator.

<u>Common Control Features for All Modes of Operation</u>
a. None

<u>Monitoring Requirements</u>
a. It is necessary that the plant control system calculate a polymer usage and average polymer dosage, over a 24-hour period, based on the day tank's weigh scale. Since both the GPOL and WPOL systems use the same day tank, the daily polymer usage will be a total of the two systems' usage.

The inputs required would be as follows:
Polymer Density (lbs/gal) [must be a constant for the 24-hour period]
Flow rate setting of GPOL PBS (gph)
Run time of GPOL PBS (hrs)
Flow rate setting of WPOL PBS (gph)
Run time of WPOL PBS (hrs)
Sludge well pump daily information: capacity (gpm) and daily run time (min/day) presented in terms of MGD
Daily volume of wash water in terms of MGD, need average volume of wash water (i.e. 70,000 gallons) and number of washes per day

The equation for combined GPOL and WPOL daily polymer usage would be as follows:
Polymer Usage (gal/day) = total day tank weight reduction (lb/day) / polymer density (lb/gal)

The equation for daily gravity thickener polymer dosage would be as follows:
Polymer Dosage (mg/l) = Flow of GPOL PBS (gph) X Daily run time of GPOL PBS (hr/day) X polymer density (lb/gal) = ppd of polymer X Total daily sludge pump flow (MGD) X 8.34

The equation for daily wash water waste polymer dosage would be as follows:

Polymer Dosage (mg/l) = Flow of WPOL PBS (gph) X Daily run time of WPOL PBS (hr/day) X polymer density (lb/gal) = ppd of polymer X Total daily wash water flow (MGD) X 8.34

b. The control system must recognize that the tank will be filled during the day, possibly more than once. This could be accomplished by monitoring the changes in the day tank's weight (rising or falling) and incorporating it into the logic.

c. Monitoring of the PBS' pump run status, pump mode status, pump speed, and pump system fault shall be available at the operator workstation.

K. ALARMS

TAG NO.	DESCRIPTION	LEVEL
TS.SW-LAH-00.01	Sludge Well Level Alarm High	Warning
TS.SW-LAHH-00.01	Sludge Well Level Alarm High High	Critical
TS.SW-LAL-00.01	Sludge Well Level Alarm Low	Warning
TS.SW-LALL-00.01	Sludge Well Level Alarm Low Low	Critical
LS.LAG1-LAH-00.01	Lagoon 1 Level Alarm High	Critical
LS.LAG2-LAH-00.01	Lagoon 2 Level Alarm High	Critical
LS.LAG3-LAH-00.01	Lagoon 3 Level Alarm High	Critical
LS.LAG4-LAH-00.01	Lagoon 4 Level Alarm High	Critical
TS.GT1-DAH-00.01	Gravity Thickener 1 Solids Level Alarm High	Critical
TS.GT2-DAH-00.01	Gravity Thickener 2 Solids Level Alarm High	Critical
TS.BFT-LAH-10.01	Batch Feed Tank 1 Level Alarm High	Critical
TS-BFT-LAL-10.01	Batch Feed Tank 1 Level Alarm Low	Critical
TS.BFT-LAH-20.01	Batch Feed Tank 2 Level Alarm High	Critical
TS-BFT-LAL-20.01	Batch Feed Tank 2 Level Alarm Low	Critical
TS-FAL-10.01	Thickened Sludge to BFP 1 Flow Alarm Low	Critical
TS-FAL-20.01	Thickened Sludge to BFP 2 Flow Alarm Low	Critical
POLY.CONT-LAH-00.01	Polymer Containment Area High Level Alarm	Critical
SMOKE.DET-YL-00.01	Dewatering Building Smoke Detected Alarm	Critical
WPOL.PBS-YA-00.01	WPOL Polymer Blending System 1 Fault Alarm	Critical
WPOL.PBS-YA-00.02	WPOL Polymer Blending System 2 Fault Alarm	Critical
GPOL.PBS-YA-00.01	GPOL Polymer Blending System 1 Fault Alarm	Critical
GPOL.PBS-YA-00.02	GPOL Polymer Blending System 2 Fault Alarm	Critical
Vendor-Supplied	Sludge Collection Conveyor 1	Critical

(via data highway)	Failure Alarm	
Vendor-Supplied (via data highway)	Sludge Collection Conveyor 1 Pullcord Estop Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 1 Pullcord Estop Alarm	Critical
Vendor-Supplied (via data highway)	BPOL Polymer Blending System 1 Fault Alarm	Critical
Vendor-Supplied (via data highway)	Sludge Feed Pump 1 VFD Fault Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 1 Main Drive VFD Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 1 Air Loss Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 1 Belt Limit Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 1 Low Washwater PSI Alarm	Critical
Vendor-Supplied (via data highway)	Sludge Collection Conveyor 2 Failure Alarm	Critical
Vendor-Supplied (via data highway)	Sludge Collection Conveyor 2 Pullcord Estop Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 2 Pullcord Estop Alarm	Critical
Vendor-Supplied (via data highway)	BPOL Polymer Blending System 2 Fault Alarm	Critical
Vendor-Supplied (via data highway)	Sludge Feed Pump 2 VFD Fault Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 2 Main Drive VFD Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 2 Air Loss Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 2 Belt Limit Alarm	Critical
Vendor-Supplied (via data highway)	Belt Filter Press 2 Low Washwater PSI Alarm	Critical
LSR.LSRV2-LAHH-00.01	Lagoon Supernatant Return Vault No.2 Alarm High High	Critical
LSR.LSRV2-LAH-00.01	Lagoon Supernatant Return Vault No.2 Alarm High	Warning
LSR.LSRV2-LAL-00.01	Lagoon Supernatant Return Vault No.2 Alarm Low	Warning
LSR.LSRV2-LALL-00.01	Lagoon Supernatant Return Vault No.2 Alarm Low Low	Critical
BPOL.T-LAH-00.02	2,500 Gallon Polymer Bulk Storage Tank Alarm High	Warning
BPOL.T-LAH-00.01	2,500 Gallon Polymer Bulk Storage Tank Alarm High	Warning
BPOL.T-LAL-00.01	2,500 Gallon Polymer Bulk Storage Tank Alarm High	Warning
GWPOL.T-LAH-00.02	5,000 Gallon Polymer Bulk Storage Tank Alarm High	Warning
GWPOL.T-LAH-00.01	5,000 Gallon Polymer Bulk Storage Tank Alarm High	Warning
GWPOL.T-LAL-00.01	5,000 Gallon Polymer Bulk	Warning

Warning and Critical Alarms

a. The capability for an operator to define two levels of alarms shall be provided for all variable inputs.

b. The first alarm level is referred to as a "warning alarm" and provides notification to an operator that a particular parameter is reaching an undesirable limit. The system takes no action for a warning alarm other than notification. This alarm set point would be defined on a separate supervisory display.

c. The second alarm level is referred to as a "critical alarm" and indicates that an undesirable limit has been reached. All non-variable alarms would also be classified as "critical alarms". When a critical alarm state is reached, action is required by the system in addition to providing notification. The type of action will be dependent on the specific alarm and would include, but not be limited to, the following:

- Shutdown and isolate a specific process unit
- Shutdown equipment

The system shall not attempt to rectify a problem with actions that are not typical of the normal routine plant operations.

d. A critical alarm shall not occur more than once (e.g. if a pump fails and the backup also fails, the system should not try to restart the first pump again). At this point, a secondary action would need to occur (e.g. shut down and isolate a specific process unit).

L. MOTOR ALARMS

A control system command to open or close a motor-operated valve will generate a valve failure alarm if it does not receive an open or close status signal from the valve after a predetemined amount of time. A control system command to start a motor for a pump or a mixer or other piece of equipment will generate a motor failure alarm if it does not receive a run signal from the motor after a predetermined amount of time.

L. WORKSTATION DISPLAYS

Definition

a. Each display shall include the following:
   - A title
   - A brief description of the purpose of the display
   - A listing of each point from the I/O list that shall be reflected on the display

b. The following is a list of displays for the residuals improvements:
   - Residuals System overview
   - Individual Valve House (one display per valve house)
   - Belt Filter Press Polymer Feed System
   - Individual polymer tanks (one display per tank)
   - Polymer properties table
   - Belt Filter Press System (one display per belt filter press)
   - Sludge Well
   - Lagoon System
   - Gravity Thickeners (one display per tank)
   - Lagoon Supernatant Return Vault
   - Gravity Thickener Polymer Feed System
   - Wash Water Waste Polymer Feed System

- Security overview
- Alarm and set point setup (possibly multiple screens)
- RTU communications

Colors and Conventioning

a. The color scheme shall follow the existing conventions utilized by the Kentucky-American Water Company.

b. Alarm conditions shall flash with the alarm words appearing on the screen (e.g. "High Tank Level") in red text. Once the alarm is acknowledged, it shall stop flashing but continue to be displayed in red text. The red text shall disappear once the alarm condition is rectified. Warning alarms shall be distinguished from critical alarms with the words "Warning" and "Critical". When an alarm occurs, it shall be displayed in an alarm block on the overview screen.

J. REPORTS

Definition

a. Reports will be required for the two new bulk polymer feed systems (one for the belt filter press polymer and one for the polymer used for the gravity thickeners and wash water waste).

b. The reports shall follow the existing convention utilized by the Water Company. Each defined report shall include the following:
- A title
- A brief description of the purpose of the report
- Identification of the I/O point that corresponds to each entry point on the report. If the entry point on the report requires a manual entry by an operator, it shall be defined as such. The operator shall have the ability to overwrite any information on any report that is generated by the system.

SECTION 17515
RTU-BASED CONTROL SYSTEMS-HARDWARE

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR, through the use of a qualified Instrumentation SUPPLIER and qualified electrical installers, shall furnish, supervise installation, assemble, configure, program, and place into service the RTU-based control system, hereafter called the Supervisory Control and Data Acquisition (SCADA) System, specified under this Section, and in Section 17525 – RTU-Based Control Systems Software, all in accordance with the requirements of the Contract Documents. The CONTRACTOR shall also reference the I/O list in the Appendix.

B. **Instrumentation Supplier:** The Instrumentation Supplier shall note that the SCADA System specified includes only hardware and software at the Kentucky River Station. The Instrumentation Supplier shall be responsible for selecting, configuring, and verifying correct operation of compatible hardware and software to provide a functional SCADA system.

The Kentucky River Station hardware that will be used for the Residuals Processing Facilities project consists of:

1. Existing Bristol Babcock DPC-3330 Main Processor rack(RTU-B) will be used for the new yard I/O. The existing valve house Bristol Babcock DPC-3330 Main Processor racks will be used for the new valve house I/O. There are spare I/O points and slots in these existing racks. RTU-B is located next to the Gravity Thickeners. The valve house RTU's are located one each in the valve houses. Make reference to the I/O Appendix for detailed I/O data.
2. A new Bristol-Babcock DPC-3330 Main Processor rack will be used for the non-Belt Filter Press I/O. This will be located in the new Dewatering building. Make reference to the I/O Appendix for detailed I/O data.

C. Herein after, the term "CONTRACTOR" shall be used to represent the party responsible to the OWNER for the WORK of this Division.

D. **Scope of Work:** The CONTRACTOR shall furnish and install the SCADA system as specified within these Contract Documents. The CONTRACTOR shall be responsible for all equipment selection, hardware and software submittal preparation, system integration, system configuration, programming, graphic generation, supervision of installation, testing, training, start-up and implementation activities for the SCADA system being furnished under this Contract. The SCADA system hardware and software being furnished under this Contract shall be a standardized system which utilizes off-the-shelf commercially available configurations of hardware and software modules.

The CONTRACTOR shall provide all installation, all labor supervision, and all engineering required to assure the proper installation and operation of the SCADA system. The CONTRACTOR shall be responsible for providing and installing complete and operational systems, meeting the requirements of the Contract

Documents. The following work, equipment and services shall be included in this Contract but not be limited to:

1. Prepare and submit for approval SCADA system hardware and software shop drawings.

2. Furnish and install a complete and operational SCADA system, including all peripherals and other equipment specified herein.

3. Perform all required SCADA system tests, adjustments, and calibrations.

4. Furnish qualified labor to perform SCADA system installation and start-up.

5. Furnish qualified instructors to provide SCADA system instruction and training.

6. Furnish all required SCADA system tools, test equipment, spare parts, supplies, operations and maintenance manuals, reproducible "as-built" drawings, and program listings as specified herein.

The CONTRACTOR's attention is directed to the construction sequencing requirements contained within the Contract Documents. The CONTRACTOR shall provide on-loan, any and all SCADA system equipment required for partial start-up of a process area or system.

E. **System Responsibility:** All SCADA system hardware and software furnished in accordance with the Contract Documents shall be done so by the CONTRACTOR. The CONTRACTOR shall have responsibility for providing a fully integrated and properly operating SCADA system. The CONTRACTOR shall coordinate the work of his personnel and the Instrumentation Supplier's personnel for the installation, interconnection, testing, calibration, and operation of all SCADA system equipment and coordinate the scheduling. The CONTRACTOR shall be responsible for providing equipment that properly meets the functional intent of the Contract Documents. Substitutions for SCADA system functions specified are not permitted.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS.

A. RTU-based control systems hardware reference specifications, codes, and standards shall be provided in accordance with Section 17100 - Process Control and Instrumentation Systems.

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** SCADA System submittals shall be in accordance with the applicable requirements of Section 17100 - Process Control and Instrumentation Systems. SCADA system submittals shall, however, be made separately from other process control and instrumentation system submittals. For SCADA System software submittal requirements, see Section 17525 - RTU-Based Control Systems - Software.

B. **Hardware Submittals:** The SCADA system hardware submittal shall include hardware specified under this Section and shall be a singular all inclusive submittal which shall include but not be limited to:

1. A complete index appearing in the front of a bound submittal volume.

2. Complete grounding requirements for the SCADA system including any requirements for an RTU or process LAN.

3. Requirements for physical separation between SCADA system components and 120 volt, 480 volt, and 4.2 kV power cables.

4. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.

5. A complete SCADA system diagram which depicts:

   a. Local and remote I/O racks, communication devices, and communication links. All I/O racks shall be shown with their current I/O allocation, future I/O allocation (current plus spares provided under this project), and maximum potential I/O based on available slots. Complete system information will be provided directly from the owner after notice to proceed is granted.

   b. All cables required to support the communication requirements. A separate diagram shall be submitted for each component fully annotated with conduit size and number associated with the power source.

6. Data sheets shall be included for each SCADA system component together with a technical product brochure or bulletin. These data sheets shall show: the component name as used within the Contract Documents, the manufacturer's model number or other identifying product designation, the project tag number, the project system of which it is a part, the project site to which it applies, the input and output characteristics, the requirements for electric power, the specifications for ambient operating conditions, and details on materials of construction.

7. Complete and detailed bills of materials: A bill of material list, including quantity, description, manufacturer, and part number, shall be submitted for each component of the SCADA system. Bills of material shall include all items within an enclosure.

8. Site-specific arrangement and construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, nameplates, and the like. All drawings shall be scaled, as noted above, and show the position of the equipment on its intended installation location. All drawings must show a scaled representation of the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas. All acquired access and clearances associated with the equipment must be shown with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.

9. Calibration, adjustment, and test details for all SCADA system components.

C. **OWNER'S Manuals:** General requirements for OWNER'S manuals are as described in Section 17100 - Process Control and Instrumentation Systems. The following items shall also be included in the OWNER'S manuals:

1. A documented RTU program listing including the I/O list and housing configuration for each I/O rack.

2. Operation and maintenance manuals for the Main Processor and I/O racks, and all other applicable SCADA system hardware.

D. **System Test Procedures:** System test procedures shall be developed by the CONTRACTOR in accordance with the requirements for system testing specified in Paragraph 3.2.C herein. These procedures shall be submitted to the ENGINEER for review. An approved submittal shall be required prior to the commencement of system testing.

Procedures shall be prepared for each process system. The procedures shall, in narrative form, describe sequentially the operational steps to be followed in verifying the correct operation of each process system, including all features described in the control strategies contained in Specification Section 17300 - Control Strategies. All equipment, including the SCADA system and its various workstation displays, which function together to form a complete process system shall be tested together, including interlocks between devices performed by the SCADA system.

E. **Factory Test Procedure:** Factory witness test shall not be required under this project.

1.4 MANUFACTURER'S REPRESENTATIVE

A. The CONTRACTOR shall provide visits by, and services of, technical field representatives of the SCADA System manufacturer for installation certification, system testing, training, and start-up. These visits shall be at no separate additional cost to the OWNER.

1.5 STORAGE AND HANDLING

A. All equipment and materials delivered to the job site shall be stored in a location which shall not interfere with the operations of the OWNER's personnel or interfere with construction. Storage and handling shall be performed in manners which shall afford maximum protection to the equipment and materials. It is the CONTRACTOR'S responsibility to assure proper handling and on-site storage.

1.6 WARRANTY

A. The complete SCADA system (and associated software) included therein shall be guaranteed to meet or exceed the design requirements set forth in the Contract Documents. Responsibility is limited to the extent of hardware and/or software which was furnished or modified under this contract.

B. Equipment, software, and materials which do not achieve design requirements after installation shall be replaced or modified by the CONTRACTOR to attain compliance, at no additional cost to the OWNER. Following replacement or modification, the CONTRACTOR shall retest the system and perform any additional procedures needed to place the complete SCADA system in satisfactory operation and attain design compliance approval from the ENGINEER.

C. The CONTRACTOR warrants the materials and workmanship used for the SCADA system equipment and materials furnished under the Contract and further guarantees the materials and workmanship used for any equipment and materials produced and furnished hereunder as a part of the work of this Contract to be as herein specified and agreed upon, free from injurious defects, and in all respects satisfactory for the service required.

D. The CONTRACTOR shall warrant/guarantee the satisfactory performance of the equipment and materials under operating conditions for a period of one year after date of final acceptance of the entire SCADA system (i.e., completion of all contractual items including a successful full system-wide performance test as specified in Part 3). In the event that tests and inspections disclose latent defects of failure to meet the specified requirements, the Instrumentation Supplier upon notification by the ENGINEER shall proceed at once to correct or repair any such defects or non-conformance or to furnish, at the delivery point named in the Contract, such new equipment or parts as may be necessary for conformity to the specified requirements, and shall therefore receive no additional compensation. In case of any required repairs or other corrective or remedial work covered under warranty, the warranties on all such corrections, repairs, new equipment, or parts shall be extended for an additional 12 months from the date of final acceptance or 12 months from the date of completion of any such corrections, repairs, new equipment, or parts, whichever date is later. The CONTRACTOR shall reimburse the OWNER for all costs incurred in the removal of the defective material and installation of the replacement.

PART 2 – PRODUCTS

2.1 GENERAL

A. All materials and all SCADA system equipment furnished under this Contract shall be new, free from defects, of first quality, and produced by manufacturers regularly engaged in the manufacture of these products.

B. Where there is more than one item of similar equipment being furnished under this Contract, all such similar equipment shall be the product of a singular manufacturer.

C. All SCADA system equipment furnished under this contract shall be provided with not only the resources required to meet the functional requirements of this project, but in addition all equipment and resources including hardware, memory requirements, I/O cards, power supplies, UPS, etc., shall be provided to accommodate a 20 percent growth in project requirements. All SCADA system equipment and resources shall be provided under this Contract such that the entire 20 percent project growth can be implemented into the SCADA system without any additional cost to the OWNER.

2.2 SCADA HARDWARE

A. Data Concentrator:

1. The existing Data Concentrator shall be used for Residuals Processing Facilities - KWAC. It shall be verified that the existing Data Concentrator has enough memory to accommodate the additional I/I for this project.

B. Existing Remote Terminal Units:

1. Existing RTU-B and Valve House RTU's shall be used for the Residuals Processing Facilities - KWAC.

C. New Remote Terminal Units:

1. One new RTU shall be provided for the non-Belt Filter Press I/O in the new Dewatering building. The new RTU shall support twelve (12) I/O cards in any combination. I/O cards shall be replaceable under power.

2. The new RTU rack provided shall be installed in an enclosure and located in the new Dewatering building.

3. The new RTU shall have four (4) communications ports. Each port shall be configurable as either RS 423 or RS 485. Surge protection shall be provided.

4. The new RTU shall have an integral keypad only.

5. The new RTU processor shall be provided with non-volatile memory(with lithium backup).

6. The new RTU shall be a **Bristol Babcock DPC 3330 with a 32 bit 386 processor (real mode).**

7. The new Dewatering building RTU shall be a slave, i.e. lower level node, to existing RTU-B on the plant data highway.

8. The new Belt Filter Press RTU's shall also be slaves, i.e. lower level node, to exisitng RTU-B on the plant data highway.

D. Enclosure

1. The cabinet shall be free-standing. A fan and compact lighting fixture activated by a door switch shall be included.

2. Vertical stacking of terminal blocks is desired. Staggering or alteranating of terminal blocks is not permitted.

3. Install a ground-fault interrupting type convenience receptacle.

4. 120 Vac control wires shall be physically separated from the 4-20 mAdc signal cables as much as practical

5. Instrument shields shall be grounded at the RTU or RIO end only

6. The cabinet shall house RTU-based hardware, modems, other necessary communication devices, power supplies, and peripheral equipment. The powering and grounding of these devices shall follow IEEE standard 1100-1992.

7. The cabinet shall be a NEMA 12 FRP with a quick release latch. Manufacturers to be **Hoffman or Rittal.**

8. All I/O: analog inputs, analog outputs, digital inputs, and digital outputs shall be wired to disconnecting or fused type terminal strips

   Note: Reference Electrical Specification 16485 – Local Control Stations and Miscellaneuous Electrical Devices

E. High Density I/O Cards:

1. Analog Input (AI): Cards shall be the source of all loop power. Each AI card shall have a 12 bit A/D converter, the conversion time shall be 200 us. Accuracy shall be 0.2% over -20°C to 70°C. The AI card shall have surge protection conforming to IEEE 472-1974 and C37.90-1978. The analog signal shall be 4-20 mA. The input impedance shall be 250 ohms. Eight (8) inputs per card shall be provided.
   A total of **4 analog input cards** shall be provided (1 spare).

2. Discrete Input (DI): The DI cards shall have 1500V common mode optical isolation. The DI card shall provide the voltage to the field contacts. Sixteen (16) inputs per card shall be provided.
   A total of **10 digital input cards** shall be provided (2 spare).

3. Discrete Output (DO): The DO cards shall be open drain style. Interposing relays with Form C contacts shall be provided. Eight (8) open drain outputs per card shall be provided.
   A total of **16 digital output cards** shall be provided (3 spare).

4. Analog Output (AO): shall sink 4-20 mA signals with an impedance of 0 to 650 ohms. Each AO board shall have a 12-bit converter. Accuracy is 0.2% from -20°C to 70°C. The update interval shall be software configurable between 0.02 to 5400 seconds. Four (4) outputs per card shall be provided.
   A total of **3 analog output cards** shall be provided (1 spare).

5. All I/O cards shall be capable of being used in either the Remote I/O racks or RTUs.

F. Fiber Optic Modems

1. The fiber optic modems shall accept an RS-485 input from the RTU hardware and convert it into optical impulses. Also a fiber optic modem

shall accept an RS-423 input from the PC Workstation and convert it to optical impulses. The baud rate shall be 187.5 kbaud. The CONTRACTOR shall provide all necessary power supplies RS-485 cables, and fiber optic connectors. The fiber optic modems shall be **Manmarc.**

G. Fiber Optic Cable

1. Industrial grade, water resistant optic fiber, coated with a suitable material to preserve the intrinsic strength of the glass, suitable for installation in conduits which are encased/directly buried/cable trays.

2. Cable of all dielectric construction.

3. Multi-mode, graded index, solid glass waveguides with the following characteristics:

Nominal core diameter	62.5 microns
Minimum ellipicity	2.0 percent
Outside clad diameter	125.0 microns
Maximum Numerical Aperture (NA)	0.275
Maximum attenuation (at 850 nm)	3.75 dB/Km
Maximum attenuation (at 1,300 nm)	1.5 dB/Km

4. Each fiber continuous with no factory splicer.

5. Mechanical stress present in the cable shall not be transmitted to the optical fibers.

6. FDDI compatible meets the requirements of ANSI X3T9.5 for FDDI cable.

7. The CONTRACTOR shall review the contract documents to determine exact length requirements and to compare the tensile strength associated with the cable to be provided with the pullbox spacing indicated in the contract documents. If additional pullboxes are needed to accommodate the characteristics of the CONTRACTOR cable, they shall be furnished and installed by the CONTRACTOR at no expense to the OWNER. CONTRACTOR shall use hydrophobic gel for ease in cable installation.

8. Three (3) new RTU's in the Dewatering building: one for miscellaneous I/O and the other two for the Belt Filter Presses, shall be connected together daisy-chain style via fiber-optic cable back to the data concentrator in the control room..

9. Fiber optic cables shall be **Tran specialty optics cable HCP-M0200T-A02EB-06.**

2.3 MISCELLANEOUS COMPONENTS

A. All connectors, terminators, cable splitters, cable taps, and adapters required to provide a complete SCADA system RTU peer-to-peer communication network shall be provided and installed by the CONTRACTOR.

2.4 SOFTWARE

A. **General:** All RTU programming, workstation, communication, and data gathering software shall be provided under provisions of Specifications Section 17525 – RTU-Based Control Systems Software.

2.5 SPARE PARTS

A. SCADA system spare parts shall be provided in accordance with Section 17100 - Process Control and Instrumentation Systems.

2.6 FACTORY TEST

Factory witness test shall not be required under this project

PART 3 – EXECUTION

3.1 INSTALLATION

A. The CONTRACTOR shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it furnishes. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it furnishes.

B. All components of the SCADA System installation shall be the responsibility of the CONTRACTOR unless specifically noted otherwise. After installation of the SCADA System is completed, the installation shall be inspected jointly by the CONTRACTOR and the Equipment Manufacturer's representatives. Any problems shall be corrected, and when both are satisfied with the installation, a written certification of the installation shall be delivered to the ENGINEER. The certification shall state that all RTUs and I/O modules, system grounds, and all other components of the SCADA System have been inspected and are installed in accordance with the manufacturer's guidelines.

3.2 CALIBRATION, TESTING, AND INSTRUCTION

A. **Testing:** All analog inputs and outputs of the SCADA System shall have their calibration checked at a minimum of 3 points to verify consistency with the balance of the analog RTU interconnect. This calibration check shall be done in conjunction with the analog RTU interconnect tests specified in Section 17100 - Process Control and Instrumentation Systems. Workstation displays and RTU registers shall both be verified for correctness.

B. **Testing:** After the SCADA System installation has been certified and the analog points have been calibrated, the SCADA System shall be tested to verify that all discrete inputs and outputs of the RTU's are correct. As much as possible, points shall be checked "end-to-end". For example, valve status inputs shall be checked by stroking the valve and a pump start output shall be checked by using it to start the pump. Simulated testing shall be allowed only when no practical alternative exists. Workstation displays shall be verified for correctness at the same time. An I/O checklist shall be used to record test results and a copy provided to the ENGINEER upon completion.

C. **System Testing**: When the SCADA system installation has been certified and analog RTU interconnect calibration and discrete I/O testing have been completed, system testing shall be performed in accordance with the approved test procedures. System testing shall operate the various process systems of the treatment plant to verify compliance with all functional requirements specified, including the automatic control modes and SCADA system interlocks described in the control strategies contained in Section 17300 of this Specification. Tests which fail to demonstrate the required operation shall be repeated in their entirety or continued after corrective action has been completed at the discretion of the ENGINEER.

Each workstation display including trend screens, reports, control screens, and alarm summaries and logs shall be verified for correctness during the system testing phase of this project. During system tests, the CONTRACTOR shall have a representative on-site continuously who is capable of troubleshooting and modifying the SCADA system configuration programming.

The CONTRACTOR shall submit to the ENGINEER a system testing completion report when each process system and all aspects of the configuration software have been successfully tested as described herein. The report shall note any problems encountered and what action was required to correct them. It shall include a clear and unequivocal statement that the process systems have been thoroughly tested and are complete and functional in accordance with all specification requirements.

D. **Plant Start-Up Test**: The CONTRACTOR shall provide start-up support to include the CONTRACTOR's personnel, electrical personnel, and the SCADA System manufacturer's representative as required during the testing period to produce a fully operational treatment plant. This support shall be provided at no additional cost to the OWNER. The plant start-up test shall be conducted in accordance with the requirements of Section 01660 - Equipment Testing and Plant Start-Up.

E. **Performance Test:**

1. Subsequent to the system and plant start-up testing of process areas at the Kentucky River Station, the CONTRACTOR shall conduct a successful 90 day final acceptance test for the SCADA system furnished under this contract. In the test, the entire SCADA system shall be continuously operated and maintained (i.e., 7 days per week, 24 hours per day) during the test period with zero downtime resulting from system failures. If a system failure occurs, the 90 day test shall be considered a failure and not acceptable. The CONTRACTOR shall repeat the 90 day test. The SCADA system shall be acceptable only after all equipment and software has satisfied the performance test requirements.

2. Downtime resulting from the following shall be considered system failures:

   a. If a component failure cannot be repaired/replaced within 2 hours.

b. Downtime of any component (exclusive of I/O) whose failure results in the inability of the Operator to monitor and manipulate control loops from the associated workstations using standard workstation interface procedures.

c. Downtime in excess of 2 hours resulting from any I/O component failure.

d. Downtime resulting from concurrent failure of 2 or more I/O components in a single RTU.

3. The CONTRACTOR shall submit a final acceptance test completion report which shall state that all contract requirements have been met and which shall include (1) a listing of all SCADA system equipment maintenance/repair activities conducted during testing and (2) a listing of all components which were unable to operate successfully. Final acceptance, in writing, of the SCADA system shall be provided by the ENGINEER if the results of all of the performance tests are acceptable.

4. The CONTRACTOR shall guarantee the entire SCADA system for a period of one year after acceptance of all required performance tests. The CONTRACTOR shall be responsible for furnishing the spare parts/tools on site at an inventory level the CONTRACTOR determines is sufficient. All spare parts/tools stored on-site shall become the property of the OWNER upon completion of the guarantee period. The CONTRACTOR shall guarantee that the completed system shall perform all of the data acquisition, control, and reporting functions as shown and specified.

F. **Training:** The CONTRACTOR shall provide 4 weeks of on site training for the purpose of familiarizing the OWNER's maintenance and operating personnel with the use, maintenance, calibration, and repair of all components of the SCADA system.

- END OF SECTION -

SECTION 17525
RTU-BASED CONTROL SYSTEMS-SOFTWARE

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR, through the use of a qualified Instrumentation Supplier and qualified electrical installers, shall furnish, supervise installation, assemble, configure, program, and place into service the RTU-based control system, hereafter called the Supervisory Control and Data Acquisition (SCADA) System, specified under this Section, in Section 17515 – RTU-Based Control Systems Hardware.

B. The CONTRACTOR shall use the existing software to develop the logic and graphics for Residuals Processing Facilities in Kentucky River Station.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS.

A. RTU-based control systems software reference specifications, codes, and standards shall be provided in accordance with Section 17100 - Process Control and Instrumentation Systems.

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** RTU-based control systems software shop drawing submittals shall be provided in accordance with Section 17100 - Process Control and Instrumentation Systems, and Section 17515 – RTU Based Control Systems Hardware.

B. **Software Submittals:** The software submittal shall be included in a singular all inclusive submittal which shall include but not be limited to:

1. Complete description of the standard application software programs, operating system and utility program to be furnished, including modifications and explanation of how the specific functional requirements will be met. A cross reference between the specification and the software submittal shall be provided in order to give the ENGINEER the ability to identify how each specified section or function is being met by the CONTRACTOR.

2. A complete set of all available software algorithms.

3. A complete set of control strategies which depict all monitoring and control functions on a loop by loop basis.

4. An English language narrative of each data acquisition or control loop mission and anticipated action. Narratives shall enumerate the signal point name, signal descriptor, associated RTU number, associated graphic displays, system functions activated by the signal (i.e., interlocks, alarms, logs, etc.)

5. A complete set of module configuration sheets depicting each loop linkage.

6. A complete listing of the SCADA system data base for each data point with relevant parameters such as range, active state, contact orientation, limits,

incremental limits, I/O card byte, I/O hardware address and Remote I/O assignment. The list shall be divided and grouped by remote I/O rack, for in-plant and remote sites, and divided into type of I/O. In addition to the active I/Os, the list shall also include implemented spare I/Os. Final format shall be approved by the ENGINEER.

7. Detailed descriptions of procedures used to implement and modify control strategies and data base construction.

8. One complete set of all workstation accessible displays which are unique to this project complete with color conventions and labeling conventions. These displays shall be a full size color graphic format arranged in hierarchical order and shall meet the same quality and format of the existing displays at the plant.

C. **Additional Submittals:** After all shop drawings submittals required herein, have been approved by the ENGINEER, the CONTRACTOR shall submit the following items. Favorable review and implementation of these submittals is required prior to the start of system testing (i.e. the SCADA System must be operational prior to any process system test).

1. All workstation displays (both graphic displays and trend displays) submittals shall be in full color as they will appear on the CRT.

2. Each display shall be uniquely titled. Locations for process data shall be clearly identified either through the use of simulated data or by showing variables on the displays and providing a reference list describing those variables. All dynamic points shall be identified by tag number as a minimum and their operation shall be described on separate sheets (color change, symbol change, etc.). Three sets of submittals (with screen prints in color) are required for review by the ENGINEER. One set will be returned with comments. All other copies of the submittals required may be provided in black and white.

3. All periodic reports for the entire SCADA system shall be clearly identified, either through the use of simulated data or by showing variables on the report and providing a reference list describing those variables. These reports shall be similar to the reports currently being generated at the plant.

D. **Additional Requirements:** The following items shall be submitted with the final sets of technical manuals required 15 days prior to the plant operational test.

1. All RTU program and workstation configuration program files stored on labeled disks. The RTU program and workstation configuration file disks shall also be updated as required if any changes or corrections are required in this programming prior to project completion.

E. **Operator's Reference Manual:** The CONTRACTOR shall prepare and submit a users reference manual for the workstation system for use by the plant operators. This manual shall be bound in a soft cover folder (Accopress) and contain the following:

1. An index to the manual.

2. A list of workstation display screens, trends, and reports, with display name and description.

3. A list of the control screens with the display names and description. It shall also provide a summary of possible commands and operator inputs to these screens including set points. All control actions shall be included.

4. A SCADA system block diagram with names and locations of major components.

5. Instructions for manually printing screens or reports, both real time and historical as applicable.

6. A summary of security levels and their privileges and limitations.

7. Spaces for operators to make notes.

8. A copy of this manual shall be provided to each operator during training on the workstation operations. The training class shall include a review of this manual with the operators in addition to more detailed instruction on the workstation configuration and its use.

1.4 MANUFACTURER'S REPRESENTATIVE

A. RTU-based control systems software manufacturer's representative services shall be provided in accordance with Section 17515 – RTU Based Control Systems Hardware.

PART 2 — PRODUCTS

2.1 GENERAL

A. The plant's existing software packages will be used for this project.

2.2 HARDWARE

A. General: All RTU's, communication equipment, etc., shall be provided under provisions of Section 17515 – RTU Based Control Systems Hardware.

2.3 RTU SOFTWARE

A. **RTU Programming Software:** All RTU programming shall be accomplished using the plant's existing software package. All RTU flow rate and run status inputs shall be totalized within the RTU registers.

B. All programming, monitoring, searching, and editing shall be accomplished using this RTU programming software. It shall be usable both on-line (while connected to the RTU) and off-line. The software shall be able to monitor the status of all inputs, outputs, timers, counters, and coils. It shall have the capability to disable/force all inputs, outputs, and coils. It shall include a search capability to locate any address or element and its program location. RTU status information, such as error indication and amount of memory remaining shall be shown on the CRT screen.

C. The RTU programming software shall have the capability to generate an RTU program printout which is fully documented. Fully documented program listings shall have appropriate code with comments to clarify to a reader what that segment of the program accomplishes. A fully documented listing shall also include a cross reference report of program addresses. The RTU programming software shall be suitable for the existing RTUs, and new RTU furnished under Section 17515 – RTU Based Control Systems Hardware.

1. Modified and new programs shall be needed for the Residuals Processing Facilities at Kentucky River Station. The I/O shall be wired to the existing RTU-B located near the Gravity Thickeners, the existing Valve House RTU's, and the new RTU located in the Dewatering building. A new program shall be developed for the new Dewatering building RTU. The existing RTU-B and Valve House RTU programs shall be modified to incorporate the additional Residuals Processing Facilities I/O signals. It is the sole responsibility of the CONTRACTOR to have a working Residuals Processing Facility and the interface of the program with the Residuals Processing Facility graphics. Refer to the attachment for a complete list of I/O.

D. The plant's existing RTU software is **ACCOL. II.**

2.4 WORKSTATION SOFTWARE

A. **Workstation Software Package:**

Plant's existing Workstation software packages shall be used.

B. **SCADA System Graphics:**

The workstations and RTU systems which make up the SCADA system shall be fully configured by the CONTRACTOR as specified in the Contract Documents. Configuration requirements are contained in this Specification Section and functional control descriptions are contained in Specification Section 17300 – Control Strategies. Such configuration as is required to perform data transfer and communication is also required even though not specifically described.

C. Workstation screens shall be configured to maximize user friendliness for the plant operators, and shall meet the same quality and format of the existing graphics. The process of calling up a display screen shall consist of pointing a cursor at pre-configured targets on the current screen and clicking, or of pushing a function key which shall be selected from a labeled list on the current display. Each screen shall include targets or function key labels to related screens and to the main menu screen.

D. The various required screens shall use text of all capital letters with the exception of certain engineering units. All text shall be horizontal. Screens showing equipment shall include the equipment number and name as used in the Contract Drawings. Total equipment run times shall be displayed as hours and tenths of hours adjacent to equipment symbols. Each screen shall show the current time and date which shall appear in the same place on each screen. The CONTRACTOR shall provide screens as dictated by Specification Section 17300 for the Kentucky River Station.

1. **Display Screens:** The CONTRACTOR shall configure display screens to show all status and analog data contained in the SCADA system database. The Contract Drawings, Control Strategies, and Specifications shall form the basis of the SCADA

system database. Some status and analog points shall be displayed on more than one display screen, especially where it relates to more than one process or is significant to facility operations. Every analog and status value shall appear on at least one display screen. Analog values shall be displayed with appropriate engineering units, and shall use techniques such as variable fill and/or color changes to provide clarity to plant operators. Status points shall incorporate symbol and/or color changes along with labels (OPEN/CLOSE, ON/OFF, etc.) to inform plant operators of the current status. Color and labeling conventions shall be approved by the OWNER in writing prior to submitting display screens for review as required in Paragraph 1.4.C.

2. **Trend Display Screens:** The CONTRACTOR shall configure trend display screens which show real time and historical process data in an X-Y plot with time on the horizontal axis. Trend displays shall be configured from one to four process variables displayed. Each variable shall be drawn in a separate color with its vertical axis, scale, units, tag number, and description shown in the same color. All variables on a trend display shall be shown on a single full screen X-Y plot with a vertical axis and scale for each variable, and a common horizontal time axis. Each trend display shall have a preset time window when called up by a plant operator, but shall be easily changed by operator inputs to display alternate time ranges. It shall also be possible to scroll a cursor across the X-Y plot to a specific time and read the corresponding process variables digitally at that point.

3. **Alarm System Configuration:** The SCADA system shall be configured by the CONTRACTOR to provide the plant operators with an alarm system to identify treatment plant and control system problems. Most of the required alarms are identified in the Alarm Summary. Additional alarms, along with detailed configuration requirements, are described in the alarm handling of Specification Section 17300 - Control Strategies.

   All analog values in the workstations shall be provided with the capability to generate alarms for HI-HI, HI, LO, LO-LO, and Rate of Change. Only those alarms identified in the Contract Documents shall have set points entered by the CONTRACTOR. Set points not identified shall be able to be easily entered, by personnel with the required security level, in the future as required in the Control Strategy. Alarm system displays, logs, and files shall comply with the Control Strategy requirements.

4. **Security:** The CONTRACTOR shall configure the workstations to incorporate at least 5 security levels to protect the plant operation and the workstations from unauthorized changes. Security levels with corresponding restrictions and privileges shall be as follows:

   a. Level One: This shall be the lowest level of privilege and shall only allow a system user to view the various configured displays and to print out those displays. No password shall be required at this level.

   b. Level Two: This level shall permit all functions of the previous level and shall also allow control modes to be changed. An examples would be START/STOP selection.

   c. Level Three: This level shall permit all functions of previous levels and shall also allow set points to be changed and control inputs to be entered.

d. Level Four: This level shall permit all functions of previous levels and shall also allow the workstation configuration to be changed by modifying display and other screens, editing the system database, and adding additional displays or database points. It shall also allow modifying variable logging and enable a user to exit from the workstation software package. Alarm classes may also be changed at this level.

e. Level Five: This level shall permit all functions of previous levels and shall also allow the security system described herein to be modified, or to add or delete operators and passwords.

Each individual shall have a preset security level assigned, which may only be changed by a level 5 clearance. Any individual shall be able to change their own password at any time. An operator shall be able to log on to each terminal individually and independently and shall be able to log off in the same manner.

E. **Workstation Graphics Generation:** It is the sole responsibility of the CONTRACTOR to configure the workstations and to develop, design, engineer, configure and test all of the CRT-based graphic displays required for this project. All of this work shall take into account the specific needs of the end user. The displays shall meet the same quality and format of the existing graphics. The CONTRACTOR shall prepare a formalized submittal of the graphic package for review by the ENGINEER. The graphic package shall include graphics for the Residuals Processing Facilities in Kentucky River Station. The CONTRACTOR shall be responsible for updating the existing residuals processing graphics to incorporate the new equipment in the Dewatering building. It is the sole responsibility of the CONTRACTOR to have a working Residuals Processing Facilities system.

F. **SCADA System Data Base:** The workstation software shall incorporate a disk memory resident data base which shall store all software elements necessary to implement all data acquisition, calculation, logging and reporting functions. The system data base shall be comprised of the following elements:

1. Current data base; includes process status information.

2. Historical data base; includes non-current process status information.

G. **SCADA System Documenter:** Subsequent to system configuration or configuration updates, all information which defines the hardware, control and display configuration of the SCADA system shall be stored in mass memory within the workstations. All documentation shall be printed/plotted in both a text and graphic format. All documentation shall be accessible in report formats. It is not acceptable to utilize screen prints as a documentation report method. The workstation shall provide the means to produce the following documentation.

1. Current control system data bases, (including tags, descriptors, alarm limits, engineering units, associated alarm priority, logical states, etc.) control loops, and ladder logic.

2. Definition of the current hardware configuration including locations and associated RTU numbers.

3. Definition of the current display hierarchy and all displays currently in the system.

H. **Data Base Generation:** All software shall be provided to enable historical data base generation to be accomplished by a conversational fill-in-the-blanks technique on CRT display formats in which operational characteristics (i.e., name, scan class, alarm limits, etc.) are inserted into linkable prewritten software modules which perform scanning, computational, and collection functions. Once the information is transcribed into data records, the data base software shall:

1. Read and interpret the information.

2. Manage all process input and output hardware assignments.

3. Generate data files.

4. Perform self documenting functions such as producing hard copies of listings, main and disk memories, and data sorts by analog input, analog output, contact input and contact output.

I. **Data Acquisition:** Scan blocks shall extract data from the network at specifiable rates, condition the signals, convert the data to engineering units in a floating point format, and store the data to produce a SCADA system data base. Typical input signals to be scanned include:

1. Limit, status, or position information from open/close valves, motors and process monitoring devices such as level and pressure switches.

2. Measured variables such as percent solids and levels.

3. Measurements, set points, and outputs from all RTUs.

4. Computed values such as inferential measurements.

5. Operational commands from workstation keyboards.

J. **Data Collection:** The CONTRACTOR shall provide programming that collects current values of specified variables from on line data storage areas, statistically manipulates data, and creates and maintains an historical data base of collected values. Statistical manipulation shall include linear averaging, filtered averaging, and noting of "bad" values. Statistically manipulated data shall then be stored in a historical data base.

1. The frequency of historical collection shall be Engineer selectable between once per second to once per month. The type and quantity of historical data shall be selectable by addition and deletion to/from the historical data base.

2. The CONTRACTOR shall provide adequate on-line storage to retain 60 days of 6 minute average values for 2,000 variables and hourly maximum, minimum, and average values of 2,000 variables.

3. The CONTRACTOR shall additionally provide adequate on-line storage to retain 2 years of daily average values for 2,000 variables and monthly maximum, minimum, and average values for 2,000 variables.

4. Historical records shall be transferred to redundant CD-ROM writeable devices and shall be an automatic function.

2.5 REPORTS

A. **General:** The CONTRACTOR shall provide a SCADA system which is capable of generating reports for the Residuals Processing Facilities similar to the reports currently being generated at the plant. The CONTRACTOR shall use the plant's existing software resources for reporting.

B. **Configuration of Reports:** It is the sole responsibility of the CONTRACTOR to configure the workstations and to develop, design, engineer, configure and test all of the reports required for this contract. The reports will be limited to tracking polymer usage only. All of this work shall take into account the specific needs of the end user. The reports shall be specifically defined to the CONTRACTOR at the time of construction.

2.6 FACTORY TEST

A. **General:** The RTU-based control systems software factory test shall be provided in accordance with Section 17515 RTU Based Control Systems Hardware.

PART 3 — EXECUTION

3.1 INSTALLATION

A. The RTU-based control systems software installation shall be provided in accordance with Section 17515 – RTU Based Control Systems Hardware.

3.2 CALIBRATION, TESTING, AND INSTRUCTION

A. **General:** The RTU-based control systems software calibration, testing, and instruction shall be provided in accordance with Section 17515 – RTU Based Control Systems Hardware.

- END OF SECTION -

APPENDIX

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL
PROCESSING FACILITES
I/O LIST

KEN[illegible]CKY-[illegible]RIC[illegible]WAT[illegible]OM[illegible]Y
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
1	TS-HS-10.01B	DISC OUTPUT	VALVE TO CLOSE COMMAND	BFT 1 INLET VLV	DEWATERING BLDG. RTU (NEW)
2	TS-HS-10.01A	DISC OUTPUT	VALVE TO OPEN COMMAND	BFT 1 INLET VLV	DEWATERING BLDG. RTU (NEW)
3	TS-ZL-10.01	DISC INPUT	SWITCH - L/R STATUS	BFT 1 INLET VLV	DEWATERING BLDG. RTU (NEW)
4	TS-ZLO-10.01A	DISC INPUT	VALVE OPEN STATUS	BFT 1 INLET VLV	DEWATERING BLDG. RTU (NEW)
5	TS-ZLC-10.01A	DISC INPUT	VALVE CLOSED STATUS	BFT 1 INLET VLV	DEWATERING BLDG. RTU (NEW)
6	TS-HS-20.01B	DISC OUTPUT	VALVE TO CLOSE COMMAND	BFT 2 INLET VLV	DEWATERING BLDG. RTU (NEW)
7	TS-HS-20.01A	DISC OUTPUT	VALVE TO OPEN COMMAND	BFT 2 INLET VLV	DEWATERING BLDG. RTU (NEW)
8	TS-ZL-20.01	DISC INPUT	SWITCH - L/R STATUS	BFT 2 INLET VLV	DEWATERING BLDG. RTU (NEW)
9	TS-ZLO-20.01A	DISC INPUT	VALVE OPEN STATUS	BFT 2 INLET VLV	DEWATERING BLDG. RTU (NEW)
10	TS-ZLC-20.01A	DISC INPUT	VALVE CLOSED STATUS	BFT 2 INLET VLV	DEWATERING BLDG. RTU (NEW)
11	TS.BFT-LI-10.01	ANALOG INPUT	LEVEL INDICATION	BATCH FEED TNK 1	DEWATERING BLDG. RTU (NEW)
12	TS.BFT-LI-20.01	ANALOG INPUT	LEVEL INDICATION	BATCH FEED TNK 2	DEWATERING BLDG. RTU (NEW)
13	TS.MX-YL-10.01C	DISC INPUT	ON/OFF STATUS	BATCH FD TK 1 MX	DEWATERING BLDG. RTU (NEW)
14	TS.MX-HS-10.01B	DISC OUTPUT	START COMMAND	BATCH FD TK 1 MX	DEWATERING BLDG. RTU (NEW)
15	TS.MX-ZL-10.01	DISC INPUT	SWITCH - L/R STATUS	BATCH FD TK 1 MX	DEWATERING BLDG. RTU (NEW)
16	TS.MX-YL-20.01C	DISC INPUT	ON/OFF STATUS	BATCH FD TK 2 MX	DEWATERING BLDG. RTU (NEW)
17	TS.MX-HS-20.01B	DISC OUTPUT	START COMMAND	BATCH FD TK 2 MX	DEWATERING BLDG. RTU (NEW)
18	TS.MX-ZL-20.01	DISC INPUT	SWITCH - L/R STATUS	BATCH FD TK 2 MX	DEWATERING BLDG. RTU (NEW)
19	TS-FI-10.01	ANALOG INPUT	FLOW INDICATION	THICK SLUDGE TO BFP1	DEWATERING BLDG. RTU (NEW)
20	TS-FI-20.01	ANALOG INPUT	FLOW INDICATION	THICK SLUDGE TO BFP2	DEWATERING BLDG. RTU (NEW)
21	TS.BFP-TURI-20.01	ANALOG INPUT	TURBIDITY INDICATION	FILTER PRESS 2	DEWATERING BLDG. RTU (NEW)
22	TS.BFP-TURI-10.01	ANALOG INPUT	TURBIDITY INDICATION	FILTER PRESS 1	DEWATERING BLDG. RTU (NEW)
23	SC.CON-YL-10.01	DISC INPUT	ON/OFF STATUS	BFP1 EXIT CONV	DEWATERING BLDG. RTU (NEW)
24	SC.CON-YL-20.01	DISC INPUT	ON/OFF STATUS	BFP2 EXIT CONV	DEWATERING BLDG. RTU (NEW)
25	BPOL.T-LAH-00.02	DISC INPUT	HIGH LEVEL ALARM	BPOL BULK TANK	DEWATERING BLDG. RTU (NEW)
26	BPOL.T-LI-00.01	ANALOG INPUT	LEVEL INDICATION	BPOL BULK TANK	DEWATERING BLDG. RTU (NEW)
27	BPOL.MX-YL-00.01	DISC INPUT	ON/OFF STATUS	BPOL DAY TK MIX	DEWATERING BLDG. RTU (NEW)
28	BPOL.T-WI-00.02	ANALOG INPUT	WEIGHT INDICATION	BPOL DAY TANK	DEWATERING BLDG. RTU (NEW)
29	GWPOL.T-LAH-00.02	DISC INPUT	HIGH LEVEL ALARM	GWPOL BULK TANK	DEWATERING BLDG. RTU (NEW)
30	GWPOL.T-LI-00.01	ANALOG INPUT	LEVEL INDICATION	GWPOL BULK TANK	DEWATERING BLDG. RTU (NEW)
31	GWPOL.MX-YL-00.01	DISC INPUT	ON/OFF STATUS	GWPOL DAY TK MIX	DEWATERING BLDG. RTU (NEW)
32	GWPOL.T-WI-00.02	ANALOG INPUT	WEIGHT INDICATION	GWPOL DAY TANK	DEWATERING BLDG. RTU (NEW)
33	WPOL.PBS-YL-00.01	DISC INPUT	ON/OFF STATUS	WPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)

S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
34	WPOL.PBS-YL-00.02	DISC INPUT	ON/OFF STATUS	WPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
35	WPOL.PBS-SI-00.02	ANALOG INPUT	SPEED INDICATOR	WPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
36	WPOL.PBS-HS-00.02	DISC OUTPUT	START COMMAND	WPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
37	WPOL.PBS-SC-00.02	ANALOG OUTPUT	SPEED CONTROL	WPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
38	WPOL.PBS-ZL-00.02	DISC INPUT	LOCAL/REMOTE STATUS	WPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
39	WPOL.PBS-YA-00.02	DISC INPUT	SYSTEM FAULT	WPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
40	SMOKE.DET-YL-00.01	DISC INPUT	SMOKE DETECTED	DEWATERING BUILDING	DEWATERING BLDG. RTU (NEW)
41	WPOL.PBS-SI-00.01	ANALOG INPUT	SPEED INDICATOR	WPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
42	WPOL.PBS-HS-00.01	DISC OUTPUT	START COMMAND	WPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
43	WPOL.PBS-SC-00.01	ANALOG OUTPUT	SPEED CONTROL	WPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
44	WPOL.PBS-ZL-00.01	DISC INPUT	LOCAL/REMOTE STATUS	WPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
45	WPOL.PBS-YA-00.02	DISC INPUT	SYSTEM FAULT	WPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
46	GPOL.PBS-YL-00.01	DISC INPUT	ON/OFF STATUS	GPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
47	GPOL.PBS-YL-00.02	DISC INPUT	ON/OFF STATUS	GPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
48	GPOL.PBS-SI-00.02	ANALOG INPUT	SPEED INDICATOR	GPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
49	GPOL.PBS-HS-00.02	DISC OUTPUT	START COMMAND	GPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
50	GPOL.PBS-SC-00.02	ANALOG OUTPUT	SPEED CONTROL	GPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
51	GPOL.PBS-ZL-00.02	DISC INPUT	LOCAL/REMOTE STATUS	GPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
52	GPOL.PBS-YA-00.02	DISC INPUT	SYSTEM FAULT	GPOL BLEND SYS 2	DEWATERING BLDG. RTU (NEW)
53	GPOL.PBS-SI-00.01	ANALOG INPUT	SPEED INDICATOR	GPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
54	GPOL.PBS-HS-00.01	DISC OUTPUT	START COMMAND	GPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
55	GPOL.PBS-SC-00.01	ANALOG OUTPUT	SPEED CONTROL	GPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
56	GPOL.PBS-ZL-00.01	DISC INPUT	LOCAL/REMOTE STATUS	GPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
57	GPOL.PBS-YA-00.01	DISC INPUT	SYSTEM FAULT	GPOL BLEND SYS 1	DEWATERING BLDG. RTU (NEW)
58	DRN-ZLC-00.11	DISC INPUT	VALVE OPEN STATUS	BFT 1 DRN VLV	DEWATERING BLDG. RTU (NEW)
59	DRN-ZLO-00.11	DISC INPUT	VALVE CLOSED STATUS	BFT 1 DRN VLV	DEWATERING BLDG. RTU (NEW)
60	DRN-ZL-00.11	DISC INPUT	SWITCH - L/R STATUS	BFT 1 DRN VLV	DEWATERING BLDG. RTU (NEW)
61	DRN-HS-00.11A	DISC OUTPUT	VALVE TO OPEN COMMAND	BFT 1 DRN VLV	DEWATERING BLDG. RTU (NEW)
62	DRN-HS-00.11B	DISC OUTPUT	VALVE TO CLOSE COMMAND	BFT 1 DRN VLV	DEWATERING BLDG. RTU (NEW)
63	DRN-ZLC-00.12	DISC INPUT	VALVE OPEN STATUS	BFT 2 DRN VLV	DEWATERING BLDG. RTU (NEW)
64	DRN-ZLO-00.12	DISC INPUT	VALVE CLOSED STATUS	BFT 2 DRN VLV	DEWATERING BLDG. RTU (NEW)
65	DRN-ZL-00.12	DISC INPUT	SWITCH - L/R STATUS	BFT 2 DRN VLV	DEWATERING BLDG. RTU (NEW)
66	DRN-HS-00.12A	DISC OUTPUT	VALVE TO OPEN COMMAND	BFT 2 DRN VLV	DEWATERING BLDG. RTU (NEW)

KENTUCKY-AMERICAN WATER COMPANY
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
67	DRN-HS-00.12B	DISC OUTPUT	VALVE TO CLOSE COMMAND	BFT 2 DRN VLV	DEWATERING BLDG. RTU (NEW)
68	DRN-ZLC-00.02A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
69	DRN-ZLO-00.02A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
70	DRN-ZL-00.02	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
71	DRN-HS-00.02A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
72	DRN-HS-00.02B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
73	DRN-HS-00.01B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
74	DRN-HS-00.01A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
75	DRN-ZL-00.01	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
76	DRN-ZLO-00.01A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
77	DRN-ZLC-00.01A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
78	SS-HS-00.02B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
79	SS-HS-00.02A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
80	SS-ZL-00.02	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
81	SS-ZLO-00.02A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
82	SS-ZLC-00.02A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
83	SS-HS-00.04B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
84	SS-HS-00.04A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
85	SS-ZL-00.04	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
86	SS-ZLO-00.04A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
87	SS-ZLC-00.04A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
88	PW-HS-00.01A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
89	PW-ZL-00.01	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
90	PW-HS-00.02A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
91	PW-ZL-00.02	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.1	VALVE HOUSE NO. 1 RTU (EXIST.)
92	DRN-ZLC-00.04A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
93	DRN-ZLO-00.04A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
94	DRN-ZL-00.04	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
95	DRN-HS-00.04A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
96	DRN-HS-00.04B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
97	DRN-HS-00.03B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
98	DRN-HS-00.03A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
99	DRN-ZL-00.03	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)

KENTUCKY-AMERICAN WATER COMPANY
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S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
100	DRN-ZLO-00.03A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
101	DRN-ZLC-00.03A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
102	SS-HS-00.08B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
103	SS-HS-00.08A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
104	SS-ZL-00.08	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
105	SS-ZLO-00.08A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
106	SS-ZLC-00.08A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
107	SS-HS-00.06B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
108	SS-HS-00.06A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
109	SS-ZL-00.06	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
110	SS-ZLO-00.06A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
111	SS-ZLC-00.06A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
112	PW-HS-00.03A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
113	PW-ZL-00.03	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
114	PW-HS-00.04A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
115	PW-ZL-00.04	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.2	VALVE HOUSE NO. 2 RTU (EXIST.)
116	DRN-ZLC-00.06A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
117	DRN-ZLO-00.06A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
118	DRN-ZL-00.06	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
119	DRN-HS-00.06A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
120	DRN-HS-00.06B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
121	DRN-HS-00.05B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
122	DRN-HS-00.05A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
123	DRN-ZL-00.05	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
124	DRN-ZLO-00.05A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
125	DRN-ZLC-00.05A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
126	SS-HS-00.12B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
127	SS-HS-00.12A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
128	SS-ZL-00.12	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
129	SS-ZLO-00.12A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
130	SS-ZLC-00.12A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
131	SS-HS-00.10B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
132	SS-HS-00.10A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)

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S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
133	SS-ZL-00.10	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
134	SS-ZLO-00.10A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
135	SS-ZLC-00.10A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
136	PW-HS-00.05A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
137	PW-ZL-00.05	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
138	PW-HS-00.06A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
139	PW-ZL-00.06	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.3	VALVE HOUSE NO. 3 RTU (EXIST.)
140	DRN-ZLC-00.08A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
141	DRN-ZLO-00.08A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
142	DRN-ZL-00.08	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
143	DRN-HS-00.08A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
144	DRN-HS-00.08B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
145	DRN-HS-00.07B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
146	DRN-HS-00.07A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
147	DRN-ZL-00.07	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
148	DRN-ZLO-00.07A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
149	DRN-ZLC-00.07A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
150	SS-HS-00.16B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
151	SS-HS-00.16A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
152	SS-ZL-00.16	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
153	SS-ZLO-00.16A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
154	SS-ZLC-00.16A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
155	SS-HS-00.14B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
156	SS-HS-00.14A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
157	SS-ZL-00.14	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
158	SS-ZLO-00.14A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
159	SS-ZLC-00.14A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
160	PW-HS-00.07A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
161	PW-ZL-00.07	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
162	PW-HS-00.08A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
163	PW-ZL-00.08	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.4	VALVE HOUSE NO. 4 RTU (EXIST.)
164	DRN-ZLC-00.10A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
165	DRN-ZLO-00.10A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)

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S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
166	DRN-ZL-00.10	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
167	DRN-HS-00.10A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
168	DRN-HS-00.10B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
169	DRN-HS-00.09B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
170	DRN-HS-00.09A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
171	DRN-ZL-00.09	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
172	DRN-ZLO-00.09A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
173	DRN-ZLC-00.09A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
174	SS-HS-00.20B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST
175	SS-HS-00.20A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST
176	SS-ZL-00.20	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
177	SS-ZLO-00.20A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
178	SS-ZLC-00.20A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
179	SS-HS-00.18B	DISC OUTPUT	VALVE TO CLOSE COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
180	SS-HS-00.18A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
181	SS-ZL-00.18	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
182	SS-ZLO-00.18A	DISC INPUT	VALVE OPEN STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
183	SS-ZLC-00.18A	DISC INPUT	VALVE CLOSED STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
184	PW-HS-00.09A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
185	PW-ZL-00.09	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
186	PW-HS-00.10A	DISC OUTPUT	VALVE TO OPEN COMMAND	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
187	PW-ZL-00.10	DISC INPUT	SWITCH - L/R STATUS	VALVE HOUSE NO.5	VALVE HOUSE NO. 5 RTU (EXIST.)
188	SS-HS-00.01A	DISC OUTPUT	VALVE TO OPEN COMMAND	GRAV THICKENER 1	VALVE HOUSE NO.3 RTU (EXIST)
189	SS-ZL-00.01	DISC INPUT	SWITCH - L/R STATUS	GRAV THICKENER 1	VALVE HOUSE NO.3 RTU (EXIST)
190	SS-ZLO-00.01A	DISC INPUT	VALVE OPEN STATUS	GRAV THICKENER 1	VALVE HOUSE NO.3 RTU (EXIST)
191	SS-ZLC-00.01A	DISC INPUT	VALVE CLOSED STATUS	GRAV THICKENER 1	VALVE HOUSE NO.3 RTU (EXIST)
192	TS.GT1-DI-00.01	ANALOG INPUT	SLUDGE DEPTH LEVEL INDICATION	GRAV THICKENER 1	VALVE HOUSE NO.3 RTU (EXIST)
193	TS.SC-YL-00.01C	DISC INPUT	ON/OFF STATUS	THICK SLUDGE COL 1	VALVE HOUSE NO.3 RTU (EXIST)
194	SS-HS-00.22B	DISC OUTPUT	VALVE TO CLOSE COMMAND	GRAV THICKENER 2	YARD RTU-B (EXIST.)
195	SS-HS-00.22A	DISC OUTPUT	VALVE TO OPEN COMMAND	GRAV THICKENER 2	YARD RTU-B (EXIST.)
196	SS-ZL-00.22	DISC INPUT	SWITCH - L/R STATUS	GRAV THICKENER 2	YARD RTU-B (EXIST.)
197	SS-ZLO-00.22A	DISC INPUT	VALVE OPEN STATUS	GRAV THICKENER 2	YARD RTU-B (EXIST.)
198	SS-ZLC-00.22A	DISC INPUT	VALVE CLOSED STATUS	GRAV THICKENER 2	YARD RTU-B (EXIST.)

S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
199	TS.GT2-DI-00.02	ANALOG INPUT	SLUDGE DEPTH LEVEL INDICATION	GRAV THICKENER 2	YARD RTU-B (EXIST.)
200	TS.P-YL-00.03C	DISC INPUT	ON/OFF STATUS	THICK SLUDGE PP3	YARD RTU-B (EXIST.)
201	TS.P-HS-00.03B	DISC OUTPUT	START COMMAND	THICK SLUDGE PP3	YARD RTU-B (EXIST.)
202	TS.P-ZL-00.03	DISC INPUT	SWITCH - L/R STATUS	THICK SLUDGE PP3	YARD RTU-B (EXIST.)
203	TS.SC-YL-00.03C	DISC INPUT	ON/OFF STATUS	THICK SLUDGE COL2	YARD RTU-B (EXIST.)
204	TS.P-YL-00.04C	DISC INPUT	ON/OFF STATUS	THICK SLUDGE PP4	YARD RTU-B (EXIST.)
205	TS.P-HS-00.04B	DISC OUTPUT	START COMMAND	THICK SLUDGE PP4	YARD RTU-B (EXIST.)
206	TS.P-ZL-00.04	DISC INPUT	SWITCH - L/R STATUS	THICK SLUDGE PP4	YARD RTU-B (EXIST.)
207	TS.SC-XA-00.02	DISC INPUT	OVERTORQUE ALARM	THICK SLUDEG COL 2	YARD RTU-B (EXIST.)
208	TS.P-YL-00.01C	DISC INPUT	ON/OFF STATUS	THICK SLUDGE PP1	YARD RTU-B (EXIST.)
209	TS.P-HS-00.01B	DISC OUTPUT	START COMMAND	THICK SLUDGE PP1	YARD RTU-B (EXIST.)
210	TS.P-ZL-00.01	DISC INPUT	SWITCH - L/R STATUS	THICK SLUDGE PP1	YARD RTU-B (EXIST.)
211	TS.P-YL-00.02C	DISC INPUT	ON/OFF STATUS	THICK SLUDGE PP2	YARD RTU-B (EXIST.)
212	TS.P-HS-00.02B	DISC OUTPUT	START COMMAND	THICK SLUDGE PP2	YARD RTU-B (EXIST.)
213	TS.P-ZL-00.02	DISC INPUT	SWITCH - L/R STATUS	THICK SLUDGE PP2	YARD RTU-B (EXIST.)
214	SS-HS-00.01B	DISC OUTPUT	VALVE TO CLOSE COMMAND	GRAV THICKENER 1	YARD RTU-B (EXIST.)
215	TS.SC-XA-00.01	DISC INPUT	OVERTORQUE ALARM	THICK SLUDGE COL 1	YARD RTU-B (EXIST.)
216	TS.SW-LI-00.01	ANALOG INPUT	LEVEL INDICATION	SLUDGE WELL	YARD RTU-B (EXIST.)
217	SS.P-ZS-00.02	DISC INPUT	SWITCH - L/R STATUS	SLUDGE WELL PP 2	YARD RTU-B (EXIST.)
218	SS.P-HS-00.02B	DISC OUTPUT	START COMMAND	SLUDGE WELL PP 2	YARD RTU-B (EXIST.)
219	SS.P-YL-00.02C	DISC INPUT	ON/OFF STATUS	SLUDGE WELL PP 2	YARD RTU-B (EXIST.)
220	SS.P-YL-00.01C	DISC INPUT	ON/OFF STATUS	SLUDGE WELL PP 1	YARD RTU-B (EXIST.)
221	SS.P-HS-00.01B	DISC OUTPUT	START COMMAND	SLUDGE WELL PP 1	YARD RTU-B (EXIST.)
222	SS.P-ZS-00.01	DISC INPUT	SWITCH - L/R STATUS	SLUDGE WELL PP 1	YARD RTU-B (EXIST.)
223	LSR.LSRV2-LI-00.01	ANALOG INPUT	LEVEL INDICATION	LAG SUP RET VLT2	YARD RTU-B (EXIST.)
224	LSR.LSRV2-HS-00.01D	DISC INPUT	VAULT 1 SELECTED	LAG SUP RET VLT2	YARD RTU-B (EXIST.)
225	LSR.LSRV2-HS-00.01E	DISC INPUT	VAULT 2 SELECTED	LAG SUP RET VLT2	YARD RTU-B (EXIST.)
226	LSR.P-YL-00.01C	DISC INPUT	ON/OFF STATUS	LAG SUP RETN PP1	YARD RTU-B (EXIST.)
227	LSR.P-HS-00.01B	DISC OUTPUT	START COMMAND	LAG SUP RETN PP1	YARD RTU-B (EXIST.)
228	LSR.P-ZL-00.01	DISC INPUT	SWITCH - L/R STATUS	LAG SUP RETN PP1	YARD RTU-B (EXIST.)
229	LSR.P-YL-00.02C	DISC INPUT	ON/OFF STATUS	LAG SUP RETN PP2	YARD RTU-B (EXIST.)
230	LSR.P-HS-00.02B	DISC OUTPUT	SWITCH - L/R STATUS	LAG SUP RETN PP2	YARD RTU-B (EXIST.)
231	LSR.P-ZL-00.02	DISC INPUT	SWITCH - L/R STATUS	LAG SUP RETN PP2	YARD RTU-B (EXIST.)

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S.No.	TAG NAME	SIGNAL TYPE	TAG DESCRIPTION	ASSOCIATED EQUIP	RTU
232	LS-HS-00.04B	DISC OUTPUT	VALVE TO RAISE COMMAND	LAGOON 4 TEL VLV	YARD RTU-B (EXIST.)
233	LS-HS-00.04A	DISC OUTPUT	VALVE TO LOWER COMMAND	LAGOON 4 TEL VLV	YARD RTU-B (EXIST.)
234	LS-ZL-00.04	DISC INPUT	SWITCH - L/R STATUS	LAGOON 4 TEL VLV	YARD RTU-B (EXIST.)
235	LS-ZL-00.03	DISC INPUT	SWITCH - L/R STATUS	LAGOON 3 TEL VLV	YARD RTU-B (EXIST.)
236	LS-HS-00.03A	DISC OUTPUT	VALVE TO RAISE COMMAND	LAGOON 3 TEL VLV	YARD RTU-B (EXIST.)
237	LS-HS-00.03B	DISC OUTPUT	VALVE TO LOWER COMMAND	LAGOON 3 TEL VLV	YARD RTU-B (EXIST.)
238	LS-ZL-00.02	DISC INPUT	SWITCH - L/R STATUS	LAGOON 2 TEL VLV	YARD RTU-B (EXIST.)
239	LS-HS-00.02A	DISC OUTPUT	VALVE TO RAISE COMMAND	LAGOON 2 TEL VLV	YARD RTU-B (EXIST.)
240	LS-HS-00.02B	DISC OUTPUT	VALVE TO LOWER COMMAND	LAGOON 2 TEL VLV	YARD RTU-B (EXIST.)
241	LS-ZL-00.01	DISC INPUT	SWITCH - L/R STATUS	LAGOON 1 TEL VLV	YARD RTU-B (EXIST.)
242	LS-HS-00.01A	DISC OUTPUT	VALVE TO RAISE COMMAND	LAGOON 1 TEL VLV	YARD RTU-B (EXIST.)
243	LS-HS-00.01B	DISC OUTPUT	VALVE TO LOWER COMMAND	LAGOON 1 TEL VLV	YARD RTU-B (EXIST.)
244	LS.LAG4-LI-00.04	ANALOG INPUT	LEVEL INDICATION	LAGOON 4	YARD RTU-B (EXIST.)
245	LS.LAG3-LI-00.03	ANALOG INPUT	LEVEL INDICATION	LAGOON 3	YARD RTU-B (EXIST.)
246	LS.LAG2-LI-00.02	ANALOG INPUT	LEVEL INDICATION	LAGOON 2	YARD RTU-B (EXIST.)
247	LS.LAG1-L1-00.01	ANALOG INPUT	LEVEL INDICATION	LAGOON 1	YARD RTU-B (EXIST.)
248	FP-HS-00.03B	DISC OUTPUT	VALVE TO CLOSE COMMAND	LAG 3 INLET VLV	YARD RTU-B (EXIST.)
249	FP-HS-00.03A	DISC OUTPUT	VALVE TO OPEN COMMAND	LAG 3 INLET VLV	YARD RTU-B (EXIST.)
250	FP-ZL-00.03	DISC INPUT	SWITCH - L/R STATUS	LAG 3 INLET VLV	YARD RTU-B (EXIST.)
251	FP-ZLO-00.03A	DISC INPUT	VALVE OPEN STATUS	LAG 3 INLET VLV	YARD RTU-B (EXIST.)
252	FP-ZLC-00.03A	DISC INPUT	VALVE CLOSED STATUS	LAG 3 INLET VLV	YARD RTU-B (EXIST.)
253	WWW-ZLC-00.01A	DISC INPUT	VALVE CLOSED STATUS	LAG 1 INLET VLV	YARD RTU-B (EXIST.)
254	WWW-ZLO-00.01A	DISC INPUT	VALVE OPEN STATUS	LAG 1 INLET VLV	YARD RTU-B (EXIST.)
255	WWW-ZL-00.01	DISC INPUT	SWITCH - L/R STATUS	LAG 1 INLET VLV	YARD RTU-B (EXIST.)
256	WWW-HS-00.01A	DISC OUTPUT	VALVE TO OPEN COMMAND	LAG 1 INLET VLV	YARD RTU-B (EXIST.)
257	WWW-HS-00.01B	DISC OUTPUT	VALVE TO CLOSE COMMAND	LAG 1 INLET VLV	YARD RTU-B (EXIST.)
258	WWW-ZLC-00.02A	DISC INPUT	VALVE CLOSED STATUS	LAG 2 INLET VLV	YARD RTU-B (EXIST.)
259	WWW-ZLO-00.02A	DISC INPUT	VALVE OPEN STATUS	LAG 2 INLET VLV	YARD RTU-B (EXIST.)
260	WWW-ZL-00.02	DISC INPUT	SWITCH - L/R STATUS	LAG 2 INLET VLV	YARD RTU-B (EXIST.)
261	WWW-HS-00.02A	DISC OUTPUT	VALVE TO OPEN COMMAND	LAG 2 INLET VLV	YARD RTU-B (EXIST.)
262	WWW-HS-00.02B	DISC OUTPUT	VALVE TO CLOSE COMMAND	LAG 2 INLET VLV	YARD RTU-B (EXIST.)

DESIGN MEMORANDUM
REVISION NO. 3

Kentucky-American Water Company

KENTUCKY RIVER STATION ADDITIONAL RESIDUALS PROCESSING FACILITIES

KENTUCKY-AMERICAN WATER COMPANY
Lexington, Kentucky

Prepared By:

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June 1999

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DESIGN MEMORANDUM

1. Executive Summary

The American Water Works Service Company has requested this design memorandum to consolidate the project design data for the Kentucky River Station Additional Residuals Processing Facilities. Based upon solids testing analyses and an evaluation of mechanical dewatering technologies, the Kentucky-American Water Company has decided to install belt filter presses.

This design memorandum presents project design data utilized in sizing the dewatering facilities. The critique of the design concept is also included as an attachment to the design memorandum, since the critique includes information on the solids mass balances throughout the plant and this information is not duplicated in the text of the design memorandum.

The new proposed dewatering facilities will consist of two, 2.8 meter belt filter presses operating at a solids loading rate of 4000 lb/hr each. These units will process the plant's average solids production (13,500 lb/day to the dewatering units) in 5 days, with one press operating for approximately 5 hours per day. This will provide several hours for start-up and shutdown. Under maximum conditions, which are based on the maximum 15-day solids production of 76,400 lb/day to the dewatering units, the total processing time required is 19 hours. This can be met with both presses operating for approximately 10 hours per day, which is essentially one and a half shifts of operating time with several hours available for start-up and shutdown.

A new 100 ft. by 68 ft. dewatering building is proposed to house the belt filter presses, along with the polymer systems for the belt filter presses, gravity thickeners and wash water waste, and the solids feed pumps. Several ancillary will also be located in the new dewatering building. These systems include plant water booster pumps for cleaning the belt filter presses and supplying water to the polymer blending system, two air compressors for maintaining belt alignment and two batch feed tanks. An electrical room, a HVAC mechanical area, a storage area and a janitorial area will be included in the building.

The existing Wash Water Waste Holding Tanks (WWWHTs) will be converted to flow-through Gravity Thickeners through the removal of the supernatant pumps and the addition of mechanical solids collectors and effluent weir troughs. The existing solids handling pumps will be modified and reused to pump the settled solids to the Dewatering Building. Supernatant will flow by gravity to the lagoons. The existing supernatant pumps will be modified and relocated to the new lagoon supernatant return vault.

The lagoons will now be utilized to settle the wash water waste and the Gravity Thickener effluent flows. The limiting factor on the lagoon system is the existing 6-inch discharge piping from the lagoons to the lagoon supernatant return vault. The existing lagoon supernatant return vault is not capable of processing the anticipated wash water waste and Gravity Thickener effluent flow rates even if the discharge piping was not the limiting factor. In order to accommodate the additional flows, the lagoon discharge piping will be increased to 12-inch, a second lagoon supernatant return vault and a parallel vault discharge pipe will be installed.

2. PROJECT DESIGN DATA

2.1 Dewatering System Sizing Basis

The dewatering system is sized based upon the following solids production rates:

	Total	Settled		Thickened		Dewatered	
			(gpd)		(gpd)		(gpd)
	(dry lbs/d)	(dry lbs/d)	(@ 0.4%)	(dry lbs/d)	(@ 2%)	(dry lbs/d)	(@ 20%)
Average Daily	16,697	14,507	434,874	14,217	85,235	13,506	8,097
15-Day Maximum	84,318	82,129	2,461,895	80,486	482,532	76,462	45,840

This table is reproduced from the Critique of Design Concept Report included in this design memorandum and includes the following assumptions:

Ave. Turbidity of Settled Water: 5 NTU, which at 35 MGD plant flow equals
35 MGD x (1.5 TSS/NTU) x 5 NTU x 8.34 = 2189 ppd

Capture Efficiency of Gravity Thickeners: 98-percent

Capture Efficiency of Dewatering Units: 95-percent

Note: Although the Kentucky River Station has recently experienced higher settled water turbidities of 7 NTU with the PACl, assuming a settled water turbidity of 5 NTU provides a more conservative estimate of solids production rates for the dewatering facilities. (i.e. at 7 NTU, 35 x 1.5TSS/NTU x 7 NTU x 8.34 = 3065 ppd.) Therefore, the average daily solids rate would be 16,697 – 3065 = 13,632 ppd, instead of the 14,507 ppd shown in the table above which uses 5 NTU in the settled water. Since the production rates are being used to size the dewatering units, the values in the table above will be used for more conservative design parameters.

2.2 Purification Units/Valve Houses

2.2.1 General Information

Requirement: Upgrade the flushing capabilities for the existing 3-inch Purification Units' sludge removal lines in the Valve Houses

Provide new butterfly valve with electric operator for the existing 12" Purification Unit drain lines

There will be a total of six new electric valves in each Valve House (three new valves per Purification Unit).

2.2.2 Flushing Lines

No. of Taps: Provide a new 2-inch flushing water line connection for the 3-inch sludge removal lines. Opening of the solenoid valve on the new flushing water line will allow flushing water to start. Depending upon the position of the plug valves on the solids removal line, the flushing water will flush either the piping between the valve house and the purification unit, or the piping between the valve house and the sludge well.

Tap Size:	Replace existing 1-inch taps with 2-inch potable water taps. Provide solenoid valves on the 2-inch connection
Valve Type:	Ball
Valve Operator:	Solenoid
Plant Water Pressure:	50 psi (minimum available).
Flow Rate:	100 gpm
Flushing Time:	5 minutes
Flushing Volume:	500 gallons
Head on Sludge Line:	10 psi
Pipe:	Sch. 80 PVC

2.2.3 Drain Line

Size:	12-inch drain line from each Purification Unit
Requirement:	Remove existing butterfly valve and manual operator and replace with new 12-inch butterfly valve with an electric operator

2.2.4 Operation

Control:	Tie into local RTUs (located in each Purification Unit) for the new electric flushing valves, the new drain valve and the existing 3-inch blowdown lines.
Operation:	Flushing shall occur prior to each blow down (approximately once per hour) as selected by the operator either remote manually or automatically through the plant DCS. Typically, flushing will occur for 5 minutes before the 3-inch sludge blowdown valve opens. The 12-inch drain line valve will be operated remote manually through the DCS.

2.3 Sludge Well

2.3.1 General Information

Requirement:	Modify discharge piping from the existing sludge well. Discharge (settled solids) is currently directed to the lagoons. A new piping connection will direct discharge from the sludge well to the existing Wash Water Waste Holding Tanks (WWWHTs). (The WWWHTs will be converted to Gravity Thickeners.)
Function:	Collection of settled solids from the purification units
Number:	One well, existing
Size:	12 ft. by 12 ft. by 10 ft. deep
Construction:	Concrete

2.3.2 Discharge Piping

Piping:	Use existing 6-inch piping from the sludge well to the lagoons and tap for new sludge inlet piping to the Gravity Thickeners (converted WWWHTs)
Size:	6-inch existing, 6-inch for new connection
Material:	Ductile iron
Emergency Backup:	Maintain the existing manually valved discharge piping to the lagoons.

2.3.3 Solids Pumping Units

Desired Flow Rate: Average settled solids (14,507lb/d) at 0.4% solids = 434,874 gpd

434,874 gpd = 300 gpm

15-day max settled solids (82,129 lb/d)

- at 0.4% solids = 2,461,895 gpd = 1700 gpm
- at 1.2% solids = 820,630 gpd = 570 gpm
- at 1.5% solids = 656,500 gpd = 460 gpm
- assume that during max 15-day event, the solids in the purification units will be settled to a higher percent solids (1.2%) due to the higher raw water turbidities. Results of manufacturers' testing indicate that 1.2% is a reasonable assumption (samples received ranged from 0.53% and 4.3%)

Existing Pumps:

Pump Capacity:	690 gpm @ 30 ft. TDH
Type:	Submersible solids handling pumps
Number:	Two
Horsepower:	10

Existing Capacity – Calculate Potential for Gravity Flow:

Gravity Flow from the Purification Units to Gravity Thickeners:

Purification Unit Water Level	El. 914.25
Gravity Thickener Water Level	El. 886.00
Static Head	28.25 ft.
Existing Piping	3-in., 4-in., and 6-inch dia.
Calculated Capacity	500 gpm

Conclusion: Not able to meet 15-day max flows assuming 1.2% solids by gravity from the Purification Units to the Gravity Thickeners. Marginally meet 15-day max flows at 1.5% solids. Not able to flow by gravity all the way from the purification units to the gravity thickeners. Pumps will be required.

Gravity Flow from the Purification Units to Sludge Well:

Purification Unit Water Level	El. 914.25
Sludge Well Water Level	El. 897.00

Static Head	17.25 ft.
Existing Piping	3-inch and 4-inch dia., two lines into sludge well
Calculated Capacity	360 gpm for each 4-inch
Max Capacity (both 4-inch lines)	720 gpm total

Conclusion: Able to meet the 15-day max flows at both 1.5 % and 1.2% solids by gravity from the Purification Units to the Sludge Well.

Sludge Well System Recommendation:

Maintain gravity flow to Sludge Well, then pump solids to the Gravity Thickeners. Existing pumps are rated at 690 gpm @ 30 ft. TDH. Existing pumps will meet the 15-day max requirement. However, due to the condition of the existing pumps, they will be replaced with new vertical solids well pumps.

New Pumping Units:

Pump Capacity:	720 gpm @ 30 ft. TDH
Type:	Vertical solids handling pumps
Number:	Two
Horsepower:	10

Operation: Replace the existing mercoid level float switches with an ultrasonic level probe, both operate simultaneously at high level. Control shall be through the plant DCS.

Discharge: To Gravity Thickeners. Manual discharge to lagoons for emergency conditions. Specific lagoon and the exact discharge location in the specified lagoon is selected by existing manual valves.

2.4 Wash Water Waste Holding Tanks – Gravity Thickeners

2.4.1 General Information

Requirement:	Modify operation of the existing WWWHTs to receive and settle purification unit blow down instead of wash water waste and to operate as flow through Gravity Thickeners
Function:	As Gravity Thickeners - thicken solids for new dewatering units
Number of Tanks:	Two existing tanks
Size:	70 ft. diameter each
Construction:	Concrete
Solids Storage Capacity:	70 ft. diameter at 3 ft. solids depth ≈ 11,550 ft^3 ≈ 86,500 gal. each
Total Solids Capacity:	173,000 gallons (assuming 3 ft. of 2% solids in the tanks)

2.4.2 Tank No. 1 Existing Geometry

Bottom Slope: 31 ft. horizontal, 1.45 ft. vertical (4.7%)
Total Volume: 250,000 gallons
Solids Volume: 86,500 gallons

2.4.3 Tank No. 2 Existing Geometry

Bottom Slope: 31 ft. horizontal, 4.83 ft. vertical (15.6%)
Total Volume: 290,000 gallons
Solids Volume: 86,500 gallons

2.4.4 Supernatant (Gravity Thickener Supernatant) Discharge System

Modification: Remove existing supernatant pumps from each existing WWWHT

Tank No. 1 Pumps: (to be removed and turned over to the Water Company)

Type: Vertical Turbine
Number: Two
Capacity: 2100 gpm @ 60 ft. TDH
Motor: 50 Hp

Tank No. 2 Pumps: (to be removed – two to be relocated to the new lagoon supernatant return vault, the third will be turned over to the Water Company)

Type: Vertical Turbine
Number: Three
Capacity: 2100 gpm @ 60 ft. TDH
Motor: 40 Hp

Add effluent weir troughs along circumference of each tank

Design Parameter: Determine Required Surface Overflow Rate (SOR)

15-day max solids flow rate = 2,461,895 gpd (@0.4%)
Combined Surface Area of the 70 ft. dia. Gravity thickeners = 7700 ft^2 (3,850 ft^2 each)
$\therefore$ Surface Overflow Rate (SOR) of 317 gpd/ft^2, with both tanks in service. With one tank out-of service, SOR equals 634 gpd/ft^2. Both SORs are well within the tested SOR of 1200 gpd/ft^2 (as analyzed in the Jan. 1999 report, titled "Bench and Pilot Scale Residuals Testing for Thickener Design Parameters" by Hazen and Sawyer).

Effluent Troughs: Each tank effluent trough sized to accommodate one half of the 15-day max. flow rate, or 1,230,948 gpd.

Trough Width = 12-inches
Trough Height = 18-inches

Effluent Piping: Connect to existing lagoon inlet piping

2.4.5 Solids Removal System

Modification: Add mechanical solids collectors with center sludge well and modify existing solids removal pumps by shortening the discharge column length and raising the impeller to the bottom of the new center solids collection well

Existing Pumps: Tanks No. 1 and No. 2 (Identical pumping units – to be modified and reinstalled)

Type: Vertical Well Pump
Number: Four total (two per tank)
Capacity: 350 gpm @ 30 ft. TDH
Motor: 15 Hp

Discharge: Using existing 6-inch discharge piping and provide tie-in and route to new Dewatering Building under normal operation. Maintain existing piping and add a manual valve (this will route flow back to sludge well, which can be pumped to the lagoons or Gravity Thickener inlet). Solids will be directed to one of the four lagoons as the emergency backup contingency via manual valve selection.

2.4.6 Piping/Valves

Gravity Thickener Inlet:		Plug valve with Electric Operator (on the inlet of each tank)
Solids Outlet Piping:	Size:	6-inch
	Material:	Ductile iron pipe routed to new batch tanks located in the new Dewatering Building. Connection to the sludge well will be maintained as an emergency backup.

2.5 Lagoons

2.5.1 General Information

Requirement: Modify operation to receive and settle wash water waste instead of purification unit blow down. Modification will be made via piping rerouting and the addition of electric operators to the existing lagoon inlet valves.

Solids Removal: Manual
Solids Disposal: On-site
Number of Lagoons: Four

2.5.1.1 Lagoon No. 1 General Information

Volume: 1.3 MG
Location: Bottom of hill
High Water Level: 859.00
Overflow: Typically reserved to receive overflow from various areas of the plant (typically does not receive blow down)

2.5.1.2 Lagoon No. 2 General Information

Volume: 1.7 MG
Location: Bottom of hill
High Water Level: 869.00
Overflow: Can receive overflow from various areas of the plant

2.5.1.3 Lagoon No. 3 General Information

Volume: 1.45 MG
Location: Top of hill
High Water Level: 879.00

2.5.1.4 Lagoon No. 4 General Information

Volume: 0.45 MG
Location: Top of hill
High Water Level: 889.00

2.5.2 Lagoon Capacity Analysis

2.5.2.1 General Information

Requirement: Determine lagoon capacity when subjected to worst case loading – maximum wash water waste and maximum gravity thickener supernatant.

Goal: 30 filter washes per day, at a minimum of 70,000 gallons per wash

Function: Provide storage and settling time for purification unit wash water waste and gravity thickener supernatant.

Lagoon No.4: Due to its small size and high elevation, Lagoon No. 4 will be reserved as an emergency backup to receive blowdown from the purification units. Lagoon No. 4 will not receive wash water waste or gravity thickener supernatant.

Number in Service: For calculations, assume two active lagoons, one offline and Lagoon No. 4 as emergency blowdown.

Active lagoon total capacity: Using the two smaller of the three receiving lagoons, Lagoon 1 (1.3 MG) + Lagoon 3 (1.45 MG) = 2.75 MG.

2.5.2.2 Assumptions

The following abbreviations are used in the lagoon analysis:

AGT	Average Gravity Thickener Supernatant Flow
CAW	Current Average Wash Water Volume
CMW	Current Maximum Wash Water Volume
CP	Maximum Number of Inflow Cycles Possible
D	Duration of Filter Wash
FAW	Future Average Wash Water Volume
FMW	Future Maximum Wash Water Volume
GTS	Gravity Thickener Supernatant

I	Inflow to the Lagoons
MGT	Maximum Gravity Thickener Supernatant Flow
MWC	Maximum Number of Wash Water Waste Cycles
WWW_{max}	Wash Water Waste maximum
WWW_{min}	Wash Water Waste minimum

Determine Average Flow Rates into Lagoons:

Wash Water Waste Flows

Current Average:

Current average daily wash water waste production at a plant capacity of 30.6 MGD (from Historical Data Evaluation) CAW = 0.92 MGD

Future Average:

Projected future average daily wash water waste production at a plant capacity of 35 MGD, FAW = (35MGD/30.6MGD) x 0.92 MGD (current average) = 1.05 MGD

Gravity Thickener Supernatant Flows

Determine Average gravity thickener supernatant flow rate, AGT:

Total ave. flow to gravity thickeners (0.435 MGD) – Ave. Flow to Dewatering (0.085 MGD) = 0.35 MGD (243 gpm)

Total Average Flow into Lagoons (Wash Water Waste plus Gravity Thickener Supernatant):

FAW+AGT = 1.05 MGD + 0.35 MGD = 1.4 MGD (970 gpm)

Determine Maximum Flow Rates into Lagoons:

Wash Water Waste Flows

Current maximum (15-day) wash water waste production at a plant capacity of 30.6 MGD (from Historical Data Evaluation) CMW = 2.46 MGD

Projected future maximum (15-day) wash water waste production at a plant capacity of 35 MGD, FM

FMW = (35/30.6) x CMW = 2.77 MGD

Gravity Thickener Supernatant Flows

Maximum Gravity Thickener supernatant flow rate, MGT:

MGT = Total Max. Flow to Gravity Thickener Tank (2.46 MGD) – Max. Flow to Dewatering (0.482 MGD)

= 1.98 MGD (1374 gpm)

Gravity Thickener Supernatant volume, GTS: GTS = MGT x D = 13,740 gallons, where D is 10 minutes

Total Maximum Flow into Lagoons (Wash Water plus Gravity Thickener):

FMW + MGT = 4.75 MGD (3300 gpm)

Calculate no. of required filter washes which correlate to the wash water waste production values listed above:

Typical maximum wash water waste volume, WWW_{max}: 100,000 gallons
Typical minimum wash water waste volume, WWW_{min}: 70,000 gallons
Maximum number of wash water waste cycles (filter backwashes), MWC:

$MWC = FMW/WWW_{max} = 28$ (use 30)

Filter Wash Duration (D): 10 minutes

Evaluate lagoon capacity based on a 30 minute cycle:

Proposed lagoon inflow sequence: 30 minute fill cycle alternating between lagoons

Inflow consists of one backwash volume plus gravity thickener effluent

~~Proposed lagoon outflow cycle: 30 minute drain cycle alternating between lagoons~~

Outflow consists of lagoon supernatant flow

Outflow limited to capacity of lagoon discharge piping

Existing lagoon drain line:

6" diameter ductile iron pipe (C = 100), with 0.12 ft/ft slope.

Capacity: 1.44 MGD (996 gpm)

Initial Lagoon Volume:

25% full

Lagoon 1: 0.325 MG

Lagoon 3: 0.36 MG

2.5.2.3 Lagoon Analysis

Existing lagoon capacity evaluated for influent consisting of the maximum 15-day wash water waste flow plus the maximum 15-day gravity thickener effluent flow.

Existing lagoon drain line maximum capacity: 1.4 MGD (996 gpm)
Existing lagoon drain line velocity at maximum capacity: 11.3 fps.
Number of inflow cycles desired (per day) for maximum inflow conditions: 30
A spreadsheet was used to analyze the lagoons' inflow and outflow under various scenarios and determine when the lagoons reached their maximum capacity. The results of several scenario calculations are summarized below.

<u>Scenario 1 – Existing configuration with maximum wash water waste</u>
Maximum number of inflow cycles possible, CP1: 15
Total possible volume of inflow, I: $I = CP1 \times (WWW_{max} + 3GTS) = 2.12$ MG
Conclusion: Insufficient lagoon discharge capacity to meet anticipated future maximum wash water waste and gravity thickener supernatant conditions.

<u>Scenario 2 – Existing configuration with minimum wash water waste volume</u>
Maximum number of inflow cycles possible, CP2: 22
Total possible volume of inflow, I: $I = CP1 \times (WWW_{min} + 3GTS) = 2.45$ MG
Conclusion: Insufficient lagoon discharge capacity to meet anticipated future maximum wash water waste and gravity thickener supernatant conditions.

Scenario 3 – Add 2nd Vault, Pumps and drain line with maximum wash water waste volume

Maximum number of inflow cycles possible, CP3: 25

Total possible volume of inflow, I: $I = CP1 \times (WWW_{max} + 3GTS) = 2.53$ MG

Conclusion: Insufficient lagoon discharge capacity to meet anticipated future maximum wash water waste and gravity thickener supernatant conditions.

Scenario 4 – Add 2nd Vault, Pumps and larger (10-inch) drain line with minimum wash water waste volume

Maximum number of inflow cycles possible, CP4: 30

Total possible volume of inflow, I: $I = CP1 \times (WWW_{min} + 3GTS) = 3.34$ MG

Conclusion: Sufficient lagoon and lagoon discharge capacity to meet anticipated future minimum wash water waste and gravity thickener supernatant conditions.

Conclusion

In order to process the desired 30 filter backwashes and the maximum 15-day gravity thickener supernatant flows, a larger diameter lagoon supernatant discharge line will be required. This line is currently the limiting factor for the lagoons in terms of hydraulic capacity. This new larger lagoon supernatant line will replace the existing line, and will be routed to the existing vault and a new vault. This will yield the required lagoon discharge capacity of 1900 gpm to drain the lagoons under worst case influent loading conditions.

Although design calculations indicate that a 10-inch diameter lagoon discharge line can convey the maximum flows, a 12-inch diameter line will be installed in order to ensure open channel flow, and to minimize the possibility of flow from one lagoon backing up into another lagoon.

2.5.3 Supernatant Outlets

Type:	Telescoping valves with electric operators
Level:	New ultrasonic level indicator for lagoon supernatant level
Location:	Near telescoping valves at lagoon discharge

2.6 Lagoon Supernatant Return Vault and Pumps

2.6.1 General Information

Requirement:	Modify vault to accommodate worst-case backwash scenario (lagoon discharge from 15-day max wash water waste and gravity thickener supernatant)
Function:	Receive supernatant from the lagoons
Number:	One vault with two existing supernatant pumps
Size:	12 ft. by 14 ft. by 8 ft. deep
Construction:	Concrete

2.6.2 Supernatant Pumping System

Requirement: Modify pumps to accommodate worst case scenario (max. 15-day wash water waste and max. 15-day gravity thickener supernatant)

Function: Pump lagoon supernatant to discharge at Kentucky River

Existing Pumps

Type: Existing vertical turbine (Peerless Model 12MB, single speed, 2 stage, impeller no. 2624331)

Number: Two

Existing rated single pump capacity (Existing): 1,000 gpm @ 88 ft. TDH

Existing pump speed at rated capacity: 1760 rpm

Existing pump efficiency at rated capacity: 78%

Existing horsepower at rated capacity: 43

Existing discharge piping - single pipeline consisting of:

880 LF of 10" dia. ductile iron pipe; 1 swing check valve; 1 gate valve and 1 surge relief valve; 2-30 deg., 1-60 deg., and 1-90 deg. bend; 1-10" x 10" x 10" tee; 1-10" x 20" expansion fitting; 145 LF of 20" dia. ductile iron pipe; 1 venturi meter; and 3-45 deg. and 1-90 deg. bends.

Discharge: Kentucky River

Conclusion: Existing system does not have the capacity to handle the combined flow from the max. 15-day gravity thickener supernatant and max. 15-day wash water waste.

Modifications: Need to increase firm pumping capacity to 1900 gpm to meet worst-case backwash flow rate

Recommendation: Construct one new supernatant return vault similar to the existing vault (concrete; 12 ft x 14 ft x 8 ft deep) to service all lagoons. Install the supernatant pumps from WWWHT No. 2 in the new vault. Pumps to be modified to meet 1000 gpm capacity at 80 ft TDH. Install a parallel 10-inch supernatant return discharge line along route of existing piping, and connect to existing manhole upstream of supernatant return venturi meter.

2.7 Mechanical Dewatering Facilities

2.7.1 General Information

Requirement: New Dewatering Building and mechanical dewatering units to dewater residual solids collected in the new Gravity Thickeners to a minimum of 20% for on-site disposal

2.7.2 Dewatering Building

Size: 100 ft by 68 ft

Proposed Location: East of Purification Units No. 9 and 10 near the existing cemetery

Houses the following major components:

- Batch Feed Tanks with Mixers
- Belt Filter Press Feed Pumping Units
- Belt Filter Presses
- Liquid Polymer Systems for Gravity Thickeners, Wash Water Waste and Belt Filter Presses
- Polymer Solution Bulk Tanks and Mixers
- Polymer Feed Pumping Units
- Belt Filter Press Wash Water System
- Plant Water Booster Pumps
- Air Compressor System
- Electrical Room
- HVAC Mechanical Room
- Storage Area
- Janitorial Room

Occupation: This building is intended to be an unmanned facility

Building Style: Brick to match architectural theme of existing facilities

Building Construction

- Foundation: Drilled piers (caissons) at 30-inch minimum diameter as per recommendation of geotechnical analysis
- Wall: Cavity wall consisting of 12-inch c.m.u., 2-inch cavity with 1 ½-inch thick rigid insulation, and 4-inch face brick to match the existing buildings
- Roof: Flat roof consisting of single-ply membrane on tapered insulation on 12-inch precast concrete planks
- Structure: Load bearing walls and steel columns at midspan encased in masonry or concrete for support of precast concrete roof planks.

2.8 Mechanical Dewatering Equipment

2.8.1 Batch Feed Tanks

Function: Holding and mixing of thickened sludge to provide homogenous sludge feed to belt filter presses

Ideal Sizing Criteria: Batch tank sized to hold an average solids production volume (i.e. what the press should process in one shift)

Average Volume: 14,217 dry lb/day solids
85,235 gallons of thickened solids @ 2% solids concentration
56,800 gallons of thickened solids @ 3% solids concentration
42,600 gallons of thickened solids @ 4% solids concentration

Required Tank Size for Average Volume: 85,235 gallons = 11,395 ft^3
With a liquid level of 15 ft., results in square tank size of 27'- 6"

Due to the large size of this tank, size batch tank at half of this volume. 11,395/2 = 5700 ft^3. At 15 ft. liquid level, results in square tank 20'-0". This volume of 44,880 gallons (20'x20'x15'x7.48gal/cf) still provides sufficient stabilization time in the event of differing solids concentrations from the Gravity Thickeners. At 4% solids (42,600 gallons), each batch tank provides an average day solids production volume.

Number of Tanks:	1 Tank with two cells, each cell 20'-0" square
Agitation:	Provide a 3 Hp mechanical lineshaft mixer for each cell.
Tank Attributes:	~~Each tank will be provided with an overflow pipe to the lagoons~~ Each tank will have a drain line with an electrically operated plug valve. The drain valve shall be opened at the end of a belt filter press run to allow the solids remaining in the tank to be drained into the lagoons (to help prevent solids accumulation in the batch tank). The operation of the drain valve shall be adjustable from the plant control system.

2.8.2 Belt Filter Press Feed Pumping Units

Requirements:	One pump is sized to feed one belt filter press
Function:	Transport sludge from the Batch Feed Tank to the Belt Filter Presses
Number of Pumps:	2
Type:	Progressive Cavity
Design Capacity:	190 gpm
Maximum Capacity:	350 gpm
Minimum Capacity:	70 gpm
Motor:	20 Hp, VFD speed controller for varying solids conditions
Discharge:	Belt Filter Presses

2.8.3 Belt Filter Press

<u>General Information</u>

Number:	Two
Size:	2.8 meter
Overall Length:	290"
Overall Width:	190"
Overall Height:	101"
Overall Belt Width:	114"
Dry Weight:	35,000 lbs
Gravity Zone:	131 sf
Wedge Zone:	152 sf
High Pressure Zone:	167 sf
Total Connected Load:	10.0 HP
Washwater Requirements:	130 gpm @ 120 psi
Air Requirements:	4.0 cfm @ 90 psi

Operational Parameters

Solids Loading:	4000 lb/hr ave. (manufacturer tested at 2000, 4000 and 6000 lb/hr)
Hydraulic Loading:	190 gpm ave. (manufacturer tested at 93, 192 and 288 gpm)
Feed Solids:	2%
Cake Solids:	20%

Calculate Average Operating Conditions:

Average Solids: 13,506 lb/d

Average: Use one press, operating for one shift for 5 days per week
13,506 lb/d x 7d/wk x 1wk/5d = 18,900 lb/d to process
One press can process 4000 lb/hr
18,900 lb/d ÷ 4000lb/hr = 4.725 hr/d operation for ave.
Allows 3 hrs for start-up and shutdown of the system

Calculate Maximum (based on 15-day max) Operating Conditions:

Maximum Solids: 76,462 lb/d

Maximum: Use both presses, operating three shifts for 7 days per week
76,462 lb/d ÷ 4000lb/hr = 19.1 hr/d operation
This can be met with one press operating for three shifts, or both presses operating for 10 hrs (one and a half shifts) and allowing several hours for start-up and shutdown.

Peaks above 15-day max: Sludge pumps at Gravity Thickeners discharge to the lagoons through the sludge well via manual valve selection

2.8.4 Polymer Feed Systems

There are three polymer feed systems associated with the new Dewatering Facilities, one system for the Belt Filter Presses, one for the Gravity Thickeners and one for the wash water waste flow stream. Each of these systems will be described below:

2.8.4.1 Belt Filter Press Polymer Storage System

General Polymer Information

Chemical:	Polymer
Purpose:	Solids conditioning before dewatering with Belt Filter Presses
Product Form:	Liquid emulsion
Active Content:	28%
Product Density:	8.6 lb/gal
Shelf Life:	6 months to 1 year

Belt Filter Press Polymer Requirements

Dosage:	3.7 lb/ton ave, 6.0 lb/ton max neat polymer
Dilution Rate:	0.5%

Calculate Usage:

Assume constant solids loading to press of 4000 lb/hr for both ave and max

Average Dose: (4000 lb/hr to press) x (ton/2000 lb) x (3.7 lb/ton) x (gal/8.6 lb) = 0.86 gph neat polymer

Max. Dose: (4000 lb/hr to press) x (ton/2000 lb) x (6 lb/ton) x (gal/8.6 lb) = 1.39 gph neat polymer

Calculate Dilution Water Requirement:

Average: 0.86 gph polymer x (1/0.5%) = 172 gph

Maximum: 1.39 gph polymer x (1/0.5%) = 278 gph

Calculate Polymer in terms of mg/l:

Assume:

- Average feed to press = 4000 lb solids/hr
- Flow rate, for 4000 lb/hr: @ 2% solids = 400 gpm = 0.57 MGD
  @ 3% solids = 270 gpm = 0.39 MGD
  @ 4% solids = 200 gpm = 0.29 MGD
- Average Polymer Dose: 0.86 gph x 8.6 lb/gal x 24 hr/day = 180 ppd
- Maximum Polymer Dose: 1.4 gph x 8.6 lb/gal x 24 hr/day = 290 ppd

Calculate Polymer:

Average Polymer x Max Flow Rate:

180 ppd = (x mg/l) x 0.57 MGD x 8.34
= 38 mg/l

Maximum Polymer x Ave Flow Rate:

290 ppd = (x mg/l) x 0.29 MGD x 8.34
= 120 mg/l

<u>Bulk Storage</u>

Determine Polymer Usage based on the higher of the following:

Ave day flow x Max polymer usage = one press x 1.39 gph = 1.39 gph

Max day flow x Ave polymer usage = two presses x 0.86 gph = 1.72 gph

Therefore, use: 1.72 gph to size bulk storage requirements

Total Storage Required: 31 days

Bulk Tank Size Required: (1.72 gph) x (24 hr/d) x (31 d) = 1280 gal x 125% = 1600 gal

Bulk Shipment: 2000 gal available from supplier

125% of Min Bulk Shipment: 2500 gallons

Bulk Storage Selection: 2500 gallon tank

<u>Day Storage</u>

Neat Polymer Required: 1.72 gph

Day Tank Size Required: (1.72 gph) x (24 hr) = 41 gal

125% of Day Tank: (41 gal) x 125% = 51 gal

Day Tank Selection: 100 gallons

Max Transfer Time Desired: 2 min

Transfer Pump Capacity: 100 gal ÷ 2 min = 50 gpm

Transfer Pump Selection: 50 gpm

2.8.4.2 Belt Filter Press Polymer Blending System (PBS)

Requirements: Provide diluted polymer for sludge conditioning
Function: Transport polymer to Belt Filter Press sludge feed line
Polymer Feed Range: 0.86 gph to 1.39 gph
Dilution Water Range: 172 gph to 278 gph @ 0.5% dilution
No. of Polymer Systems Required: 2 (one for each press)
Type: Progressing cavity pump with hydroforce mixing
Polymer Blending System Selection:
Neat Polymer Range: 0.125 gph to 2.5 gph
Dilution Water Range: 60 gph to 600 gph
Max. Working Water Pressure: 150 psi
Pressure Loss through PBS: 50 psi
Dilution Water Inlet: 1-inch
Polymer Inlet: 1-inch
Solution Discharge: 1-inch at PBS, increasing to 1-1/2 inch to feed point at polymer injection ring at belt filter press

2.8.4.3 Gravity Thickener Polymer Storage System

General Polymer Information
Chemical: Polymer
Purpose: Solids conditioning before settling in Gravity Thickeners
Product Form: Liquid emulsion
Active Content: 28%
Product Density: 8.6 lb/gal
Shelf Life: 6 months to 1 year

Settling Tank Polymer Requirements
Ave Polymer Dose: 4.0 mg/l (testing by others)
Max Polymer Dose: 6.0 mg/l (testing by others)
Ave Flow Rate: 434,874 gpd (to Gravity Thickeners @ 0.4% solids)
Max Flow Rate: 2,461,895 gpd (to Gravity Thickeners @ 0.4% solids)

Bulk Storage
Determine Polymer Usage based on the higher of the following:
Ave day flow x Max polymer usage:
(0.434 MGD) x (6 mg/l) x (8.34) x (gal/8.6 lb) = 2.5 gpd
Max day flow x Ave polymer usage:
(2.46 MGD) x (4 mg/l) x (8.34) x (gal/8.6 lb) = 9.5 gpd
Therefore, use: 9.5 gpd to size bulk storage requirements
Total Storage Required: 31 days
Bulk Tank Size Required: (9.5 gpd) x (31 d) = 295 gal x 125% = 370 gal
Bulk Shipment: 4000 gal available from supplier
125% of Min Bulk Shipment: 5000 gallons
Bulk Storage Selection: 5000 gallon tank

Day Storage

Neat Polymer Required:	9.5 gpd
Day Tank Size Required:	9.5 gallon
125% of Day Tank:	(9.5 gal) x 125% = 12 gal
Day Tank Selection:	100 gallons
Max Transfer Time Desired:	2 min
Transfer Pump Capacity:	100 gal ÷2 min = 50 gpm
Transfer Pump Selection:	50 gpm

2.8.4.4 Gravity Thickener Polymer Blending System (PBS)

Requirements: Provide diluted polymer for Gravity Thickeners
Function: Transport polymer to Gravity Thickener inlet pipe
Polymer Feed Range: 0.1 gph to 0.4 gph (2.5 to 9.5 gpd)
Dilution Water Range: 20 gph to 80 gph @ 0.5% dilution
No. of Polymer Systems Required: 2 (one for redundancy)
Type: Progressing cavity pump with hydroforce mixing
Polymer Blending System Selection:
- Neat Polymer Range: 0.06 gph to 1 gph
- Dilution Water Range: 30 gph to 300 gph
- Max. Working Water Pressure: 150 psi
- Pressure Loss though PBS: 50 psi

Dilution Water Inlet: 1-inch
Polymer Inlet: 1-inch
Solution Discharge: 1-inch to feed point at gravity thickener inlet piping

2.8.4.5 Wash Water Waste Polymer Storage System

General Polymer Information

Chemical:	Polymer
Purpose:	Solids conditioning for wash water waste flow stream
Product Form:	Liquid emulsion
Active Content:	28%
Product Density:	8.6 lb/gal
Shelf Life:	6 months to 1 year

Wash Water Waste Polymer Requirements

Ave Polymer Dose:	2.0 mg/l (assumed)
Max Polymer Dose:	4.0 mg/l (assumed)
Ave Flow Rate:	1.05 MGD
Max Flow Rate:	2.77 MGD

Bulk Storage

Determine Polymer Usage based on the higher of the following:

Ave day flow x Max polymer usage:

(1.05 MGD) x (4 mg/l) x (8.34) x (gal/8.6 lb) = 4.1 gpd

Max day flow x Ave polymer usage:

(2.77 MGD) x (2 mg/l) x (8.34) x (gal/8.6 lb) = 5.4 gpd

Therefore, use: 5.4 gpd to size bulk storage requirements

Total Storage Required: 31 days

Bulk Tank Size Required: (5.4 gpd) x (31 d) = 167 gal x 125% = 210 gal

Use same polymer as Gravity Thickener, therefore use same bulk tank

Day Storage

Neat Polymer Required: 5.4 gpd

Day Tank Size Required: 5.4 gallon

Same Day Tank as Gravity Thickener Polymer

2.8.4.6 Wash Water Waste Polymer Blending System (PBS)

Requirements: Provide diluted polymer for wash water waste conditioning

Function: Transport polymer to wash water waste drain line

Size PBS to meet instantaneous flow rate from filter backwash:

- Wash Water Volume: 70,000 gallons
- Wash Water Duration: 10 minutes
- Flow Rate: 7000 gpm (10 MGD)

Average Polymer Dosage

Ave Polymer (2.0 mg/l) x 10 MGD x (gal/8.6 lb) = 19.4 gpd

Maximum Polymer Dosage

Max Polymer (4.0 mg/l) x 10 MGD x (gal/8.6 lb) = 38.8 gpd

Polymer Feed Range: 0.81 gph to 1.6 gph (19.4 to 38.8 gpd)

Dilution Water Range: 162 gph to 320 gph @ 0.5% dilution

No. of Polymer Systems Required: 2 (one for redundancy)

Type: Progressing cavity pump with hydroforce mixing

Polymer Blending System Selection:

- Neat Polymer Range: 0.125 gph to 2.5 gph
- Dilution Water Range: 60 gph to 600 gph
- Max. Working Water Pressure: 150 psi
- Pressure Loss through PBS: 50 psi

Dilution Water Inlet: 1-inch

Polymer Inlet: 1-inch

Solution Discharge: 1-inch to feed point at wash water waste manhole

2.8.5 Wash Water System

Function: Clean upper and lower belts on the belt filter presses after cake has been released

Pressure Required: 120 psi

Flow Required: 130 gpm for each belt filter press

Pressure Available: 50 psi minimum as plant water

Booster Pumps: Will be required

2.8.6 Booster Pumps

Function: Boost plant water pressure from 50 to 120 psi for belt wash water system and polymer blending systems

Number of Pumps: 2 (one for redundancy)

Type: Centrifugal end suction pump

Capacity:

- Belt Filter Presses: 130 gpm each, both running = 260 gpm
- PBS for Belt: 600 gph, one running = 10 gpm
- PBS for Gravity Thickeners: 300 gph, one running = 5 gpm
- PBS for Wash Water: 600 gph, one running = 10 gpm
- Total Flow Required: 285 gpm

Discharge Pressure:

- Minimum Plant Pressure: 50 psi
- Required at Belt for Wash Water: 120 psi
- Headloss from pump to press: 10 psi
- Allowance for Pressure Reducing Valve for control: 10 psi
- Total Pressure out of Booster Pumps: 120 psi + 10psi +10 psi = 140 psi
- Boost Required: 140 psi at pump discharge – 50 psi starting plant water pressure = 90 psi

Horsepower: 25

2.8.7 Air Compressor System

Function: Provide air for maintaining proper belt tension and alignment

Number: 2

Capacity: 4.0 cfm @ 90 psi required

2.8.8 Cake Solids Disposal System

Requirement: Dispose of cake solids from belt filter presses

Solids Collection: Belt conveyors will receive solids from belt filter presses. One conveyor will be dedicated to each press, for a total of two belts.

Solids Transport: Belt conveyors will transport solids to the outside of the new Dewatering Building. Belt conveyors are inclined at approximately 20 degrees in order to exit the building and achieve sufficient height above grade to allow for the accumulation of solids and clearance for truck disposal.

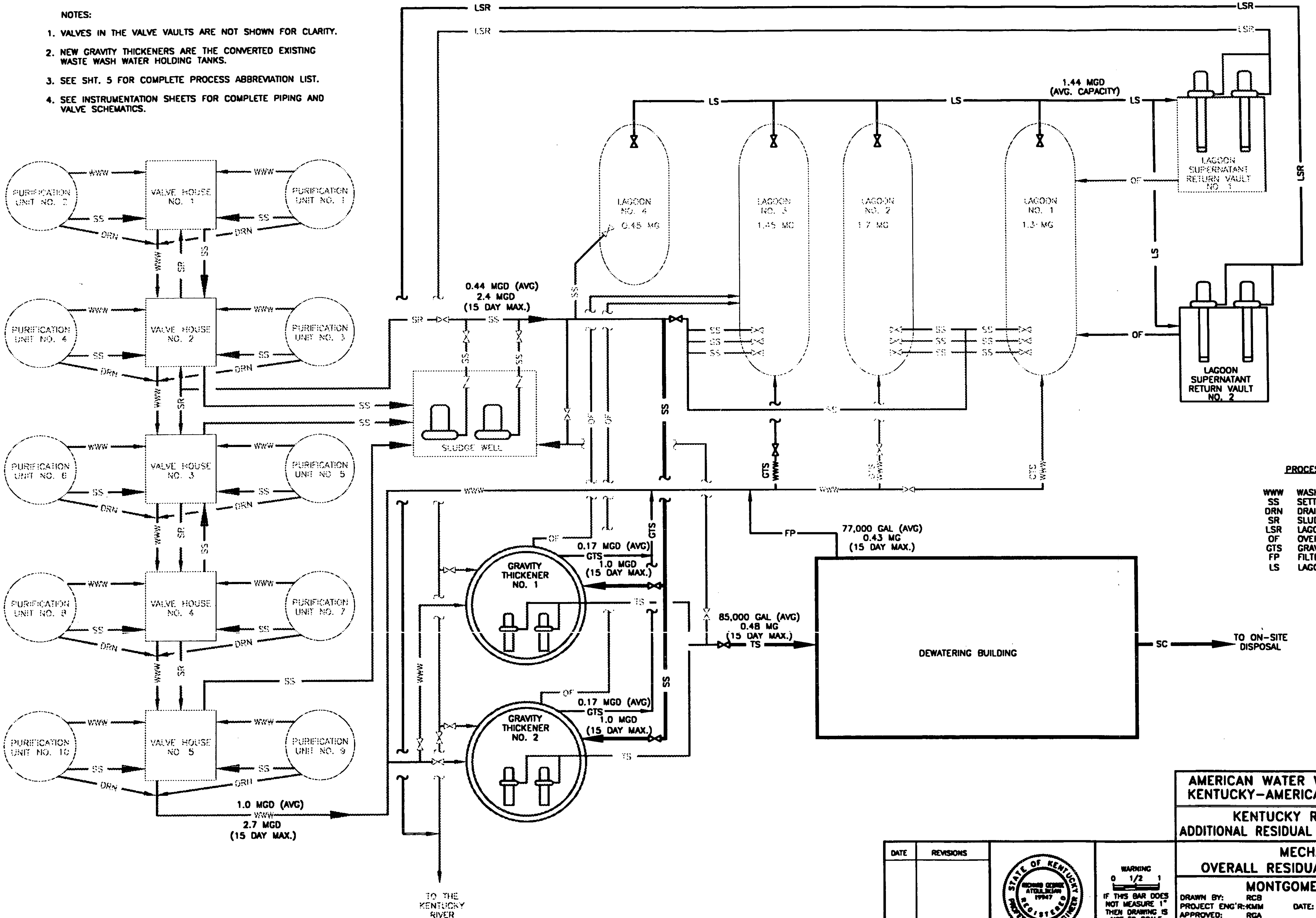
Solids Disposal: Solids will drop from the belt conveyors onto a concrete pad outside of the Dewatering Building. Solids will accumulate into a pile until loaded into a truck and transported to the on-site disposal area.

3. Overall Residuals Solids Schematic

The overall residuals solids schematic is included on the following page along with a process and equipment abbreviation legend.

NOTES:

1. VALVES IN THE VALVE VAULTS ARE NOT SHOWN FOR CLARITY.
2. NEW GRAVITY THICKENERS ARE THE CONVERTED EXISTING WASTE WASH WATER HOLDING TANKS.
3. SEE SHT. 5 FOR COMPLETE PROCESS ABBREVIATION LIST.
4. SEE INSTRUMENTATION SHEETS FOR COMPLETE PIPING AND VALVE SCHEMATICS.



PROCESS ABBREVIATIONS

WWW	WASH WATER WASTE
SS	SETTLED SLUDGE
DRN	DRAIN
SR	SLUDGE RECIRCULATION
LSR	LAGOON SUPERNATANT RETURN
OF	OVERFLOW
GTS	GRAVITY THICKENER SUPERNATANT
FP	FILTER PRESSATE
LS	LAGOON SUPERNATANT

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN 19967
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

MECHANICAL
OVERALL RESIDUAL SOLIDS SYSTEM

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-031

GENERAL - PROCESS AND EQUIPMENT ABBREVIATIONS

Kentucky River Station

PROCESS ABBREVIATIONS

AC	ACTIVATED CARBON
AIR	AIR
AL	ALUM/POLYMER
AS	AIR SCOUR
BPOL	BELT FILTER PRESS POLYMER
CA	COMPRESSED AIR
CLG	CHLORINE GAS
CLL	CHLORINE LIQUID
CLS	CHLORINE SOLUTION
DRN	DRAIN
FP	FILTER PRESSATE
G	GAS
GPOL	GRAVITY THICKENER POLYMER
GTS	GRAVITY THICKENER SUPERNATANT
GWPOL	GRAVITY THICKENER/WASH WATER WASTE POLYMER
LS	LAGOON SUPERNATANT
LSR	LAGOON SUPERNATANT RETURN
OF	OVERFLOW
PE	PLANT EFFLUENT
PW	PLANT WATER
RW	RAW WATER
SAN	SANITARY
SC	SLUDGE CAKE
SN	SUPERNATANT
SR	SLUDGE RECIRCULATION
SS	SETTLED SLUDGE
STO	STORM
TS	THICKENED SLUDGE
V	VACUUM
VT	VENT
W	FINISHED WATER
WPOL	WASTE WASH WATER POLYMER
WW	WASH WATER
WWW	WASTE WASH WATER

EQUIPMENT ABBREVIATIONS

ACU	AUTOMATIC CHANGEOVER UNIT
ANA	ANALYZER
B	BIN
BFP	BELT FILTER PRESS
CHL	CHLORINATOR
COMP	COMPRESSOR
CON	CONVEYOR
D	DAMPER
DIT	DENSITY INDICATING TRANSMITTER
EVAP	EVAPORATOR
EXP	EXPANSION CHAMBER
FDR	FEEDER
FIT	FLOW INDICATING TRANSMITTER
FM	FLOW METER
FN	FAN
G	GATE
H	HOPPER
INJ	INJECTOR
LIT	LEVEL INDICATING TRANSMITTER
MX	MIXER
P	PUMP
PBS	POLYMER BLENDING SYSTEM
PIT	PRESSURE INDICATING TRANSMITTER
REC	RECEIVER
SC	SLUDGE COLLECTOR
STR	STRAINER
T	TANK
TUR	TURBIDIMETER
V	VALVE
WSC	WEIGH SCALE
X	OTHER

KAWC Additional Residuals Processing Facilities
Equipment and Valve Schedule
06/18/99

Equipment Designation	Description	Service/Type	Quantity	Capacity/Size/Hp
AIR-COMP-00.01, -00.02	Air compressor for belt filter press alignment	Air	2	15.0 cfm, 145 psi, 5 Hp
BPOL-MX-00.01	Mixer for day tank	Polymer for BFP	1	½ Hp
BPOL-P-00.01, -00.02	Transfer pumps	Polymer for belt filter press	2	50 gpm, 15 ft. TDH, 1 Hp
BPOL-PBS-10.01, -20.01	Polymer blending system for belt filter presses	Polymer	2	0.125 – 2.5 gph polymer 60 – 600 gph dilution water
BPOL-T-00.01	Bulk storage tank	Polymer for BFP	1	2500 gal
BPOL-T-00.02	Day tank	Polymer for BFP	1	100 gal
BPOL-WSC-00.01	Weigh scale for day tank	Polymer for belt filter press	1	0-2000 lb.
DRN-P-00.01	Lagoon supernatant return vault sump pump	Drain the valve vault	1	½ Hp
GPOL-MX-00.01	Mixer for day tank	Polymer for gravity thickener and wash water waste	1	½ Hp
GPOL-P-00.01, -00.02	Transfer pumps	Polymer for gravity thickener	2	50 gpm, 15 ft. TDH, 1 Hp
GPOL-PBS-00.01, -00.02	Polymer blending system for gravity thickeners	Polymer	2	0.06 – 1 gph polymer, 30-300 gph dilution water
GPOL-T-00.01	Bulk storage tank	Polymer for gravity thickener and wash water waste	1	5000 gal
GPOL-T-00.02	Day tank	Polymer for gravity thickener and wash water waste	1	100 gal
GPOL-WSC-00.01	Weigh scale for day tank	Polymer for gravity thickener	1	0-2000 lb.
LSR-P-00.01, -00.02	Relocated and modified supernatant pumps from the wash water waste holding tank no. 1. Pumps relocated to lagoon supernatant return vault No. 2	Lagoon supernatant return	2	1000 gpm, 80 ft. TDH, 40 Hp
PW-P-00.01, -00.02	Booster pumps for belt filter press wash	Plant Water	2	30-300 gpm, 25 Hp

KAWC Additional Residuals Processing Facilities
Equipment and Valve Schedule
06/18/99

Equipment Designation	Description	Service/Type	Quantity	Capacity/Size/Hp
SC-CON-10.10	Belt conveyor for belt filter press discharge	Sludge cake from BFP	2	20 Hp
SC-CON-20.01	Belt conveyor for belt filter press discharge	Sludge cake from BFP	2	15 Hp
SS-P-00.01, -00.02	Settled Solids Pumps located in the sludge well. Controlled by new ultrasonic level sensors.	Settled Solids	2	700 gpm, 30 ft. TDH, 10 Hp
TS-BFP-10.01, -20.01	Belt Filter Press	Thickened Solids	2	2.8 meter, 4000 lb/d, 10 Hp
TS-FM-10.01, -20.01	Solids flow meter	Thickened solids	2	0-500 gpm, 6-inch
TS-MX-10.01, 20.01	Batch feed tank vertical shaft mixers	Thickened Solids	2	3 Hp
TS-P-00.01, -00.02, -00.03, -00.04	Existing Thickened Solids pumps located at the Gravity Thickeners, discharge column modified	Thickened Solids	4 total, 2 per G.T.	350 gpm, 30 ft. TDH, 15 Hp
TS-P-10.01, -20.01	Belt filter press feed pumps	Thickened Solids	2	70-350 gpm with 190 gpm ave., 20 Hp VFD
TS-SC-00.01, -00.02	Sludge Collector in Gravity Thickeners	Thickened Solids	2 total, one per G.T.	Spur gear, rake arm tip speed of 7 to 10 ft/min, continuous torque rating of 43,000ft/lb
WPOL-PBS-00.01, -00.02	Polymer blending system for wash water waste flow stream	Polymer	2	0.125 – 2.5 gph polymer 60 – 600 gph dilution water
DRN-EV-00.0X X=1-10	Purification unit drain valves	Butterfly	10	12-inch
LS-EV-00.0X X=1, 2, 3	Lagoon supernatant line	Telescoping	4	6-inch
LS-HV-00.01	Inlet line to Lagoon Supernatant Return Vault No. 2	Butterfly	1	12-inch
LSR-CV-00.0X X=1,2	Discharge of Lagoon supernatant return pumps No. 1 and 2	Check	2	10-inch

KAWC Additional Residuals Processing Facilities
Equipment and Valve Schedule
06/18/99

Equipment Designation	Description	Service/Type	Quantity	Capacity/Size/Hp
LSR-HV-00.0X X=1,2	Discharge of Lagoon supernatant return pumps No. 1 and 2	Butterfly	2	10-inch
PW-SV-00.0X X=1-10	Flushing water lines from purification units	Solenoid	10	2-inch
SS-EV-00.0X X=21, 22	Inlet valve to Gravity Thickeners	Plug	2	6-inch
SS-EV-00.0X X=1,3,...19	Settled solids blowdown line from the purification units	Existing ball valve with new operator	10	3-inch
SS-EV-00.0X X=2,4,...20	Settled solids lines from purification units to sludge well	Existing plug valve with new operator	10	4-inch
TS-CV-X0.01 X=1,2	Feed pump discharge line	Check	2	6-inch
TS-EV-X0.01 X=1,2	Batch tank inlet valves	Plug	2	6-inch
TS-HV-00.01	Thickened solids line back to the sludge well	Plug	1	6-inch
TS-HV-00.02	Feed pump suction piping interconnect line	Plug	1	10-inch
TS-HV-00.03	Feed pump discharge piping interconnect line	Plug	1	6-inch
TS-HV-X0.01 X=1,2	Feed pump suction piping	Plug	2	10-inch
TS-HV-X0.01 X=1,2	Feed pump discharge line	Plug	2	6-inch
WWW-EV-00.0X X=1,2,3	Inlet valves to Lagoons 1, 2 and 3	Butterfly	3	30-inch
SS-HV-00.01	Diverts Settled Solids to Gravity Thickeners	Plug	1	6-inch
DRN-EV-00.11, -00.12	Drain from Batch Tanks	Plug	2	8-inch

4. Description of Operation

The description of operation will be completed at the end of the project as part of the Operation and Maintenance Manual as per request of the Water Company, and will not be included in the Design Memorandum.

5. Construction Cost Estimate

The current construction cost estimate follows.

American Water Works Additional Residual Processing Facilities							
Opinion of Probable Cost for Treatment Plant Site							
June 21, 1999							
Division - Description	Unit	Quantity	Unit Price ($)	Material Cost ($)	Labor Cost	Total $	
01 - General Requirements							
Project Management/Mobilization/Insurance						375,000	
Division Total							375000
02 - Sitework							
Dewatering Building							
- Excavation and backfill	CY	7350	13	95550		95550	
Site Access Road	SY	450	17	7650		7650	
Precast Conc. Manholes	EA.	3	5167	15501		15501	
Caissons	CY	200	680	136000		136000	
Ductile Iron Pipe							
- 6"	LF	660	33	21780		21780	
- 10"	LF	840	41	34440		34440	
- 12"	LF	1220	48	58560		58560	
Division Total							369481
03 - Concrete							
Energy Dissipators	LS.	1	5000	5000	1000	6000	
Dewatering Bldg							
- Floor Slab	CY	420	500	210000		210000	
- Walls	CY	60	500	30000		30000	
- Supernatant Vault	CY	80	500	40000		40000	
- Concrete Meter/Mixer Vaults	CY	100	500	50000		50000	
-Precast Concrete	SF	8300	20	166000		166000	
-Equipment Pads	LS.					5000	
Division Total							507000
04 - Masonry							
Dewatering Bldg							
- Reinf. Brick and Block Cavity Wall w/ Insul.	SF	7,352	20	147040	14704	161744	
- 8" C.M.U./Interior (Plain)	SF	905	10	9050	905	9955	
Division Total							171699
05 - Metals							
Dewatering Bldg							
- Structural Steel	TON	10	3000	30000		30000	
- Aluminum Railings	LF	350	40	14000		14000	
- Aluminum Grating	SF	400	30	12000		12000	
Watertight Access Doors	EA.	3	1000	3000		3000	
Division Total							59000
06 - Wood and Plastics							
-Rough Carpentry	LS					3500	
Division Total							3500

Division - Description	Unit	Quantity	Unit Price ($)	Material Cost ($)	Labor Cost	Total $	
07 - Thermal and Moisture Protection							
Dewatering Bldg							
- Dampproofing	SF	1044	4	4176	835.2	5011.2	
- Membrane Roofing	SF	7000	12	84000		84000	
- Flashing and Sheet Metal	LF	700	6	4200	2100	6300	
- Vapor Barrier	SF	14626	0.1	1462.6		1462.6	
- Sealants and Caulking	LS					5000	
Division Total							101773.8
08 - Doors and Windows							
Dewatering Bldg							
- Rolling Service Door	EA.	1	3500	3500		3500	
- Galvanized Steel Doors/Frames	EA.	8	1000	8000		8000	
- Aluminum Windows/ glazing	EA.	4	900	3600		3600	
Division Total							15100
09 - Finishes							
Chemical Containment Area	LS					20000	
- Acoustical Ceiling System	SF	80	4	320		320	
- Painting (Masonry)	SF	15500	2	31000		38750	
Painting (piping and equipment)	LS					30000	
Division Total							89070
10 - Specialties							
- Signage	LS.					1000	
-Building Specialties	LS.					500	
-Fire Protection Specialties	EA	3	500	1500		1500	
-Lockers	EA	2	150	300		300	
Division Total							3300
11 - Equipment							
Vertical Shaft Mixer	EA.	2	28000	56000	11200	67200	
Belt Press Feed Pumps	LS.	2	10000	20000	4000	24000	
Belt Filter Press	LS.	2	320000	640000	128000	768000	
Wash Water Booster Pumps	LS.	2	7500	15000	3000	18000	
Air Compressors	EA.	2	2500	5000	1000	6000	
Polymer Blending System							
-Gravity Thickener/ Wash Water	LS.	4	16500	66000	13200	79200	
-Belt Press	LS.	2	16500	33000	6600	39600	
Transfer Pumps	LS.	4	4000	16000	3200	19200	
Vertical Solids Handling Pumps	LS.	2	7800	15600	3120	18720	
Ultrasonic Level Probe	EA.	5	1800	9000	4000	13000	
High Level Probe	EA.	3	500	1500	4000	5500	
Sump Leak Probe	EA.	1	500	500	2500	3000	
Gravity Thickeners	EA.	2	180000	360000	144000	504000	
Sump Pump	EA.	1	2900	2900	290	3190	
Supernatant Return Pumps	EA.	2	2500	5000	3500	8500	
Division Total							1577110
13 - Special Construction							
5000 Gallon Bulk Storage Tank w/ ladder	LS	1	7463	7463	2238.9	9701.9	

Division - Description	Unit	Quantity	Unit Price ($)	Material Cost ($)	Labor Cost	Total $	
2500 Gallon Bulk Storage Tank w/ ladder	LS	1	3710	3710	1113	4823	
100 Gallon Day Tanks	LS	2	900	1800	540	2340	
Division Total							16864.9
14 - Conveying Systems							
Belt Press Conveyor (20 hp)	LS	1	121000	121000	12100	133100	
Belt Press Conveyor (15 hp)	LS	1	75000	75000	7500	82500	
Conveyor Covers	EA.	2	8800	17600	880	18480	
Division Total							234080
15 - Mechanical							
Ductile Iron Pipe							
- 6"	LF	100	28	2800	1120	3920	
- 8"	LF	100	32	3200	1280	4480	
Check Valves							
- 6"	EA.	2	1200	2400	400	2800	
- 10"	EA.	2	2200	4400	400	4800	
Gate Valves							
-10"	EA.	2	3900	7800	400	8200	
Butterfly Valves							
-12" flanged manual oper.	EA.	1	1200	1200	200	1400	
- 12" MJ manual oper.	EA.	1	1300	1300	200	1500	
-12" (emo)	EA.	10	5663	56630	2000	58630	
-30" (emo)	EA.	3	14000	42000	600	42600	
EMO's							
- 3"	EA.	10	4750	47500	500	48000	
- 4"	EA.	10	4750	47500	500	48000	
Relief Valves	EA.	2	500	1000	100	1100	
Telescoping Valves	EA.	4	7500	30000	200	30200	
Pressure Reducing Valve	EA.	2	750	1500	100	1600	
PlugValves							
- 6" Flanged End	EA.	3	710	2130	150	2280	
- 6" MJ End	EA.	1	810	810	50	860	
- 10"	EA.	3	1500	4500	150	4650	
MO Plug Valves							
- 6"	EA.	4	5700	22800	200	23000	
Mud Valves							
- 8"	EA.	2	500	1000	100	1100	
- 10"	EA.	3	150	450	180	630	
Solenoid Valve 2"	EA.	10	600	6000	2400	8400	
Y-Strainer	EA.	1	150	150	60	210	
Expansion Joint	EA.	6	500	3000	1200	4200	
Rupture Disk	EA.	2	150	300	120	420	
Flow Switch	EA.	2	500	1000	400	1400	
Pressure Switch	EA.	5	500	2500	1000	3500	
Pressure Gauges w/Diaphragm Sea	EA.	8	400	3200	800	4000	
Weigh Scales	EA.	2	400	800		800	
5 ton split A/C unit	EA.	1	10000	10000		10000	
Inline fan	EA.	1	750	750		750	
Ductwork and Insulation	LB	500	20	10000		10000	
Fire dampers	EA.	5	300	1500		1500	
Grilles/ Diffusers	EA.	4	250	1000		1000	
Volume Dampers	EA.	3	150	450		450	
Refrigerant piping	FT.	50	30	1500		1500	
louvers	SF	75	150	11250		11250	
Ceiling Paddle fans	EA.	8	500	4000		4000	
Wall axial fans	EA.	2	8000	16000		16000	

Division - Description	Unit	Quantity	Unit Price ($)	Material Cost ($)	Labor Cost	Total $	
Electric Unit heaters	EA.	6	1000	6000		6000	
HVAC Miscellaneous	LS			10,000		10000	
Cast Iron pipe							
- 3"	FT.	105	15	1575		1575	
- 12"	FT.	110	80	8800		8800	
Floor Drains							
-3"	EA.	6	200	1200		1200	
- 12"	EA.	2	400	800		800	
3" P-Traps	EA.	6	200	1200		1200	
12" P-Traps	EA.	2	800	1600		1600	
1" copper pipe and valves	FT.	200	15	3000		3000	
3/4" hose bibbs	EA.	3	60	180		180	
Electric water heaters	EA.	1	600	600		600	
Emergency shower/eyewash	EA.	2	3000	6000		6000	
Division Total							**410085**
16 - Electrical							
Unit Substation	EA	1	65000	65000	13000	78000.00	
MCC's	EA	2	40000	80000	13000	93000.00	
Power Panels	EA	2	5500	11000	1500	12500.00	
Lighting Panels	EA	2	2250	4500	1500	6000.00	
Lighting Panel Transformers	EA	2	2900	5800	650	6450.00	
Drive Transformers	EA	2	2900	5800	650	6450.00	
Mini Load Centers	EA	2	4500	9000	1300	10300.00	
Conduit	LS			27500	53600	81100.00	
Wire	LS			39000	72000	111000.00	
Duct Bank	LS			35000	30000	65000.00	
Local control Stations	EA	21	400	8400	3360	11760.00	
Lighting	EA	64	500	32000	7680	39680.00	
Misc.	LS			15000	4800	19800.00	
Division Total							**541040.00**
17 - Instrumentation							
Level Sensors & Transmitters	EA.	10	4000	40000	6000	46000	
Level Switches	EA.	2	2000	4000	600	4600	
Solids Probe & Transmitter	EA.	2	8000	16000	2400	18400	
Magmeters	EA.	2	10000	20000	3000	23000	
Pressure Gauges w/Diaphragm Seals	EA.	2	1000	2000	300	2300	
Turbidity Sensors & Transmitters	EA.	2	4000	8000	1200	9200	
Pressure Gauges	EA.	8	500	4000	600	4600	
Miscellaneous DPC Cards	LS					8000	
Programming	LS					155000	
DPC 3330 System(includes power supplies & enclosure)	LS					25000	
Software for RTU	LS					3000	
Software for Graphics	LS					17000	
Miscellaneous(project management & mobilization)	LS					75000	
Division Total							**391100**
Estimated Division Total			**$4,865,204**				
Contingency at 10%			**$486,520.37**				
Estimated Project Total			**$5,351,724**				
***If no labor costs are shown, then unit price includes both material and installation**							

American Water Works Additional Residual Processing Facilities			
Opinion of Probable Cost			
Division Summaries			
June 21, 1999			
Division - Description			**Division Summary**
01- General Requirements			$375,000.00
02 - Sitework			$369,481.00
03 - Concrete			$507,000.00
04 - Masonry			$171,699.00
05 - Metals			$59,000.00
06 - Wood and Plastics			$3,500.00
07 - Thermal and Moisture Protection			$101,773.80
08 - Doors and Windows			$15,100.00
09 - Finishes			$89,070.00
10 - Specialties			$3,300.00
11 - Equipment			$1,577,110.00
13 - Special Construction			$16,864.90
14 - Conveying Systems			$234,080.00
15 - Mechanical			$410,085.00
16 - Electrical			$541,040.00
17 - Instrumentation			$391,100.00
Project Total			$4,865,203.70
This estimate does not include contingencies.			

6. Permit Information

6.1 KNREPC Drinking Water Branch

Contact: Tom Skaggs
Division of Water
Drinking Water Branch
14 Reilly Road
Frankfort, KY 40601
(502) 564-2225 ext. 545

Application: No standard application form

Documentation:

- Four copies of plans and specifications to be submitted; three will be returned after the review
- Average review period is approximately 30 days up to a maximum of 45 days
- Will accept a 95% review set that is stamped by the engineer and includes a cover letter from KAWC

Fees: None required due to the nature of the project. It involves sludge handling and not changes in plant capacity or treatment processes

6.2 Kentucky Department of Building and Construction

Contact: George Mann
Public Protection and Regulation Cabinet
Department of Housing, Buildings and Construction
Division of Building Code Enforcement
1047 U. S. 127 South, Suite #1
Frankfort, KY 40601
T(502) 564-8090
F(502) 564-6799

Application: No standard application form

Documentation:

- No documentation is requested for private projects less than 20,000 sf.

7. Geotechnical Information

A copy of the geotechnical report follows.

Fuller
Mossbarger
Scott &
May

ENGINEERS

Report of Geotechnical Exploration

Residuals Handling Building and Lagoon Decant Structure Kentucky River Station Water Treatment Plant Lexington, Kentucky

Prepared for
Montgomery Watson
Cleveland, Ohio

April, 1999

Fuller Mossbarger Scott & May
FMSM
ENGINEERS

1409
North Forbes Road
Lexington, Kentucky
40511-2050

606-233-0574
606-254-4800 FAX

April 27, 1999 O.1.1.99114R02

Mr. Rich Atoulikian
Montgomery Watson
2000 Bond Court Building
1300 East Ninth Street
Cleveland, Ohio 44114

Re: Report of Geotechnical Exploration
Residuals Handling Building and
Lagoon Decant Structure
Kentucky River Station Water Treatment Plant
Lexington, Kentucky

Dear Mr. Atoulikian:

As requested, our firm has performed a geotechnical exploration at the above referenced site. The fieldwork was conducted on April 14, 1999 in accordance with our proposal dated March 29, 1999. This report presents the results of the exploration, foundation design recommendations for the Residuals Handling Building and Lagoon Decant Structure.

1. General Site Description

The site is located in southern Fayette County. The site can be reached from Lexington by traveling east on Richmond Road and turning south onto Old Richmond Road. Follow Old Richmond Rd. for approximately 5 miles to Evans Mill Road and turn right. Follow Evans Mill Road for approximately 1.5 miles and the Kentucky River Water Treatment Plant is on the left. The site encompasses approximately 20 acres and is bounded on the south by an adjoining property and to the east by the Kentucky River, on the north and west by adjoining properties operated as small farms and residences. The site contains a water treatment plant that draws water from the Kentucky River to provide drinking water for the residents of Lexington and surrounding communities.

The site layout provided by Montgomery Watson shows the proposed development to consist of two new structures. The first of the two structures is an approximately 7,000 square foot building to be used as a Residuals Handling building and the second structure to be used as a Lagoon Decant facility. The existing site layout, proposed addition, and boring locations are shown on the drawing included at the end of this report.

2. General Site Geology

Available geologic mapping (Geology of the Coletown Quadrangle, Fayette County, Kentucky, USGS, 1967) shows the site to be underlain by Grier and Curdsville Limestone Members of the Clays Ferry Formation and Lexington Limestone, of the Middle and Upper Ordovician Period having a geologic age about 425 to 500 million years before the present. The bedrock underlying the site of the structures is limestone interbedded with shale and described as: gray, micro-grained, partly fossiliferous limestone and medium to dark gray shale.

Structure contours drawn on the base of Brannon Member indicates a local bedrock strata dip of approximately 40 feet per mile to the south. Numerous faults surround the area, the closest within approximately one-mile. However, the faults in this area are not known to have been active in the recent geologic past.

3. Scope of Work Performed

A total of six borings were advanced during the exploration at the approximate locations shown on the attached drawing. Three of the borings included rock coring. The boring locations were provided by Montgomery Watson and are within, or immediately adjacent to, the footprints of the two proposed structures. The boring locations were staked in the field by GRW Engineers, Inc. In order to locate the boring locations for drawing purposes, a baseline was established along the south side of the small graveyard near the proposed Residuals Handling Building.

The borings were advanced using a truck-mounted drill rig equipped with eight-inch diameter hollow-stem augers and six-inch diameter continuous-flight augers. A geotechnical engineer was present during the drilling operation to supervise the fieldwork, direct the drill crew and log the soils and rock cores encountered during the drilling process. During soil logging, particular attention was given to the soil's color, texture, consistency and moisture content. Standard penetration tests (SPTs) were performed in four of the six borings to evaluate the strength and moisture characteristics of the subsoil, while a bag sample of the predominant soil horizon was obtained for laboratory analysis. Rock core samples of the underlying bedrock were collected from three of the borings using NX rock coring equipment. The recovered rock was logged paying attention to the rock type, quality, and hardness. Upon completion of drilling, the boreholes were checked for the presence of groundwater and then backfilled with the auger cuttings.

The recovered soil samples were transported to our laboratory for testing and analysis. The SPT samples were subjected to natural moisture content determinations (ASTM D-2216); while the bag sample was subjected to standard engineering classification tests consisting of Atterberg limits (ASTM D-4318), sieve and hydrometer analysis (ASTM D-422) and specific gravity (ASTM D-854). The bag sample was also subjected to a moisture-density test (ASTM D698 – Method B).

4. Results of the Exploration

Boring locations, logs of borings, laboratory results and other pertinent geotechnical data are shown on the accompanying drawing. Table 1 provides a summary of the borings. All measurements are expressed in feet.

Table 1. Summary of Borings

Boring	Surface Elevation	Top of Rock Depth	Top of Rock Elevation	Depth to Refusal	Length of Rock Core	Bottom of Boring Depth	Bottom of Boring Elevation
1	887.5	2.3	885.2	3.5	11.4	14.9	872.6
2	886.4	9.3	877.1	--	--	9.3	877.1
3	882.9	21.9	861.0	22.0	11.2	33.2	849.7
4	884.9	6.7	878.2	9.0	6.0	15.0	869.9
5	855.7	3.1	852.6	--	--	4.0	851.7
6	855.0	12.7	842.3	--	--	12.7	842.3

4.1. Soil Conditions

The borings show one predominant soil underlying an approximately 6 to 7 inch thick layer of topsoil. The soil (designated Soil 1) is a fill described generally as a clay which is brown in color, moist in natural moisture content, and medium in consistency. This soil contains rock debris and rock fragments consisting of natural material (limestone), asphalt, concrete, and brick. The depth of this soil ranges from the surface to top of rock in all of the borings except Boring 3. In Boring 3 a residual soil (Soil 2) was found. Because Soil 1 is a fill, a soil classification was not performed. Additionally, it was reported by plant personnel that a portion of the fill found in Borings 1 through 4 contains Kentucky River silt that was removed originally from the Kentucky River and then from the drying lagoons on the site. Plant personnel indicated that material from the lagoons must remain on site and may not be disposed of in the city landfill.

In Boring 3, Soil 2 extends from Soil 1 to bedrock. It is described as dark brown sandy fat clay that is moist in natural moisture content and medium to stiff in consistency. Based on standard engineering classification tests, Soil 2 classifies as a CH according to the Unified Soil Classification System (USCS), and A-7-6(14) according to the American Association of State Highway and Transportation Officials (AASHTO) method. The maximum dry density of this soil, as determined by the standard Proctor density test, is 99.7 pounds per cubic foot at an optimum moisture content of 22.8 percent. The moisture-density data sheet in presented in the Appendix of this report.

Several years ago, our firm was involved in a project that included several improvements along the west side of the lagoons. The disturbance caused by the excavation and fill work associated with these improvements extended to the area of the existing supernatant pump vault No. 1. Accordingly, the subsoil encountered in Borings 5 and 6 consists of fill material placed there during the construction of the improvements.

Standard penetration tests were performed in Borings 2, 3, 4, and 6. Test results are shown on the boring logs on the accompanying drawing and summarized in the following table:

Table 2. Standard Penetration Test Results

Boring	Soil Type	Test Depth Interval (feet)	Hammer Blows per 6-Inch Penetration	Blow Count (N-Value)	Moisture Content (%)
2	1	4.5 - 6.0	25-36-30	66	7
3	1	4.5 - 6.0	6-8-7	15	34
	1	9.5 - 11.0	50+/4"	100+	30
	2	14.5 - 16.0	18-11-12	23	24
	2	19.5 - 21.0	8-6-7	13	27
4	1	4.5 - 6.0	10-13-16	29	41
6	1	4.5 - 6.0	8-7-5	12	21
	1	9.5 -11.0	7-7-9	16	18

The higher N-Values are frequently the result of encountering rock fragments and boulders while advancing the split spoon sampler. This definitely applies to the tests performed within Soil 1.

4.2. Bedrock Conditions

The rock cores obtained revealed predominantly limestone with interbedded shale (20 to 25 percent) layers. The limestone is described as gray with lighter gray mottling, hard and fossiliferous. The shale is described as dark gray and brown, highly weathered and thin layered. Thin soil-like zones were encountered at different depths within the bedrock.

Standard rock quality designations (RQD) and recovery for each of the cores are included in the graphical boring logs in the drawing at the end of this report.

4.3. Ground Water Conditions

Ground water was not encountered in any of the borings. However, Boring 6 exhibited an increased in moisture content at an elevation of 841.5 feet on the day the drilling proceeded. The increased moisture is probably attributed to the influence of the water level in the lagoon.

5. Conclusions and Recommendations

5.1. General

5.1.1. It is our understanding that a one-story building is to be constructed at the Kentucky River Station Water Treatment Plant, just east of the purification units. A second small structure will be placed at the north west corner of the plant just east or west of the existing supernatant pump. The new facilities will make use of space that is currently vacant. The building is to consist of a 7000± square foot new construction. The smaller structure near the pump is expected to be a lightly loaded structure approximately 100 square feet in area.

5.1.2. If the above understanding is incorrect, or if changes are made to the site layout or building footprint from that shown on the accompanying drawing, our firm should be notified so that the changes can be reviewed and the following recommendations modified as necessary.

5.2. Foundation System

The subsurface conditions, topography of the site and the purpose and size of the two structures demand different foundation recommendations. Each structure will be discussed separately.

<u>Residuals Handling Building</u>

Due to the nature of the site and the anticipated loads from the structure, it is recommended that this building be supported on bedrock through a system of drilled caissons. Caissons typically consist of a drilled shaft that extends into bedrock and is backfilled with reinforced concrete. Gravel and/or boulders were encountered prior to reaching bedrock in Borings 1 through 4. In some cases, these rocks may be capable of causing auger refusal. In addition, the upper portion of the bedrock was highly weathered up to two feet beyond the top of bedrock. It is important that whatever foundation system is chosen that the contractor ensures that the supporting element is placed on sound bedrock.

5.2.1. Drilled Shafts (Caissons)

5.2.1.1. The rock surfaces at prepared bearing elevations should be level to provide uniform load distributions. Additional rock excavations may be required to achieve such level surfaces. Each caisson should be socketed a minimum of one foot into sound rock. The bottom of pier and footing excavations should be free of all loose rock, soil, and other compressible materials prior to placement of reinforcing steel and concrete.

5.2.1.2. Based on the rock core samples obtained in the exploration, it is estimated that foundation elements placed directly on the underlying sound limestone bedrock may be designed for a net allowable bearing value of 20,000 pounds per square foot, provided the recommendations listed are followed.

5.2.1.3. An allowable passive lateral pressure for rock of 10,000 pounds per square foot is recommended for the design of the caissons. Only that area of the pier which extends more than one pier diameter below the top of sound, unweathered rock should be considered for lateral load support.

5.2.1.4. At all caisson locations, it is strongly recommended that inspection services be performed. During foundation construction, a 2.0-inch diameter percussion test hole should be drilled to a depth of 5 feet or two shaft diameters (whichever is greater) below proposed bearing elevations to verify the soundness of the underlying rock and to identify any weathered shale zones, clay seams and voids that might affect foundation support. Each hole should be inspected by a geotechnical engineer or a technician working under the direct supervision of a geotechnical engineer. The inspection should be performed using a "hooked" probe. Any zones of questionable bearing capacity encountered within the percussion holes should be evaluated by a geotechnical engineer and the proposed bearing elevations adjusted accordingly.

5.2.1.5. To facilitate the inspection of piers, the recommended minimum shaft diameter is 30 inches.

5.2.1.6. Borings advanced in this area did not encountered groundwater. However, the contractor should be aware that water might be encountered in drilled pier construction. The contractor should ensure that water does not accumulate within the pier shafts. Any water that seeps into open shafts should be removed prior to inspection and placing of concrete.

5.2.1.7. Voids or very soft soil encountered during the installation of caissons may require the installation of permanent casing to bridge the gap between continuous soils. A contract for the installation of caissons in overburden should include unit prices for soil excavation, rock excavation, and permanent casing as required.

5.2.1.8. It is recommended that the floor slab of the proposed building be supported by the caisson foundation system, i.e., use of a floating slab is not recommended.

Lagoon Decant Structure

Due to the nature of the site and anticipated loading of the structure, a shallow foundation system is recommended. It is understood that the Lagoon Decant facility will consist of a lightly loaded structure approximately 100 square feet in area. It is to be placed on the east or west side of an existing Supernatant Pump structure. It is recommended that the structure be placed on spread footings with slab-on-grade construction.

If the above information is incorrect, or if changes are made to the site layout as shown on

Sheet 1, our firm should be notified so that the changes can be reviewed and the following recommendations modified as necessary.

5.2.2. Soil Bearing Spread Footings

5.2.2.1. The borings show the subsurface conditions to consist of 3.1 feet of fill in Boring 5 and 12.7 feet of fill in Boring 6. This fill extends to the apparent bedrock surface. These subsurface conditions are normally conducive to site development provided that the topsoil and all or a portion of the existing fill are removed, and that the site is then brought to design elevation with suitable fill material that is properly placed and compacted.

5.2.2.2. In preparation of earthwork operations, construction areas should be cleared of trees and stripped of all vegetation, topsoil, organic soil and existing fill material down to the level of three feet below the proposed bottom of footing elevation. Once the undercut is complete, areas to receive fill should be proof-rolled using heavy construction compaction equipment. The response of the soil subgrade should be observed and noted by a geotechnical engineer. Soils that pump, settle, or rut may require removal and/or in-place stabilization using crushed stone, geogrid, or geotextile fabric. Once the subgrade is approved, suitable fill material (as defined in Item 5.2.2.3.) should be placed in maximum eight-inch (loose thickness) horizontal lifts, with each lift being compacted to 100 percent of the standard Proctor density at a moisture content with ±2 percent of optimum.

5.2.2.3. Suitable fill material consists of native soils free of vegetation, topsoil, organics, wet soil, construction debris and rock fragments greater than six inches in diameter. If alternate soil materials are available, it is suggested that fat clays (CH soils) not be used as fill material due to their potential for volume changes with fluctuations in moisture content. It is preferred that fill materials consist of CL, SC or GC-type soils. Engineering classification and standard Proctor tests should be performed on all potential fill materials, and the test results evaluated by a geotechnical engineer to determine the soil's suitability. Where economically feasible, crushed stone may be used as an alternative to soil fills. The existing fill material is not an acceptable material.

5.2.2.4. Soil bearing foundations for buildings should consist of continuous wall footings and/or isolated spread footings (columns) bearing on properly placed fill as described in Item 5.2.2.2. Observing the recommendations presented herein, it is recommended that soil bearing foundations be designed for a maximum net allowable bearing value of two thousand (2,000) pounds per square foot.

5.2.2.5. Prior to concrete placement, the bottom of all footing excavations should be proof compacted by use of mechanical hand tamps in the presence of a technician experienced in earthwork operations. All wet soils or soft soils encountered at foundation elevations should be excavated and backfilled with suitable fill placed and compacted as specified in Item 5.2.2.2.

5.2.2.6. It is recommended that all exterior soil bearing foundation elements extend a minimum of thirty (30) inches below finished grade to provide protection against frost heave action.

5.2.2.7. Excavated footing trenches should not be left open to allow the accumulation of water. Footings should be concreted and backfilled immediately after excavation is complete. If this cannot be done, the last four to six inches of foundation material should be left in place until preparations for placing concrete are complete. In no case should concrete be placed in footing trenches that contain water.

5.2.2.8. Reinforcing steel should be placed in all foundation elements to provide rigidity and strength to bridge over any zones of weakness that might develop in the foundation materials.

5.2.2.9. The floor slabs should be placed over a layer of compacted crushed limestone with a minimum thickness of six inches.

The conclusions and recommendations presented herein are based on information gathered from the borings advanced during this exploration using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. No warranties can be made regarding the continuity of conditions between borings.

If you should have any questions concerning the contents of this report, please contact us.

Respectfully submitted,

FULLER, MOSSBARGER, SCOTT AND MAY
ENGINEERS, INC.

Beth Nodurft

Beth Nodurft
Project Engineer

Hugo R Aparicio

Hugo R. Aparicio, P.E.
Project Manager

/car

Appendix

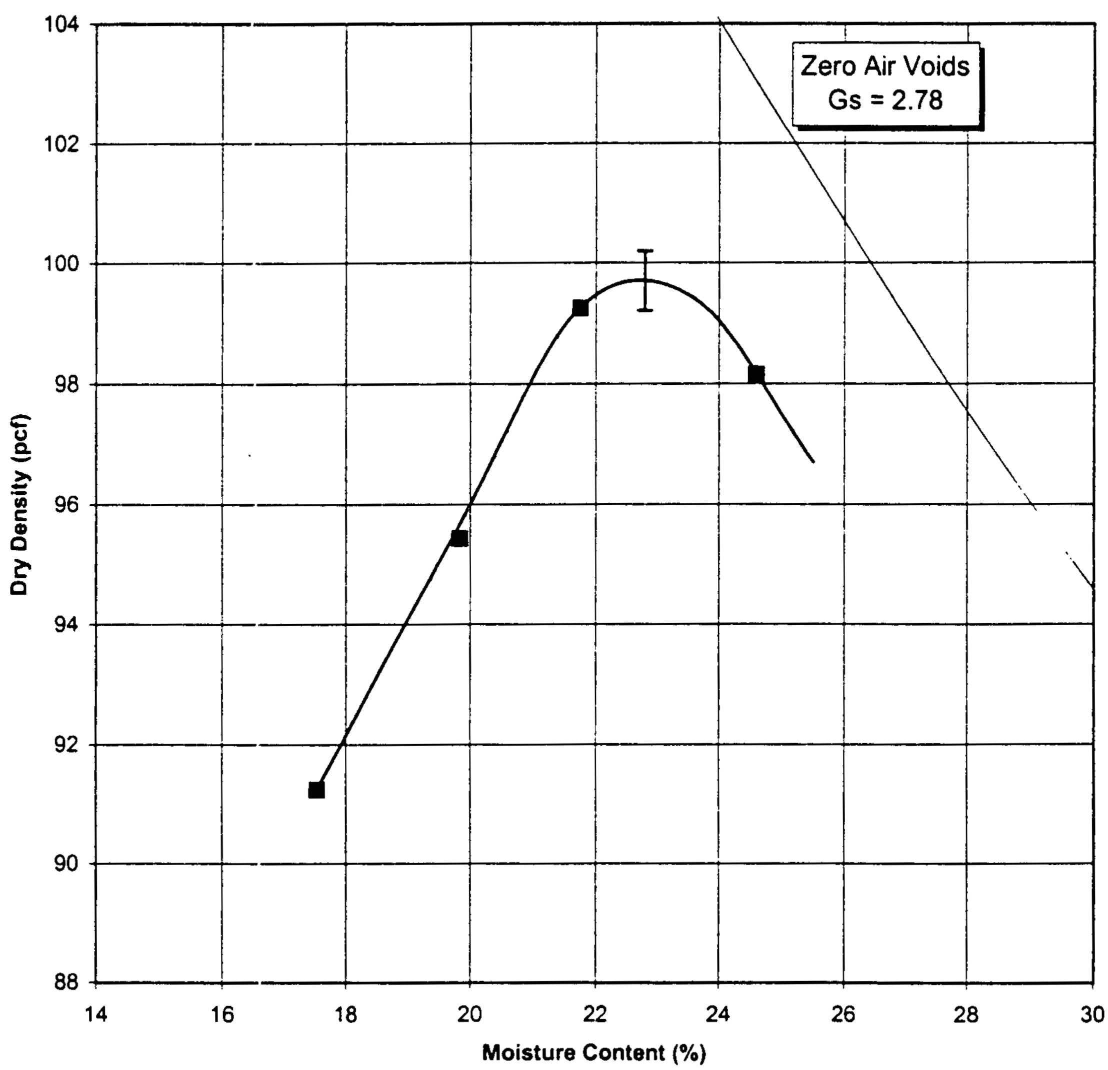
Laboratory Results

Fuller Mossbarger Scott & May
FMSM ENGINEERS

Moisture-Density Data Sheet

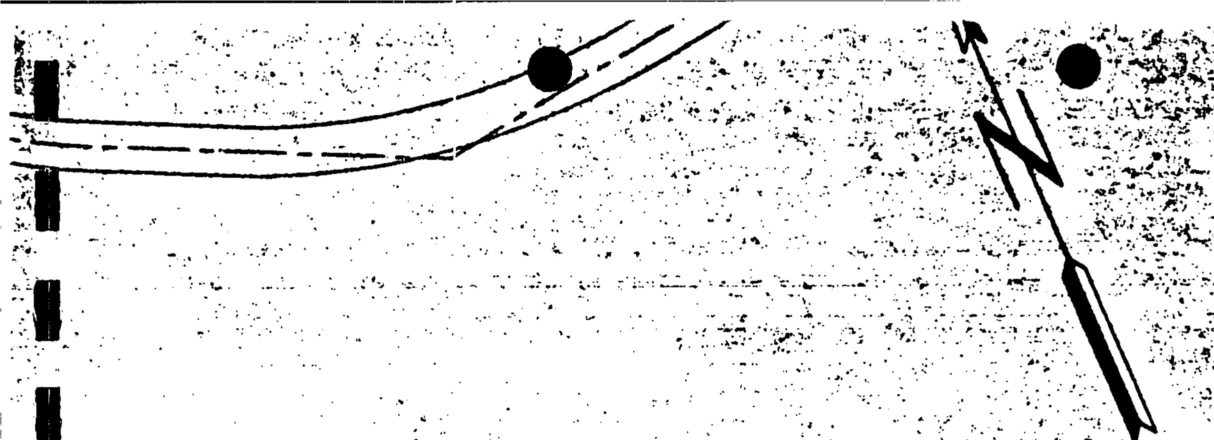
Project: Kentucky River Station Water Treatment Plant
Project No.: 99114
Source: B-3, 21.0' - 21.9'
Sample No.: B-3
Sample Description: Sandy Fat clay (CH), dark brown
Visual Notes:
Test Method: ASTM D698 - Method B
Prepared: Moist
Oversized Fraction: < 5 %
Rammer: Manual
Gs - Fines: ASTM D 854

Mold Weight 4226 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
5836	1610	542.32	472.94	77.11	17.5	91.2
5943	1717	571.40	489.55	76.81	19.8	95.4
6040	1814	535.18	452.74	73.59	21.7	99.2
6062	1836	648.37	535.19	74.92	24.6	98.2



Maximum Dry Density 99.7 PCF

Optimum Moisture Content 22.8 %



LEGEND

● Soil Profile Boring

◎ Soil Boring with Standard Penetration Tests

○ Soil Boring with Rock Core

◉ Soil Boring with Standard Penetration Tests and Rock Core

TBM Temporary Bench Mark – Southwest Corner of Concrete Slab of Supernatant Pump Vault at Elevation 910.47 Feet

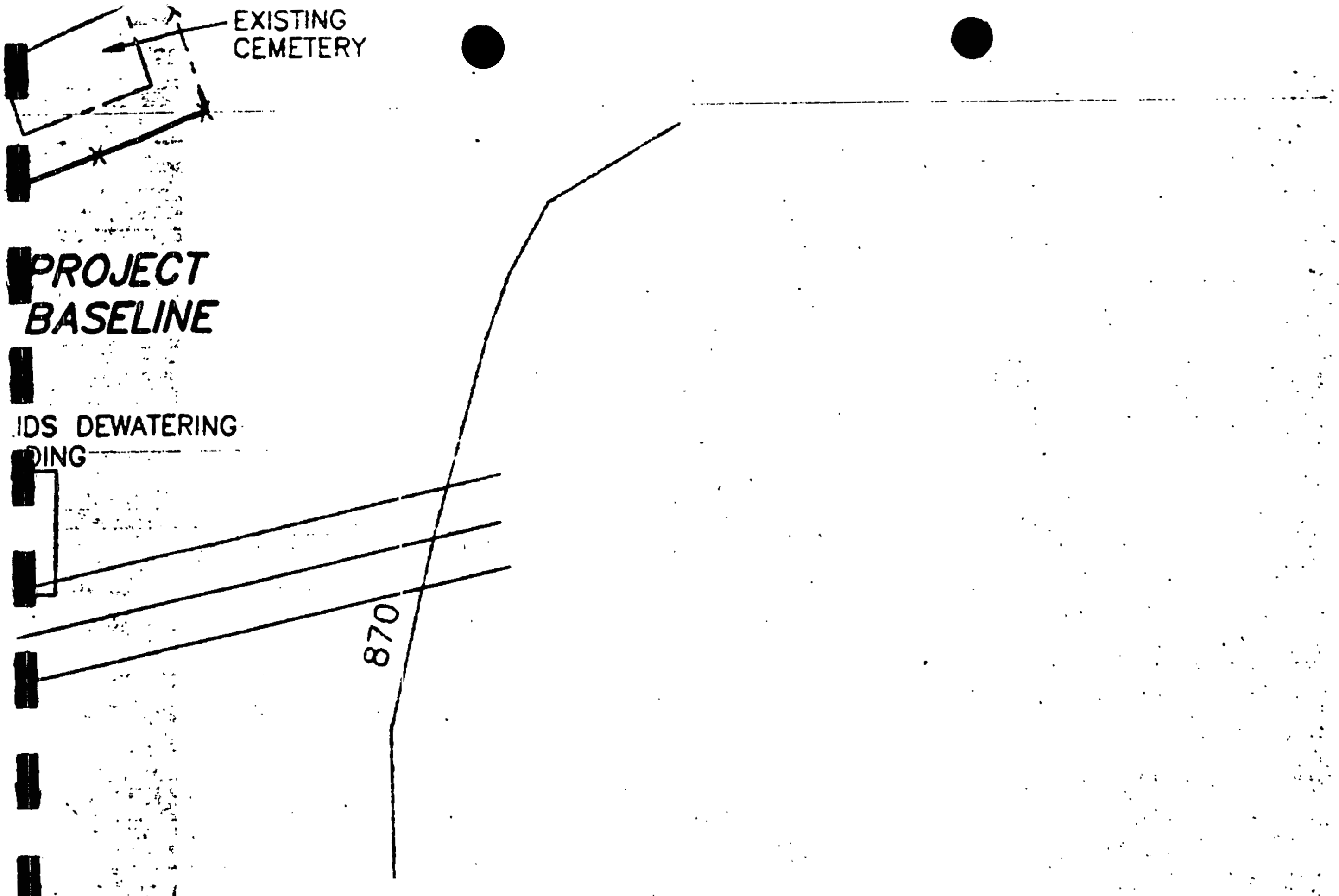
BORING LOCATION TABLE		
Boring No.	Baseline Station	Offset (Feet)
1	6+27	9 Lt.
2	5+84	26 Lt.
3	5+39	13 Lt.
4	5+57	63 Lt.

FMSM ENGINEERS

Fuller
Mossbarger
Scott &
May

STATE OF KENTUCKY PROFESSIONAL ENGINEER

...ENT PLANT



NOTES:

1.) Topographic and survey information for the boring layout was taken from a survey drawing supplied by Montgomery Watson, Cleveland, Ohio. The information is believed to be correct, but is not to be used by the Contractor for construction of the project.

2.) The project baseline shown on this drawing was established to locate test boring positions only. It should not be used for construction or any other purpose. The baseline extends in a westerly direction from the southwest corner of the cemetery fence, with said corner designated as Station 5+00.

20 0 40 80 FEET

GRAPHIC SCALE: 1" = 40'

99114\99114LAY.DWG

GEOTECHNICAL EXPLORA

PROJECT

DATE

DRAWN BY

CHECKED

CHECKED

SCALE

REVISED

1.

2.

3.

4.

5.

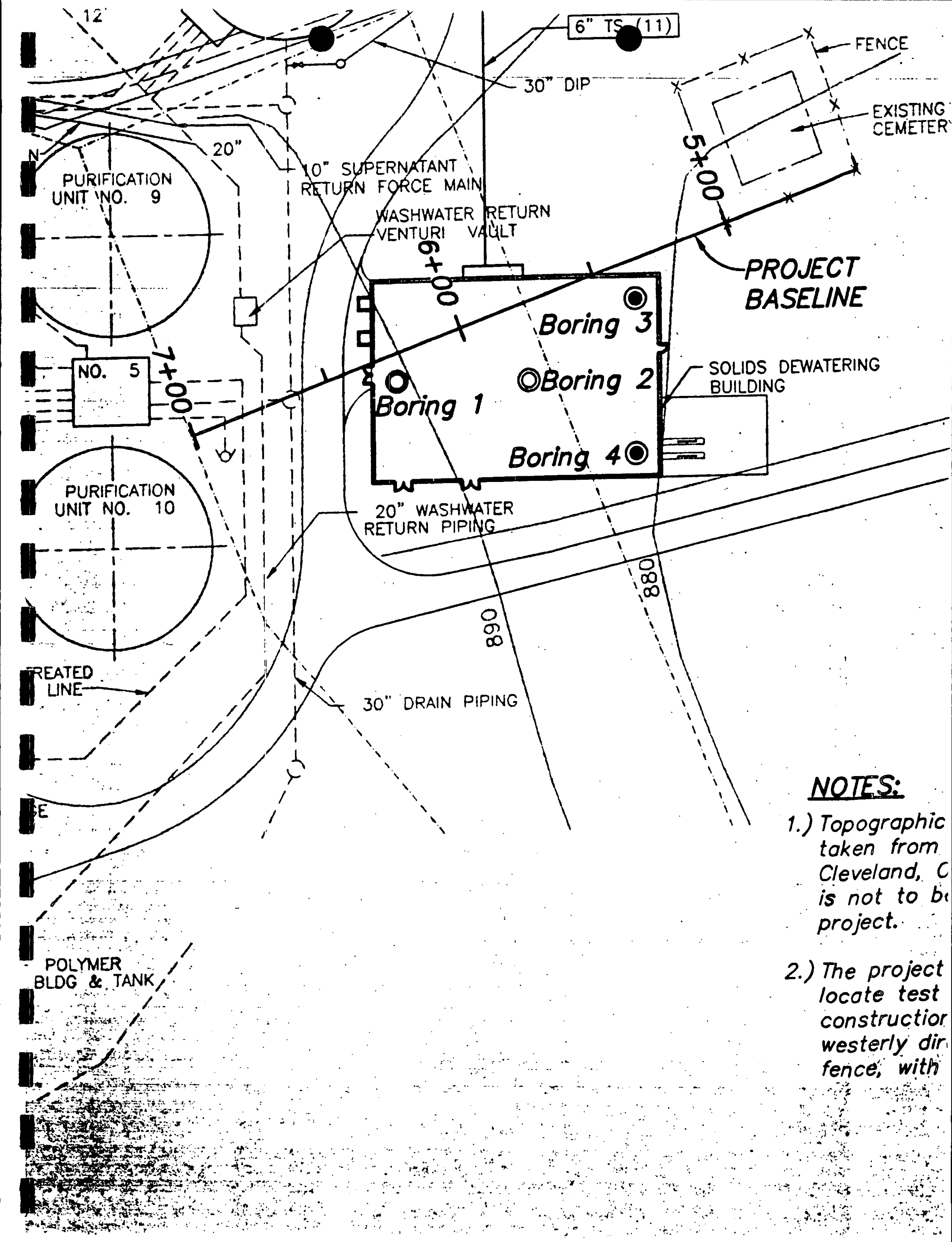
6.

7.

8.

SHEET

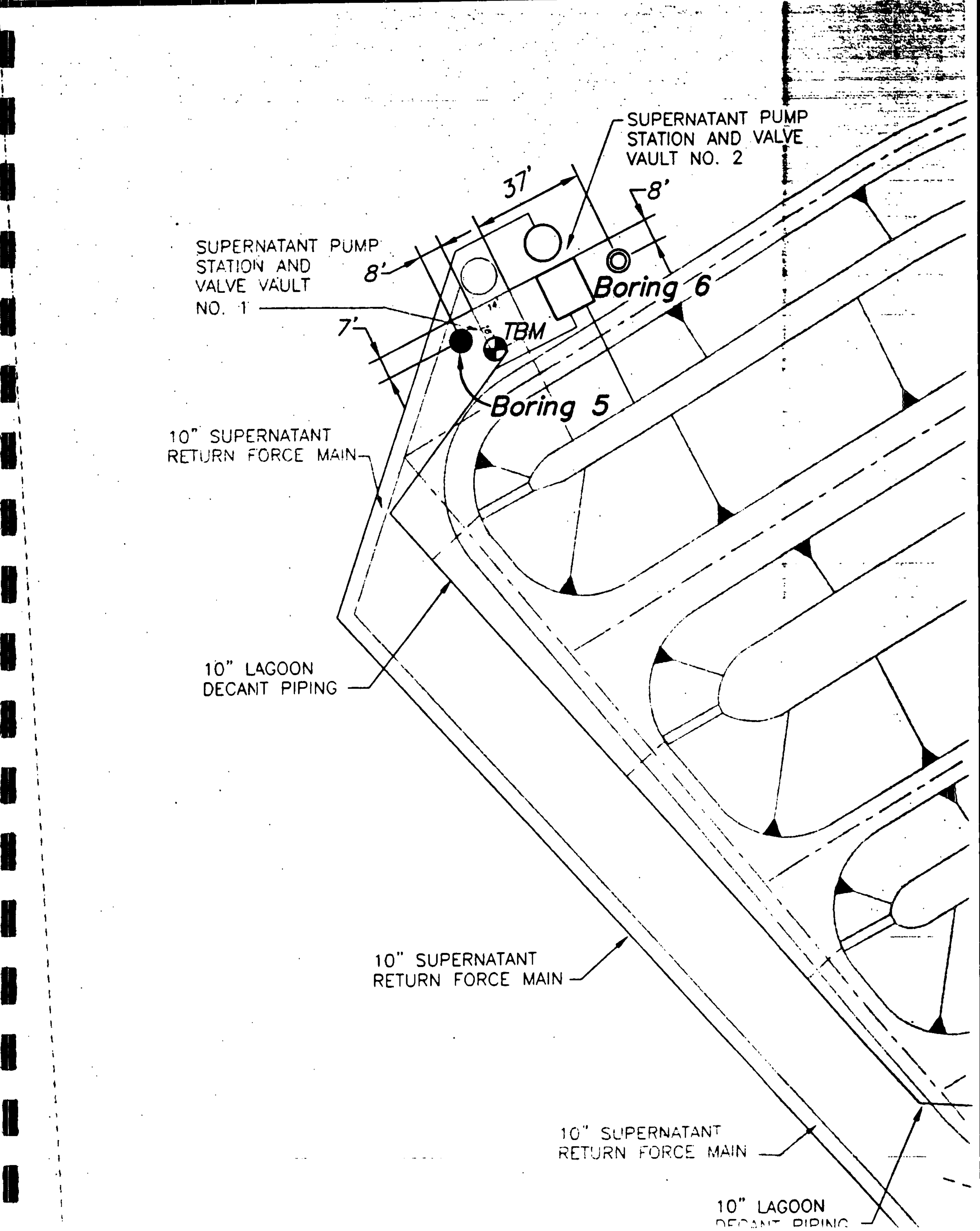
1



NOTES:

1.) Topographic
taken from
Cleveland, C
is not to b
project.

2.) The project
locate test
constructior
westerly dir
fence, with



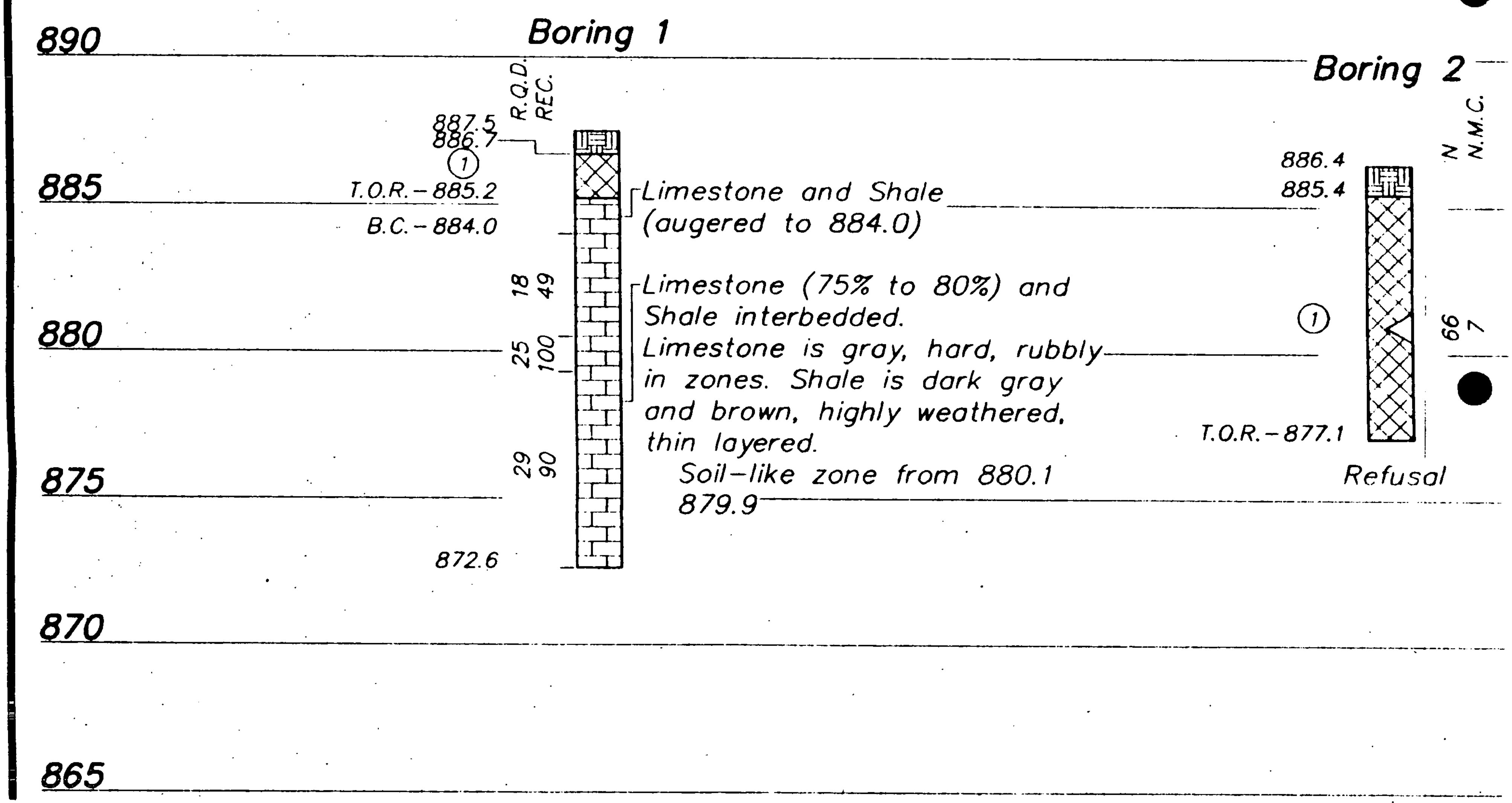
SUPERNATANT PUMP STATION AND VALVE VAULT NO. 2
37'
8'
SUPERNATANT PUMP STATION AND VALVE VAULT NO. 1
8'
Boring 6
7'
TBM
Boring 5
10" SUPERNATANT RETURN FORCE MAIN
10" LAGOON DECANT PIPING
10" SUPERNATANT RETURN FORCE MAIN
10" SUPERNATANT RETURN FORCE MAIN
10" LAGOON

SOIL SUMMARY

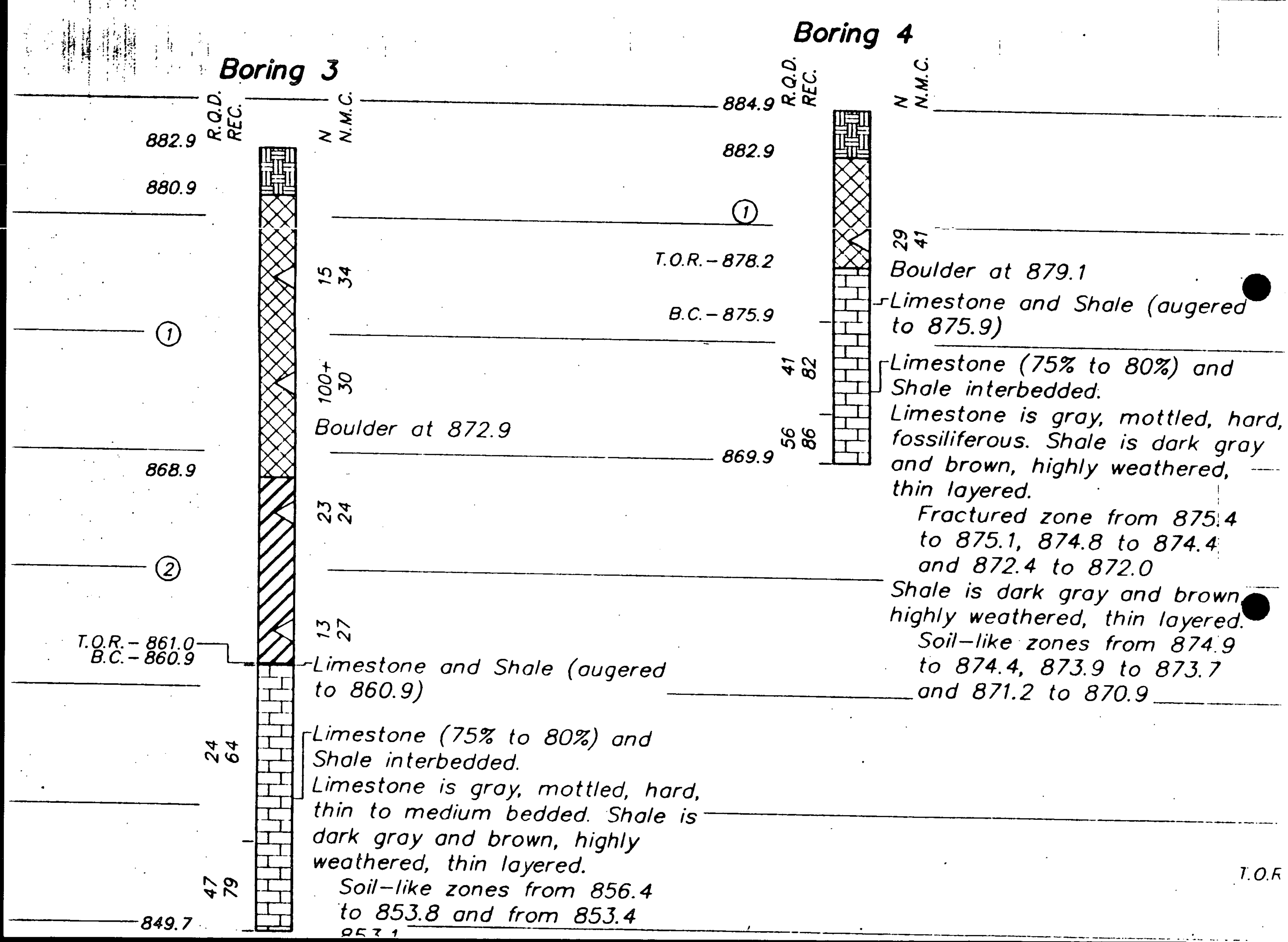
SAMPLE NO.		2
STATION		Boring 3
OFFSET		–
DEPTH		21.0'–21.9'
Composition of Total Sample	GRAVEL(–3" +No.4)	12.5
	SAND(–No.4 +No.200)	33.9
	SILT(–No.200 +0.005mm)	19.0
	CLAY(–0.005mm)	34.6
LIQUID LIMIT		55
PLASTIC LIMIT		22
PLASTICITY INDEX		33
ACTIVITY INDEX		1.14
SPECIFIC GRAVITY		2.78
AASHTO CLASSIFICATION		A–7–6(14)
UNIFIED CLASSIFICATION		CH
CALIF. BEARING RATIO		N/A
MAXIMUM DRY DENSITY (pcf)		99.7
OPTIMUM MOISTURE (%)		23

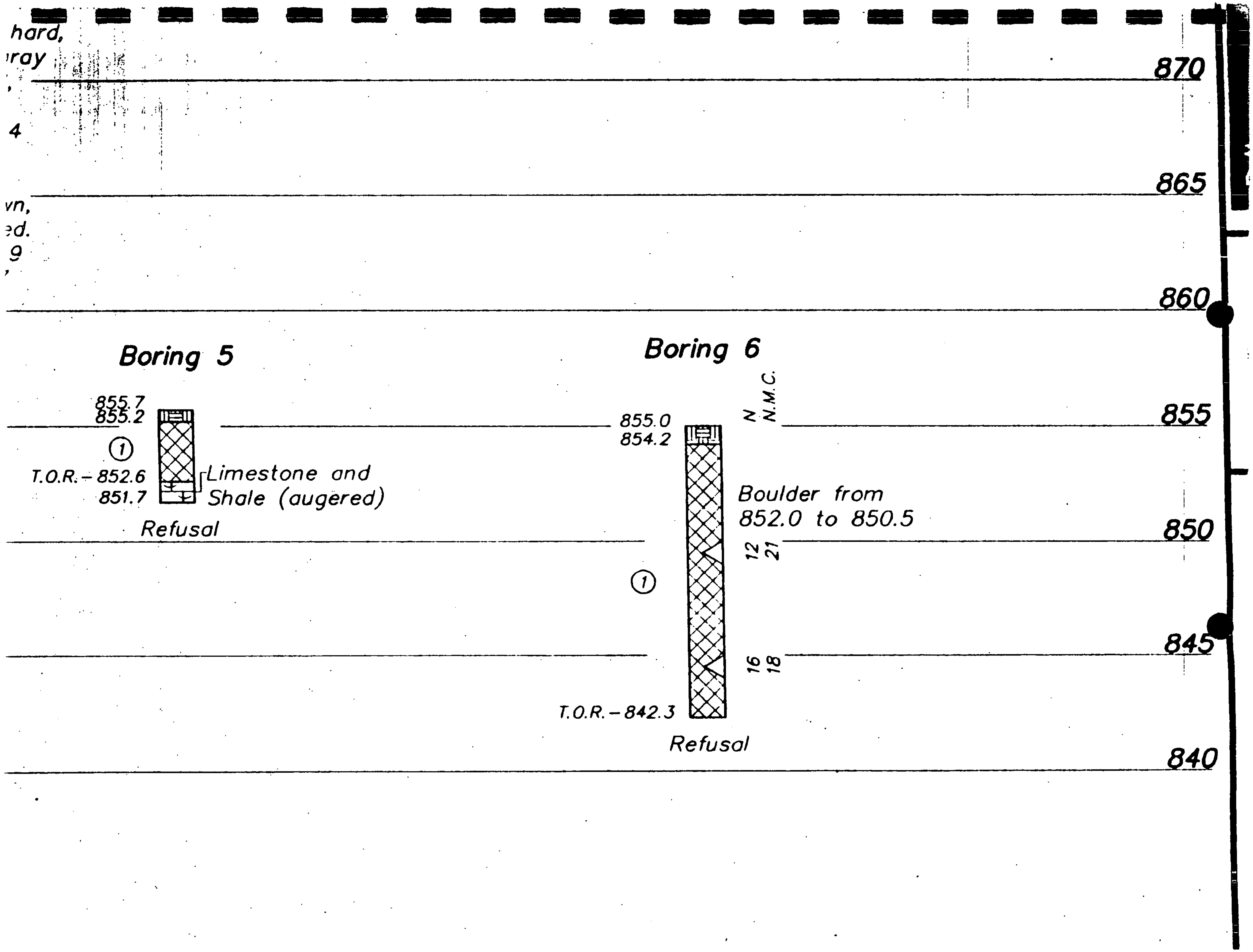
LEGEND

	Topsoil
1	*Fill: Clay, dark brown, moist, medium, with gravels, organics, occasional boulders and asphalt remnants (Field classification)*
2	*Sandy Fat Clay, dark brown, moist, medium to stiff*
	Standard Penetration Test Interval
N	*Standard Penetration Test Blow Count (blows/ft.)*
N.M.C.	*Natural Moisture Content (%)*
T.O.R.	*Top of Rock (Indicates the beginning of rock–like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)*
B.C.	*Begin Core*
Refusal	*Auger Refusal using a carbide–tipped tooth auger bit*
R.Q.D.	*Rock Quality Designation(%)*
REC.	*Recovery(%)*



Boring 1
Boring 2
890
885
880
875
870
865
R.Q.D.
REC.
887.5
886.7
1
T.O.R. – 885.2
B.C. – 884.0
18 49
25 100
29 90
872.6
Limestone and Shale
(augered to 884.0)
Limestone (75% to 80%) and
Shale interbedded.
Limestone is gray, hard, rubbly
in zones. Shale is dark gray
and brown, highly weathered,
thin layered.
Soil–like zone from 880.1
879.9
N
N.M.C.
886.4
885.4
1
66
7
T.O.R. – 877.1
Refusal


Boring 3
R.Q.D.
REC.
N
N.M.C.
882.9
880.9
15
34
1
100+
30
Boulder at 872.9
868.9
23
24
2
13
27
T.O.R. – 861.0
B.C. – 860.9
Limestone and Shale (augered to 860.9)
24
64
Limestone (75% to 80%) and Shale interbedded.
Limestone is gray, mottled, hard, thin to medium bedded. Shale is dark gray and brown, highly weathered, thin layered.
Soil-like zones from 856.4 to 853.8 and from 853.4
47
79
849.7
Boring 4
884.9
R.Q.D.
REC.
N
N.M.C.
882.9
1
T.O.R. – 878.2
B.C. – 875.9
869.9
29
41
Boulder at 879.1
Limestone and Shale (augered to 875.9)
41
82
Limestone (75% to 80%) and Shale interbedded.
56
86
Limestone is gray, mottled, hard, fossiliferous. Shale is dark gray and brown, highly weathered, thin layered.
Fractured zone from 875.4 to 875.1, 874.8 to 874.4 and 872.4 to 872.0
Shale is dark gray and brown highly weathered, thin layered.
Soil-like zones from 874.9 to 874.4, 873.9 to 873.7 and 871.2 to 870.9
T.O.R



hard,
ray
4
vn,
ed.
g
870
865
860
855
850
845
840
Boring 5
855.7
855.2
1
T.O.R. - 852.6
851.7
Limestone and
Shale (augered)
Refusal
Boring 6
N
N.M.C.
855.0
854.2
Boulder from
852.0 to 850.5
12
21
1
16
18
T.O.R. - 842.3
Refusal

8. Electric Utility Contact and Electrical Narrative

8.1 Electric Utility Contact

The contact for the electric utility is:

Derrick Dean
Kentucky Utilities
Ph. 606-367-4309
Fax 606-27-8115

8.2 Electrical Load Narrative

The new loads and provisions are anticipated to include the following:

1. Approximately 250 HP from process equipment.
2. Lights and Receptacles for the new building
3. HVAC equipment for the new building
4. Provisions for the addition of future loads in or near the new building

8.3 Proposed Power Distribution

The proposed power distribution for the Dewatering Building includes:

1. A bus tap at Substation E
2. One 5kV Fused Switch located adjacent to Substation E
3. One Unit Dry Type Power Center in the new Dewatering Building Consisting of:
   a. 5kV Air Terminals
   b. One 750 KVA (Preliminary) 4160 - 480 Volt Transformer
   c. Two sections of 480V Switchgear
4. Two 480 Volt Motor Control Centers (Equally dividing the Belt Filter Press loads)
5. Two 480 - 120/208 Volt Transformers
6. Two 120/208 Lighting Panels

The proposed power distribution for the new supernatant vault includes:

1. 480V feed from Substation B

The proposed power distribution for the gravity thickeners includes:

1. One new 480V power panel
2. One new 480-120/208 V mini load center

The proposed power distribution for the new valve operators in the valve houses includes:

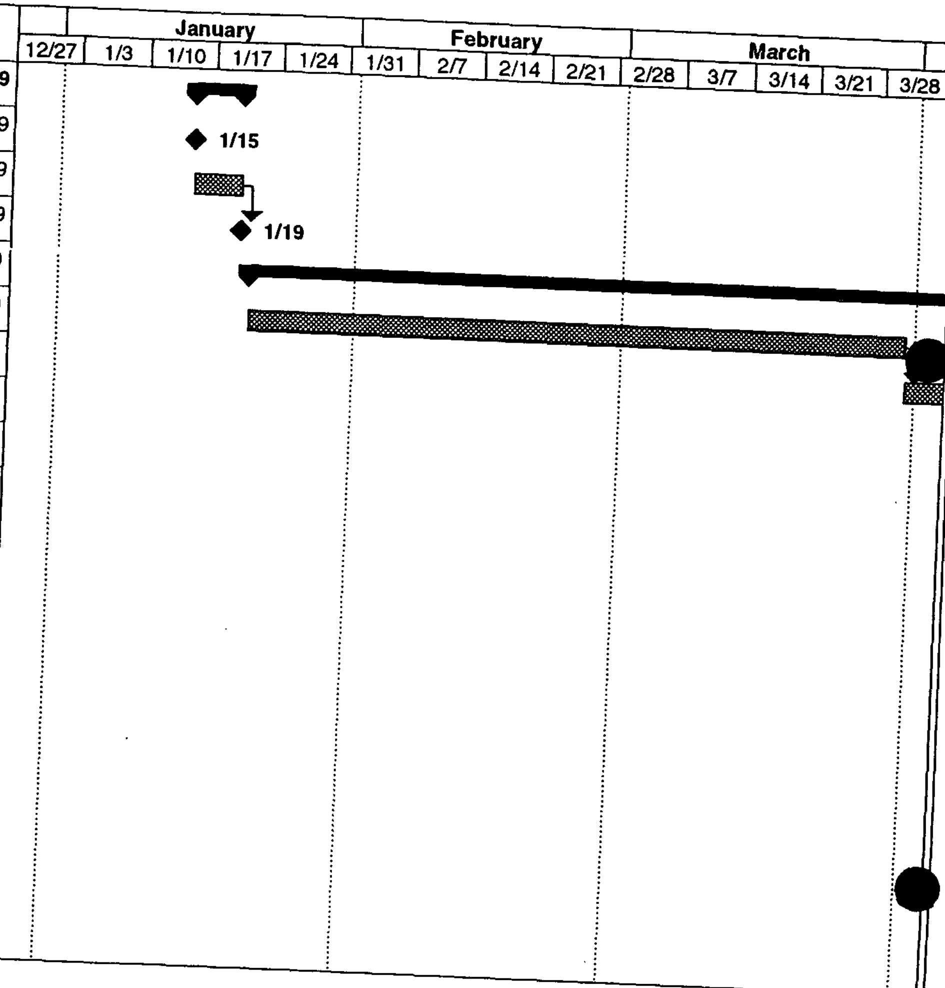
1. One circuit breaker in each existing power panel feeding one new sub-power panel in each valve house

9. Project Schedule

An updated project schedule is included on the following pages.

Kentucky-American Water Company
Kentucky River Station
Additional Residuals Processing Facility

ID	Task Name	Duration	Start	Finish
1	**Design Memorandum**	**3 days**	**Fri 1/15/99**	**Tue 1/19/99**
2	Submit Design Memorandum	0 days	Fri 1/15/99	Fri 1/15/99
3	Review Design Memorandum	3 days	Fri 1/15/99	Tue 1/19/99
4	Meeting to Discuss Design Memorandum	0 days	Tue 1/19/99	Tue 1/19/99
5	**Preparation of Detailed Drawings**	**107 days**	**Thu 1/21/99**	**Mon 6/21/99**
6	50% Design	69 edays	Thu 1/21/99	Wed 3/31/99
7	Review	7 edays	Wed 3/31/99	Wed 4/7/99
8	Review Meeting	0 days	Wed 4/7/99	Wed 4/7/99
9	90% Design	49 edays	Wed 4/7/99	Wed 5/26/99
10	Review	6 edays	Wed 5/26/99	Tue 6/1/99
11	Review Meeting	0 days	Tue 6/1/99	Tue 6/1/99
12	Project Wrap-Up	20 edays	Tue 6/1/99	Mon 6/21/99
13	Advertise	0 days	Mon 6/21/99	Mon 6/21/99
14	Bid Period	30 edays	Mon 6/21/99	Wed 7/21/99
15	Pre-Bid Conference	0 days	Wed 6/30/99	Wed 6/30/99
16	Receive Bids	0 days	Tue 7/20/99	Tue 7/20/99
17	Review/Evaluate Bids	14 edays	Tue 7/20/99	Tue 8/3/99
18	Notice of Award	30 edays	Tue 8/3/99	Thu 9/2/99
19	Notice to Proceed	30 edays	Thu 9/2/99	Sat 10/2/99
20		0 days	Sat 10/2/99	Sat 10/2/99



Project: Kentucky River Station - Additi
Date: Mon 6/21/99

Task	Rolled Up Task
Progress	Rolled Up Milestone ◇
Milestone ◆	Rolled Up Progress
Summary	External Tasks
Project Summary	
Split	
Rolled Up Split	

Kentucky-American Water Company
Kentucky River Station
Additional Residuals Processing Facility

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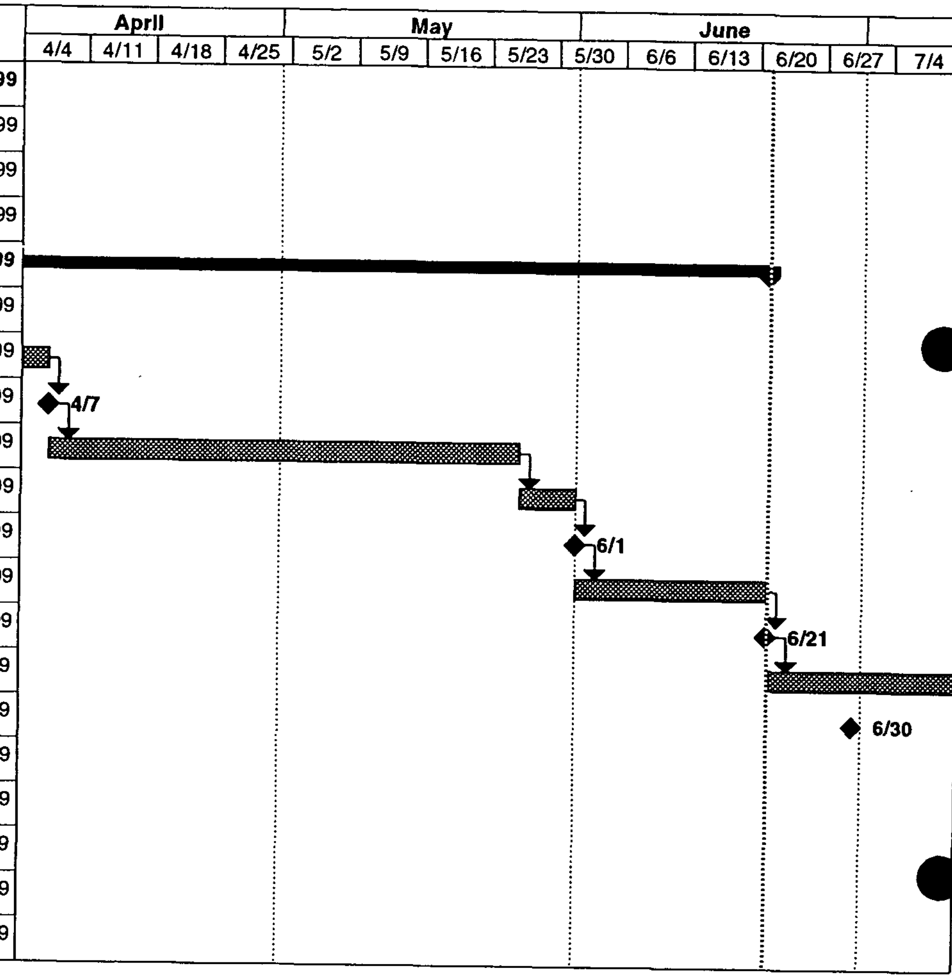
19	Notice to Proceed	30 edays	Thu 9/2/99	Sat 10/2/99
20		0 days	Sat 10/2/99	Sat 10/2/99



Project: Kentucky River Station - Additi
Date: Mon 6/21/99

Task	Rolled Up Task	Project Summary	
Progress	Rolled Up Milestone ◇	Split	
Milestone	Rolled Up Progress	Rolled Up Split	
Summary	External Tasks		

Kentucky-American Water Company
Kentucky River Station
Additional Residuals Processing Facility

ID	Task Name	Duration	Start	Finish
1	**Design Memorandum**	**3 days**	**Fri 1/15/99**	**Tue 1/19/99**
2	Submit Design Memorandum	0 days	Fri 1/15/99	Fri 1/15/99
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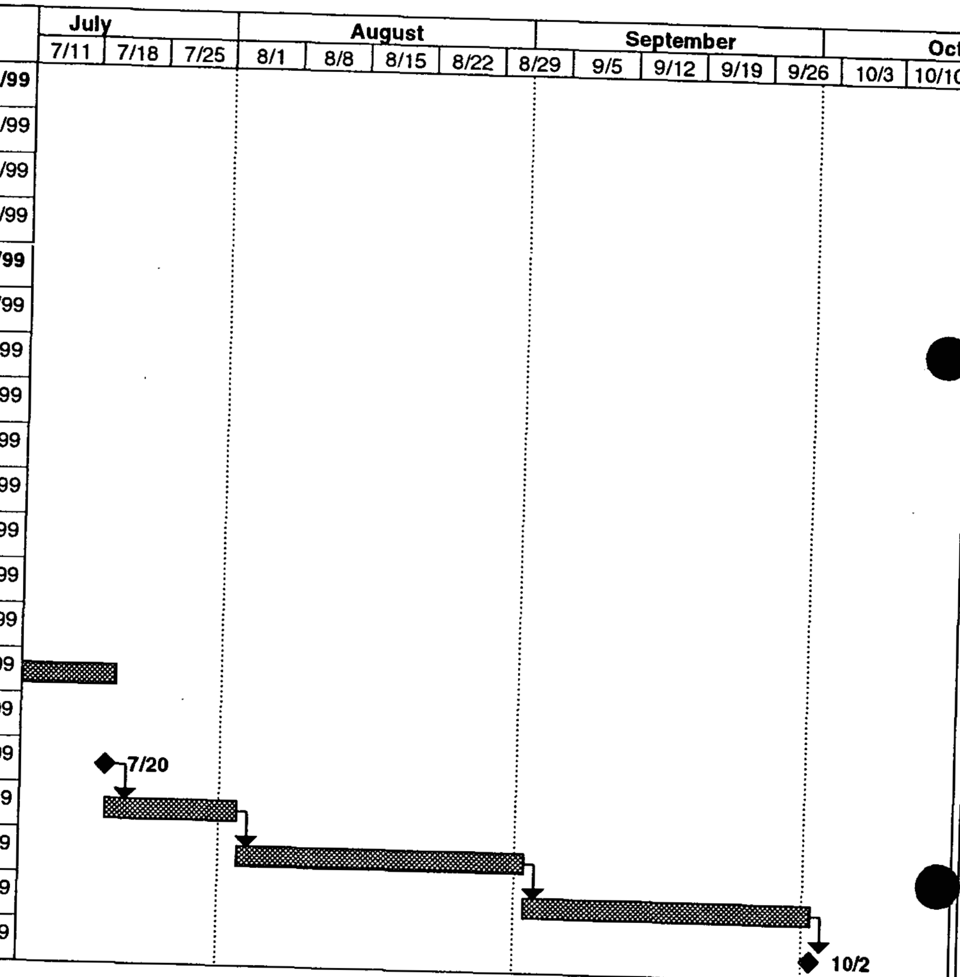
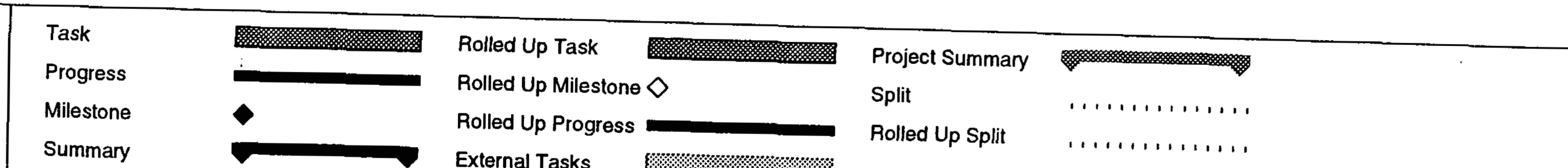
18	Notice of Award	30 edays	Tue 8/3/99	Thu 9/2/99
19	Notice to Proceed	30 edays	Thu 9/2/99	Sat 10/2/99
20		0 days	Sat 10/2/99	Sat 10/2/99



Project: Kentucky River Station - Additi
Date: Mon 6/21/99



10. Equipment Manufacturers

Major equipment manufacturers are listed below.

Equipment	Number	Manufacturer
Sludge Mixer	2	Chemineer Flygt Komax
Progressing Cavity Pump (Belt Filter Press Feed Pump)	2	Moyno Netzsch
Belt Filter Press	2	Andritz Ruthner
Wash Water Booster Pumps	2	Aurora Worthington
Air Compressor	2	Quincy Ingersoll Rand
Polymer Blending Systems	6	Stranco Polymax Dynablend
Polymer Storage Tanks Bulk and Day Tanks	2 Bulk and 2 Day	Nalgene Polyprocessing

11. Drawing List

A copy of the current drawing list follows.

Kentucky-American Water Company
Kentucky River Station
Additional Residual Processing Facilities

LIST OF DRAWINGS

SHEET	TITLE
GENERAL	
380-575-001	Title Sheet List of Drawings
380-575-002	General Symbols and Notes
380-575-003	General Abbreviations
380-575-004	Piping Schedule
380-575-005	Process and Equipment Abbreviations
SITE	
380-575-006	Existing Partial Site Plan
380-575-007	Partial Site Plan
380-575-008	Miscellaneous Details
380-575-009	Miscellaneous Details
DEMOLITION	
380-575-010	Washwater Waste Holding Tanks (1 of 2)
380-575-011	Washwater Waste Holding Tanks (2 of 2)
STRUCTURAL	
380-575-012	General Names and Abbreviations
380-575-013	Gravity Thickeners
380-575-014	Dewatering Building Foundation
380-575-015	Dewatering Building Floor Plan and Details
380-575-016	Dewatering Building Roof Plan
380-575-017	Dewatering Building Sections
380-575-018	Dewatering Building Plans and Sections
380-575-019	Lagoon Supernatant Vault
380-575-020	Miscellaneous Details
380-575-021	Miscellaneous Details
380-575-022	Miscellaneous Details
380-575-023	Miscellaneous Details

SHEET	TITLE
ARCHITECTURAL	
380-575-024	Dewatering Building Floor Plan
380-575-025	Dewatering Building Roof Plan
380-575-026	Dewatering Building Elevations
380-575-027	Dewatering Building Elevations
380-575-028	Dewatering Building Wall Sections
380-575-029	Schedules and Details
MECHANICAL	
380-575-030	Equipment and Valve Schedule
380-575-031	Overall Residual Solids Systems
380-575-032	Typical Valve House Drain Line
380-575-033	Typical Valve House Flushing Line
380-575-034	Demolition/New Sludge Well Plan and Section
380-575-035	Gravity Thickeners (1 of 2)
380-575-036	Gravity Thickeners (2 of 2)
380-575-037	Dewatering Building Plan at EL. 888.50
380-575-038	Dewatering Building Plan at EL. 907.83
380-575-039	Dewatering Building Sections
380-575-040	Dewatering Building Details
380-575-041	Lagoon Improvements
380-575-042	Lagoon Supernatant Vault No. 2
380-575-043	Miscellaneous Details
380-575-044	Miscellaneous Details
HVAC/PLUMBING	
380-575-045	Dewatering Building Plan and Abbreviations
380-575-046	Dewatering Building Sections and Details
INSTRUMENTATION	
380-575-047	Legends, Symbols and Abbreviations
380-575-048	Valve House 1 of 5 P&ID
380-575-049	Valve House 2 of 5 P&ID
380-575-050	Valve House 3 of 5 P&ID
380-575-051	Valve House 4 of 5 P&ID
380-575-052	Valve House 5 of 5 P&ID
380-575-053	Sludge Well P&ID

SHEET	TITLE
380-575-054	Lagoon System P&ID
380-575-055	Gravity Thickener No. 1 P&ID
380-575-056	Gravity Thickener No. 2 P&ID
380-575-057	Thickened Sludge Feed System P&ID
380-575-058	Belt Filter Press System P&ID
380-575-059	Lagoon Supernatant Vault P&ID
380-575-060	BFP Polymer Feed System P&ID
380-575-061	GT and WWW Polymer Feed System P&ID
380-575-062	Gravity Thickener PBS P&ID
380-575-063	Washwater Waste PBS P&ID
380-575-064	RTU Dewatering Bldg. (New) – (1 of 2)
380-575-065	RTU Dewatering Bldg. (New) – (2 of 2)
380-575-066	RTU B DPC 3330 (Exist) – (1 of 4)
380-575-067	RTU B DPC 3330 (Exist) – (2 of 4)
380-575-068	RTU B RIO 3331 (Exist) – (3 of 4)
380-575-069	RTU B RIO 3331 (Exist) – (4 of 4)
380-575-070	RTU Valve House No. 1 (Exist)
380-575-071	RTU Valve House No. 2 (Exist)
380-575-072	RTU Valve House No. 3 (Exist)
380-575-073	RTU Valve House No. 4 (Exist)
380-575- 074	RTU Valve House No. 5 (Exist)

ELECTRICAL

380-575-075	General Symbol and Notes I
380-575-076	General Symbols and Notes II
380-575-077	Standard Details
380-575-078	Existing Partial One-Lines
380-575-079	Revised Partial One-Lines
380-575-080	One-Line – Unit Substation
380-575-081	MCC-1 One-Line, Layout and Schedule
380-575-082	MCC-2 One-Line, Layout and Schedule
380-575-083	Lighting & Power Panel Schedules I
380-575-084	Elementary Schematics I
380-575-085	Elementary Schematics II
380-575-086	Elementary Schematics III
380-575-087	Elementary Schematics IV
380-575-088	Elementary Schematics V
380-575-089	Site Plan and Duct Sections
380-575-090	Dewatering Building Plan at EL. 907.83
380-575-091	Dewatering Building Plan at EL. 888.50
380-575-092	Dewatering Building Lighting Plan

SHEET	TITLE
380-575-093	Gravity Thickeners Plan
380-575-094	Vault Plans
380-575-095	Conduit Development I
380-575-096	Conduit Development II
380-575-097	Conduit Development III
380-575-098	Conduit Development IV
380-575-099	Conduit Schedule I
380-575-100	Conduit Schedule II
380-575-101	Conduit Schedule III
380-575-102	Conduit Schedule IV
380-575-103	Conduit Schedule V

12. Specification List

A copy of the specification list is included on the following pages.

CONTRACT DOCUMENTS TABLE OF CONTENTS

BIDDING REQUIREMENTS, CONTRACT FORMS, AND
CONDITIONS OF THE CONTRACT

VOLUME 1 OF 2

DIVISION 01 - GENERAL REQUIREMENTS Page

DIVISION 02 - SITE WORK

DIVISION 03 - CONCRETE

DIVISION 04 - MASONRY

DIVISION 05 - METALS

DIVISION 12 - FURNISHINGS

Not Used

DIVISION 13 - SPECIAL CONSTRUCTION

DIVISION 14 - CONVEYING SYSTEMS

DIVISION 15 - MECHANICAL

DIVISION 16 - ELECTRICAL

DIVISION 17 - INSTRUMENTATION

13. Design Concept

A copy of the original design concept follows.

KENTUCKY-AMERICAN WATER COMPANY
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

DESIGN CONCEPT

I. BACKGROUND

A. GENERAL

Kentucky-American Water Company owns and operates two surface water treatment plants primarily serving the City of Lexington, Kentucky. The larger of the two plants is referred to as the Kentucky River Station (KRS) and has a rated capacity of 40.0 MGD. This plant derives its sole source of supply from the Kentucky River and currently has an average day production rate of approximately 31.1 MGD. It is not expected that expansion of this plant will occur in the future due to site constraints, however, an increase in the average day production rate to at least 35 MGD is expected. Pretreatment chemicals include either ferric chloride or PACl in conjunction with a cationic polymer. Lime is currently applied at the head of the plant for pH/alkalinity adjustment, however, this mode of operation is expected to be changed in the near future. At that time, coagulation will occur at a lower pH for better organics removal resulting in either the elimination of or a significant reduction in the use of lime. Upflow sedimentation and filtration occur in ten integral purification units. Residuals handling is currently accomplished with the use of lagoons, wash water waste holding tanks, and on site disposal.

In 1996, a study was completed for the Water Company which evaluated the current practice of disposing residuals on site. The study concluded that this practice could be continued in the future provided that a minimum solids concentration of 20% was achieved prior to final disposal. Currently, a 20% solids concentration is not achieved in the lagoons nor is it be possible to do so without significant capital improvements. A detailed description of the existing residual handling facilities as well as a preliminary analysis to correct the problem are presented below. Drawings of the existing facilities are provided in the Attachments to supplement the text.

B. EXISTING RESIDUAL HANDLING FACILITIES AND OPERATIONS

Solids which accumulate in each of the ten purification units are withdrawn through individual 3-inch lines. Electric valves on these lines as well as a number of other valves and sample taps are located in valve houses between the purification units. There is one valve house for each pair of purification units (e.g. Valve House No. 1 serves Purification Unit No. 1 and No. 2). The 3-inch electric valve in each line opens on a manually set timer and remains open for approximately 6-8 minutes. The timer controls the 3-inch valves in series for each pair of purification units (e.g. the valve for Unit No. 1 opens for 6-8 minutes, closes, then the valve for Unit No. 2 opens). It is possible to withdraw solids from more than one pair of purification units at the same time. This operation cycles continuously through each of the ten purification units. The frequency of the valve operation is normally once an hour but is adjusted by the operator depending on the turbidity in the river.

The Water Company currently experiences frequent plugging in the 3-inch sludge withdrawal lines. A 2-inch potable water line runs through each valve house, and some, but not all of these potable water lines have 1-inch taps with manual valves for back flushing the 3-inch sludge withdrawal lines. However, the 1-inch taps are not adequately sized which at times results in the need to utilize a 12-inch purification unit drain line for sludge removal. The practice of utilizing this 12-inch drain line is not desired due to the large amounts of water which are wasted in the process.

The solids which are withdrawn from the purification units accumulate in a 12' x 12' x 10' deep well which houses two 10 HP solids handling pumps, each rated for 690 gpm @ 30' TDH. These pumps operate on a mercoid level switch and discharge the solids to one of four lagoons. Both pumps will run simultaneously if a high level is reached in the well. The lagoon in use and the point of discharge within that lagoon are chosen by operation of manual valves. The four lagoons (numbered 1 through 4) have approximate total volumes of 1.4, 1.9, 1.6, and 0.5 MG respectively. Additionally, the overflow from various areas of the plant (clearwell, wash water storage tanks, laboratory, etc.) can be directed to either Lagoon No. 1 or Lagoon No. 2. Lagoon No. 1 is typically reserved for this purpose and not utilized for blow down from the purification units.

Supernatant is withdrawn from the lagoons by means of manually operated telescoping valves and is collected in a 12' x 14' x 8' deep vault located below Lagoon No. 1. The vault contains two 40 HP vertical turbine pumps each rated for 1,000 gpm @ 88' TDH which discharge the supernatant back to the Kentucky River. Overflow from this vault in the event of a power failure is directed back to Lagoon No. 1 which is normally empty. It is also possible with manual valves changes to direct the supernatant back to the head of the plant or to the wash water waste holding tanks (discussed below) for additional settling. Neither of these modes of operation are normally utilized. The solids which accumulate in the lagoons are manually removed approximately every two years and deposited on the east end of the plant property.

Filter backwash waste water is normally collected in two 70-foot diameter concrete wash water waste holding tanks. When frequent filter backwashes are required under periods of high river turbidity, it is possible to direct wash water waste directly to Lagoon No. 1 or No. 2. Tank No. 1 has a bottom slope of 31' horizontal to 1.45' vertical (4.7%) and a total volume of approximately 250,000 gallons. Tank No. 2 has a bottom slope of 31' horizontal to 4.83' vertical (15.6%) and a total volume of approximately 290,000 gallons. There is no mechanical collection equipment in either tank and they are operated in batch mode with a typical settling time of approximately one hour.

Supernatant is withdrawn from each wash water waste holding tank by means of vertical turbine pumping units. Tank No. 1 contains two 50 HP units, each rated for 2100 gpm at 60' TDH. Tank No. 2 contains three 40 HP units, each rated for 2100 gpm at 60' TDH. The supernatant can be recycled back though the head of the plant but is typically discharged back to the Kentucky River. Overflow from either tank will collect in Lagoon No. 3. Solids are withdrawn from each tank by means of submersible pumping units. Both Tanks No. 1 and No. 2 each contain two 15 HP units, each rated for 350 gpm at 30' TDH. The solids are discharged to one of the four lagoons.

All supernatant which is pumped back to the Kentucky River from both the lagoons and the wash water waste holding tanks first passes through a common venturi meter. The supernatant is then dechlorinated with sodium thiosulfate. The dechlorination facilities are located in the plant chemical building and consist of a 12,000 gallon bulk storage tank, a 300 gallon day tank, and two redundant metering pumps, each with a capacity of 75 gal/hr. The pumps are currently manually operated, however, the Water Company is in the process of changing the operation of these pumps to a flow paced mode with a manual stroke adjustment.

The existing plant electrical distribution system consists of a feed from a Kentucky Utilities step down transformer rated at 69kV - 4160V. Two incoming aerial feeds are terminated into a switchgear lineup located in the Incoming Switchgear Building. This switchgear facility feeds plant Substations A, E, the Intake Electrical Building, the Raw Water Transfer Building, and the High Service Building which includes Substation B. The feeds from the incoming switchgear building are overhead lines. This equipment is predominantly manufactured by Westinghouse and has been installed at various times as the plant has expanded over the years. The breakers inside the Incoming Switchgear Building that feed the various substations are rated for 1200A continuous. Single line diagrams of the electrical distribution system can be found in the Attachments.

Substation B is located closest to and currently feeds the existing residual handling facilities. There are four (4) existing major loads on the existing switchgear line-up for this substation. These loads include a 112.5kVA 4160/480V transformer, a 4160V 800HP motor, a 4160V 900HP motor (connected to a diesel driver and equipped with reduced voltage starting), and a 150kVA 4160V/480V transformer. The two 4160/480V transformers serve existing low voltage.

A distributed control system based on Bristol Babcock 3300 Series RTUs running Accol software currently exists at the plant. This system incorporates the monitoring and control of the wash water waste holding tanks, the lagoon supernatant return vault, and a number of other plant functions. The operation of the dechlorination facilities is currently being incorporated into the system. Monitoring and control of the vault and pumping units which collect the solids from the purification units are not incorporated into the control system. The system also includes a data concentrator and two redundant operator workstations located in the plant control room running Genesis for DOS. The I/O that currently is or shortly will be incorporated for the residual handling facilities consists of the following:

Digital Inputs

- Run status for all pumps (including sodium thiosulfate metering pumps)

- Open limit for 3 wash water valves (inlet to each of the waste tanks and one directed to the lagoons)
- Closed limit for 3 wash water valves (inlet to each of the waste tanks and one directed to the lagoons)

Digital Outputs
- Starting all pumps
- Stopping all pumps

Analog Inputs
- All tank levels (except the bulk and day sodium thiosulfate tanks)
- Supernatant flow rate from venturi meter

Analog Outputs
- Supernatant flow rate (to pace sodium thiosulfate metering pumps)
- Positioning of the 3 wash water valves (inlet to each of the waste tanks and one directed to the lagoons)

The I/O for the dechlorination facilities is incorporated into RTU E located in the chemical building. The I/O for the holding tanks and the supernatant return vault is incorporated into RTU B which is a 3330 12-slot RTU with a 3331 RIO unit. This RTU currently has 1 empty slot on the 3330 and 0 empty slots on the 3331. There are also 16 DI, 12 DO, 1 AI, and 0 AO spare points available on the 3330, and 23 DI, 0 DO, 4 AI, and 0 AO spare points available on the 3331. All of the DO boards are 4 point boards which could be replaced with 8 point boards if necessary.

C. ESTIMATION OF RESIDUALS GENERATION

The quantity of residuals produced were first estimated using historical data over a 12-month period. Since lime usage is expected to cease or be significantly reduced in the future, it was not taken into account. Although the plant uses two different coagulants, ferric chloride was used in the calculations resulting in a slightly conservative estimate. Both the average and maximum values are summarized below. <u>The maximum value is the worst single day in terms of residuals production that occurred over the period of review and DOES NOT reflect the maximum individual values for each variable</u>.

	<u>Average</u>	<u>Maximum</u> (May 7, 1996)
Plant Flow Rate	31.1 MGD	24.5 MGD
Ferric Chloride Dosage	109.8 lb/MG	453.2 lb/MG
Polymer Dosage	18.5 lb/MG	13.2 lb/MG
Raw Water Turbidity	24.9 NTU	232.0 NTU
Suspended Solids : Turbidity Ratio	1.5 : 1	1.5 : 1
TOTAL RESIDUALS (DRY WEIGHT)	**11,870 lb/day**	**76,663 lbs**

D. EVALUATION OF EXISTING LAGOONS

In evaluating the potential for achieving a 20% solids concentration in the lagoons, it was first assumed that all four lagoons would be utilized and operated on an alternating basis. Lagoon No. 1 and No. 3 (3.0 MG total) would be filled and decanted regularly until they reached an assumed maximum solids concentration of 5% while in operation. At this point, use of these two lagoons would be discontinued while they continued to decant and dry, and utilization of Lagoon No. 2 and No. 4 (2.4 MG total) would begin. Ideally, a one year period of drying would ensure that a solids concentration of at least 15% was achieved since we would also have the benefit of a freeze-thaw cycle over the winter months.

Assuming that 3/4 of the volume of Lagoon No. 1 and No. 3 is actual useable storage, a 5% solids concentration equates to approximately 79 days of storage based on the average residuals generation. These lagoons would then be taken off line to dry while Lagoon No. 2 and No. 4 were filled and compressed to a 5% solids concentration which would take approximately 63 days. Thus, Lagoon No. 1 and No. 3 could dry for approximately no more than two months allowing time for removal of the solids. This was not expected to be an adequate amount of drying time to achieve a 20% solids concentration, and has been confirmed by actual operations. A year's worth of drying and freeze-thaw which would be ideal would result in the need for five times the lagoon volume which currently exists.

If the concentration of residuals entering the lagoons was improved, the residuals may concentrate slightly better than a more dilute influent. However, the primary benefit would be that the lagoons could be utilized for a slightly longer period of time since more blow down could continue to be applied as the lagoon was nearing its capacity. Additionally, there would not be as much supernatant to deal with, however, since recycling to the head of the plant is not normally practiced, there is no hydraulic limit to how quickly supernatant could be discharged back to the river other than the settling time in the lagoons which is more than adequate. The conclusion is that there is a substantial deficiency in the capacity of the lagoons to allow for proper operation and drying time.

E. EVALUATION OF EXISTING WASH WATER WASTE HOLDING TANKS

In addition to a deficiency in the volume of the lagoons, the wash water waste holding tanks are also not adequate when periods of successive backwashing are required. During these periods, wash water waste is directed to either Lagoon No. 1 or No. 2. An average of 100,000 gallons is required for each filter backwash, and there are a total of 10 filters at the plant. The two holding tanks with respective total volumes of 250,000 gallons and 290,000 gallons are limited to approximately 3-4 consecutive backwashes as the overflow elevation in each tank limits its usable volume. The potential to operate these units in a flow through rather than batch mode under worst case conditions results in a loading rate of 3.73 gpm/sf with one unit or 1.87 gpm/sf with both units in parallel. These rates are expected to be too high to allow for settling of dilute wash water waste.

F. ESTIMATION OF WASTE CONCENTRATIONS

The percent solids that are achieved in various stages of the present residuals handling process are basically unknown. The percent solids in the wash water waste was estimated by comparing the average raw water turbidity to the average settled water turbidity. The total calculated sludge production for the plant based on an average raw water turbidity of approximately 25 NTU was 11,870 lbs/day. The average settled water turbidity from the same period was 5.0 NTU. Thus it was assumed that 80% of the residuals are removed in the clarification compartment of the purification units and the remaining 20% by the filters. 20% of 11,870 lbs/day equates to 2,374 lbs/day. The average volume of wash water reported daily by the plant operator is just slightly less than 1.1 MG. This results in a wash water waste solids concentration of approximately 0.03% which appears to be a reasonable number.

The percent solids in the blow down from the purification units was estimated based on the historical run time of the lagoon supernatant pumps dating back to 1993. A total run time of 1,700 hours/year for the total of both of the two identical pumps was utilized based on the available data and discussions with the Water Company. The pumps are relatively new with a design rating of 1,000 gpm which equates to 280,000 gal/day based on the estimated run time. The volume of water entering the lagoons is a combination of purification unit blow down and thickened wash water waste. The thickened wash water waste has a small effect on the calculations and was estimated to enter the lagoons at 1%. The amount of wash water waste solids was taken from the calculation in the above paragraph. It was also assumed that the solids which remain in the lagoons after decanting are concentrated to a maximum of 5%. Performing a mass balance on the lagoons results in an estimated solids concentration from the purification units of 0.4%. This also appears to be a reasonable value.

G. EVALUATION OF UTILIZING EXISTING LAGOONS FOR WASH WATER WASTE

The feasibility of utilizing the lagoons for wash water waste only was then investigated where two lagoons would dry while the other two are in service. Based on 2,374 lbs/day of solids calculated above, assuming that the lagoons would concentrate to 5%, and assuming that only 75% of the lagoons could be utilized, the amount of drying time would be approximately 316 days. Considering that some of these values are based on conservative assumptions, it appears that the lagoons could be utilized primarily to handle wash water waste and provide close to one year of drying time. The solids would still need to be manually removed and disposed on site.

The average amount of wash water used per day is 1,100,000 gallons. Decanting this with the existing 1,000 gpm supernatant pumps would require a single pump to run for approximately 18 hours per day. Under worst case conditions, it is possible to use as much as 2,500,000 gallons per day of wash water. This amount of water would exceed the capacity of two of the lagoons. The supernatant pump station would need to run at a rate of at least 1,700 gpm for the entire day to keep pace with the wash water waste entering the lagoons. This could possibly be accomplished by running both of the existing pumps together (no redundancy), or modifying the existing pumps and increasing the size of the motors.

H. EVALUATION OF UTILIZING EXISTING WASH WATER WASTE HOLDING

TANKS FOR PURIFICATION UNIT BLOW DOWN PRIOR TO MECHANICAL DEWATERING

If wash water is discharged directly into the lagoons, the two existing wash water waste holding tanks could then be used as purification unit blow down thickening tanks in conjunction with mechanical dewatering. Based on a residuals quantity of 9,496 lbs/day collected in the settling chamber of the purification units at a 0.4% concentration, the average daily volume of blow down is approximately 284,000 gallons. This volume could easily be accommodated by the existing tanks allowing for nearly a days worth of settling if operated in batch mode. Assuming that the same settled turbidity of 5.0 NTU would be achieved under a worst case scenario where 76,663 total dry pounds of solids are generated (based on the period of review), the maximum volume of blow down would be approximately 2,500,000 gallons assuming the same 0.4% concentration. This would theoretically result in about 2 hours of settling time in the tanks which also would be adequate. It would also be possible to allow the solids to remain in the purification units longer (provided there was no carry over onto the filters) or just discharge the solids to the lagoons in an emergency.

Operating the tanks in a flow through mode would be possible and the loading rates would only be 0.18 gpm/sf with one tank in operation and 0.09 gpm/sf with both tanks operating in parallel. However, the potential modifications to the tanks (weirs, collectors, etc.) would not be practical to construct. Utilizing the tanks and the pumps as they currently exist without any modifications would be the most cost effective approach. The existing supernatant pumps in these tanks with capacities of 2,100 gpm are more than adequate to handle the amount of supernatant generated even under worst case conditions. The existing solids pumps in these tanks with capacities of 350 gpm would run for less than 4 hours on an average day and less than 24 hours even under worst case conditions assuming a concentration of 2%. Thus, the tanks could be utilized as they currently exist for settling prior to mechanical dewatering.

I. EVALUATION OF EXISTING DECHLORINATION FACILITIES

Based on typical American Water Standards for sizing chemical storage and feed equipment, the existing facilities are more than adequate in terms of capacity, even if the instantaneous supernatant flow rates would increase significantly. The existing 300 gallon day tank could be as small as 50 gallons, however, it is currently adequate to limit the potential for overfeed. Additionally, the maximum feed rate under worst case dosage and flow conditions is only 3.6 gph in comparison to the existing 75 gph metering pumps. Smaller pumps would be more efficient, however, the turndown on the stroke and speed of the pumps is generally adequate to achieve the proper dosage.

II. <u>DESIGN SCOPE</u>

Based on the above information, the following scope of work is required as part of this project. The information provided below is broken down into sections which describe the desired improvements required for each component of the residuals handling facilities. This information includes general requirements as well as preliminary I/O information. In general, the design scope of work shall include minor modifications to the lagoons to allow them to function solely as wash water waste holding tanks, minor modifications to the existing wash water waste holding tanks to allow them to function as purification unit blow down settling tanks, and installation of new mechanical dewatering equipment. Some other miscellaneous improvements needed at the plant which are not related to the residuals handling functions are also described below and will need to be included in the scope of work for this project.

A. GENERAL

1. *Review of Preliminary Analysis*: The Consultant shall perform a complete and detailed review and critique of all preliminary information provided in the analysis above and review this with the Water Company prior to initiating any other work on the project. The Consultant's evaluation shall not extend beyond the generally defined scope which encompasses switching the functions of the existing lagoons and wash water waste holding tanks and providing mechanical dewatering equipment.
2. *Budget*: The Water Company's budgeted construction cost (contractor bid price) for this project is approximately $2,500,000.
3. *Input/Output Lists*: Those provided in each section below are <u>preliminary</u> and are only provided to give a general indication of the level of monitoring and control that will be required. The consultant is required to develop a complete I/O list based on the final design details.

B. PURIFICATION UNITS / VALVE HOUSES

1. *General*: The scope of work for this area will consist of upgrading the flushing capabilities for the 3-inch sludge removal lines.
2. *Flushing Lines*: Provide new 2-inch potable water taps with electric valves off the 2-inch potable water header.
3. *Operation of Flushing Lines*: Tie into the existing local timers for the 3-inch sludge blow down lines. Flushing shall occur prior to each blow down. It is purposely desired not to tie this operation into the existing distributed control system since the operators routinely visit the valves houses to take samples.

C. SLUDGE WELL

1. *General*: The scope of work for this area will consist of directing the discharge from the well to the current wash water waste holding tanks.
2. *Discharge Piping*: Utilize existing piping where possible. Maintain manually valved discharge to the lagoons for emergency backup.
3. *Pumping Units*: Consultant shall evaluate the operation of the pumping units with the new head conditions. Minor deviations from the best efficiency point are acceptable. For the purposes of the proposal, it shall be assumed that pumping improvements, if necessary, can be achieved with modifications to the existing units (impeller replacement, impeller trim, additional stages, motor replacement, etc.). Actual modifications to be determined by the Consultant in the preliminary design stages.

D. WASH WATER WASTE HOLDING TANKS

1. *General*: The scope of work for this area will consist of modifying the operation of the existing tanks to receive and settle purification unit blow down instead of wash water waste.
2. *Valving*: Provide electric sludge inlet valves for each tank on the line from the sludge well. Existing electric inlet valves for wash water waste to remain in place.
3. *Supernatant Pumping Units and Piping*: Existing facilities and operations to be maintained.
4. *Solids Pumping Units and Piping*: Utilize existing piping where possible and direct discharge to new dewatering building (discussed below). Maintain manually valved discharge to the lagoons for emergency backup. Consultant shall evaluate the operation of the pumping units with the new head conditions and develop the proposal per the same criteria discussed above for the sludge well pumps.

I/O List (note: all existing I/O to be maintained)

Description	*Type*	*Local Redundancy*
Tank 1 Inlet Valve Open	DO	manual operator
Tank 1 Inlet Valve Close	DO	manual operator
Tank 1 Inlet Valve Open Limit	DI	indicator on valve
Tank 1 Inlet Valve Closed Limit	DI	indicator on valve
Tank 1 Inlet Valve Local/Remote Status	DI	switch at valve
Tank 2 Inlet Valve Open	DO	manual operator
Tank 2 Inlet Valve Close	DO	manual operator
Tank 2 Inlet Valve Open Limit	DI	indicator on valve
Tank 2 Inlet Valve Closed Limit	DI	indicator on valve
Tank 2 Inlet Valve Local/Remote Status	DI	switch at valve

E. LAGOONS

1. *General*: The scope of work for this area will consist of modifying the operation of the existing lagoons to receive and settle wash water waste instead of purification unit blow down. The solids would continue to be manually removed and disposed on-site.
2. *Wash Water Waste Inlets*: Provide inlet piping, energy dissipaters, and electric valves for Lagoon No. 3 and No. 4. Provide electric operators on the existing inlet valves for Lagoon No. 1 and No. 2.
3. *Supernatant Outlets (Telescoping Valves and Piping)*: Modify as necessary to accommodate a worst case backwash volume of 2,500,000 gallons when utilizing two lagoons. Provide electric operators on all telescoping valves. Ensure that flow from one lagoon to a lower lagoon is not possible.
4. *Level Monitoring*: Provide ultrasonic level indicators in each lagoon near the telescoping valves.

I/O List (note: I/O shown for one lagoon to be duplicated for other lagoons as necessary)

Description	*Type*	*Local Redundancy*
Lagoon Inlet Valve Open	DO	manual operator
Lagoon Inlet Valve Close	DO	manual operator
Lagoon Inlet Valve Open Limit	DI	indicator on valve
Lagoon Inlet Valve Closed Limit	DI	indicator on valve
Lagoon Inlet Valve Local/Remote Status	DI	switch at valve
Lagoon Telescoping Valve Open	DO	manual operator
Lagoon Telescoping Valve Close	DO	manual operator
Lagoon Telescoping Valve Open Limit	DI	indicator on valve
Lagoon Telescoping Valve Closed Limit	DI	indicator on valve
Lagoon Telescoping Valve L/R Status	DI	switch at valve
Lagoon Level	AI	visual

F. LAGOON SUPERNATANT RETURN VAULT

1. *General*: The scope of work for this area will consist of modifying the existing supernatant vault such that it can accommodate a worst case backwash scenario.
2. *Supernatant Pumping Units*: Increase the reliable (one unit out of service) capacity to accommodate a worst case backwash scenario. This rate shall be recommended by the Consultant but is expected to be approximately 1,700 gpm. Head conditions shall be based on pumping to the Kentucky River. Modification of pumping appurtenances (air valves, check valves, etc.) shall also be evaluated by the Consultant. For the purposes of the proposal, it shall be assumed that pumping improvements can be achieved with modifications to the existing units (impeller replacement, additional stages, motor replacement, larger valves, etc.). Actual modifications to be determined by the Consultant in the preliminary design stages.
3. *Discharge Piping*: Consultant shall evaluate adequacy of existing piping and replace/parallel as necessary. Piping directed into the existing wash water waste holding tanks shall be maintained for emergency purposes, however, no modifications shall be made. For the purposes of the proposal, it shall be assumed that an additional parallel main will be required.

G. DECHLORINATION FACILITIES

1. *General*: No improvements by the Consultant are required for this area.

H. MECHANICAL DEWATERING FACILITIES

1. *General*: The scope of work for this area will consist of a new building housing mechanical equipment and other related facilities for dewatering the settled purification unit blow down.
2. *Mechanical Dewatering Unit*: The Consultant shall first complete a cost/performance evaluation of several different mechanical dewatering technologies. A complete operational plan shall then be developed in conjunction

with the critique of the preliminary analysis before proceeding with any preliminary design work. The technologies would include belt presses, plate and frame presses, and centrifuges. Samples of purification blow down will be provided to the Consultant for use in evaluating the performance of mechanical dewatering equipment from suggested manufacturers (listed below). The minimum acceptable solids concentration is 20%. The evaluation shall consider both capital and operational costs (such as electrical power) as well as manpower requirements for each of the different technologies. A capital investment of $300,000 has been identified by the Water Company as being the revenue requirement equivalent of one full time operator, 40 hrs/week, 5 days/week. The evaluation shall also consider that the lagoons will continue to be available in the new mode of operation for emergency use should the mechanical dewatering units be out of service. For the purposes of submitting a lump sum proposal, the Consultant shall assume that a single centrifuge sized to operate 8 hours per day (including start up and shut down), 7 days per week shall be provided. The actual number and size of units shall be determined after all preliminary evaluations are complete.

3. *Batch Tanks*: The ability to provide a consistent feed to the mechanical dewatering unit shall be provided. The Consultant shall evaluate the appropriate number, size, and materials of construction of tank(s) for this purpose which will receive solids from the settling tanks. Each tank shall be equipped with a mixer to keep the solids in suspension.
4. *Polymer Feed Systems*: In conjunction with the evaluation of mechanical dewatering equipment, the use of polymers shall also be evaluated by the Consultant to improve settling of both purification unit blow down in the tanks and wash water waste in the lagoons. For the purposes of submitting a lump sum proposal, it shall be assumed that two liquid polymer blending systems (one for each waste stream in addition to any polymers required by the mechanical dewatering unit) shall be provided. It shall also be assumed that a bulk system will be provided (bulk tank and day tank) meeting the requirements of American Water Standard T-2. All polymers must be NSF approved. The Water Company will provide the names of acceptable manufacturers and suppliers during the preliminary design stages.
5. *Building Location*: The Consultant shall select the best location for this facility on the existing Water Company property. The dewatered solids will ultimately need to be deposited on the east side of the site. Access road surfaces to and around the building shall be paved (asphalt).
6. *Building Requirements*: The building shall house the mechanical dewatering unit, batch tanks, and polymer feed systems. It is preferred, if economical, that the cake from the mechanical dewatering unit drop directly into a dumpster or dump truck (provided by the Water Company) in lieu of requiring a conveyor. Architecture of the building shall match that of the existing plant facilities. Proper HVAC and climate control facilities shall be provided. A keypad security system identical to those which currently exist at the plant shall also be provided.

Suggested Mechanical Dewatering Equipment Manufacturers:

Equipment Description	*Manufacturers*
Belt Presses	Ashbrook-Simon-Hartley Komline-Sanderson
Plate and Frame Presses	Netzsch, Incorporated
Centrifuges	Humboldt Decanter, Inc. Sharpless

I/O List (note: list to revised as necessary following completion of preliminary evaluation)

Description	*Type*	*Local Redundancy*
Mechanical Dewatering Equip Run Status	DI	visual
Batch Tank Level	AI	LED readout at tank
Batch Tank Mixer Run Status	DI	visual
Batch Tank Inlet Valve Open	DO	manual operator
Batch Tank Inlet Valve Close	DO	manual operator
Batch Tank Inlet Valve Open Limit	DI	indicator on valve
Batch Tank Inlet Valve Closed Limit	DI	indicator on valve
Batch Tank Inlet Valve L/R Status	DI	switch at valve
Polymer Bulk Tank Level	AI	LED readout at tank and fill conn
Polymer Day Tank Level	AI	LED readout at tank
Polymer Bulk Tank High-High Level	DI	alarms in building and fill conn
Polymer Day Tank High-High Level	DI	alarm in building
Polymer Blending System Run Status	DI	visual
Polymer Blending System Speed Control	AO	at metering pump
Security System Status	DI	at keypad
Intrusion Alarm	DI	at keypad

I. ELECTRICAL

1. *General*: The scope of work for this area will consist of upgrading the electrical distribution system as necessary and providing appropriate electrical equipment for all new and/or modified process equipment. Refer to single line diagram ELESK-1 in the Attachments.
2. *Substation B Upgrade*: If it is necessary to modify this substation with an upgraded transformer due to the connected load exceeding the nameplate capability, the Consultant's scope of work shall include developing the size for the transformer based on the proposed loads. Transformer selection factors shall include:
    a. Basic Impulse Level and Protective Margin coordination for insulation based on transient overvoltage occurences, isokeraunic number, etc.
    b. Development of appropriate grounding electrode system for supplementary ground.
    c. Interface to existing system grounding to prevent large transient over voltages.

d. Analysis of transformer core losses to determine total operating cost of transformer.
e. Analysis of appropriate medium (dry type or cast coil design will be considered; cast coil is preferred if project economics and the size of the unit are appropriate).
f. Interface with protective relaying from the 4160V main switchgear source and the existing loads.
g. Development of appropriate 5kV and 480V over current protection on the primary and secondary of the proposed transformer.
h. Development of appropriate protective relaying for transformer protection.
i. Re-wire existing equipment into the proposed enlarged transformer.

3. *Substation B New Transformer*: If it is necessary to add a new transformer at this substation due to the connected load exceeding the nameplate capability, the Consultant's scope of work shall include/consider the following in addition to those listed above:
   a. Define a location for the new unit. Space around the equipment is limited, so the addition of a new transformer may be difficult.
   b. Coordinate bus taps for the new equipment into the existing switchgear (assuming that the existing gear's current carrying capacity is not exceeded).
   c. Provide appropriate structural details for the setting of the proposed unit.
4. *Centrifuge Starter*: Should a centrifuge be provided, a starter based on the unit's starting characteristics shall be provided. The starter shall be included in the centrifuge supplier's scope of work. Because of the varying inertia and long starting time of the load (as compared with centrifugal pumps), the starting method for the centrifuge shall be either wye-delta closed transition starting or starting via VFD so that the ramping effect is adequately accounted for. The Consultant shall ensure that a time versus starting analysis is performed to ensure that the torque of the centrifuge is match to its driver. Because the proposed centrifuge load is relatively far from the proposed centrifuge, the Consultant must perform a voltage drop calculation to ensure that the conductor size will not impact the voltage which will impact the available torque to drive the load.

J. INSTRUMENTATION

1. *General*: The scope of work for this area will consist of incorporating the additional I/O into the existing distributed control system.
2. *Remote Telemetry Units*: Spare I/O points or slots in existing RTU B shall be fully utilized for additional I/O. If an additional RTU is required, it shall conform to the requirements listed below.
   a. Utilize only Bristol Babcock Distributed Process Controller (DPC) 3330 real time mode 32-bit 386 processor architecture. Each processor shall be provided with nonvolatile memory (with lithium battery back-up).
   b. Provide four configurable ports per remote telemetry unit.
   c. Cabinets shall be free standing. Include fan and heater and compact lighting fixture activated by a door switch.

d. Use of remote mounted keypads is not allowed. Use integral units only.

e. Vertical stacking of terminal blocks is permitted, staggered or alternating stacking not permitted.

f. Use only ground-fault interrupter type convenience receptacles.

g. 120 VAC control cable shall be physically separated from 4-20 mA signals as much as practicable inside control cabinets.

h. 12 slot boards required. 6 slot boards are not acceptable.

i. High density I/O boards are not permitted.

j. 4 Wire Control required for all pieces of equipment (one contact for open and one for close, etc.).

k. A fiber optic data highway shall be provided between RTUs.

3. *Modes of Operation*: The following modes of operation anticipated for improvements associated with this project are described below:

a. Local/Remote Capabilities - Each electric valve will be equipped with a Local-Off-Remote selector switch (at the piece of equipment) to allow the location of control to be changed. In order to ensure that the RTU (in the Remote Manual or Remote Automatic Mode) has control, a contact block will be added on the Remote leg of the selector switch. The output of the contact block will drive a digital input that will serve as a permissive in the DCS. If the DCS attempts to control a device from the RTU when it is not in the Remote mode, a failure condition will be delineated at the operator's interface.

b. Local-Manual - An operator at a piece of process equipment will turn the device on and off. Required for all electric valves.

c. Local-Automatic - Controls are hardwired into pieces of equipment by a vendor (such as prepackaged process equipment). Required where applicable.

d. Remote Manual - An operator in the control room turns items on and off via the operator interface connected to the DCS. Required for all electric valves.

4. *Operator Interface Functions*: The Consultant shall include paragraph descriptions of screens (including a listing of each specific I/O point required on each screen) to give the system integrators an understanding of the level of detail required. Each screen shall utilize the Water Company's standard color conventions for stop, run, open, closed, and intermediate conditions. It is expected that modification of 4 existing screens will be required.

5. *Protection of Sensitive Electronic Equipment*: The Consultant shall follow guidelines for the powering and grounding of sensitive electronic equipment listed in I.E.E.E. Standard 1100-1992. The following shall also be considered:

a. Each RTU cabinet shall be provided with a direct connection to the ground grid via a driven rod in addition to the equipment safety ground required by the National Electrical Code. Daisy chaining of grounds is not acceptable. A grounding detail showing the interface between the RTU cabinet and the proposed grounding system is required. Instrumentation shields shall be grounded at the DCS end only. Provide grounding straps on unit lengths of conduit runs for better electromagnetic interference. The electrical grounding specifications must be cross referenced to the instrumentation and control specifications so that it is understood that the system integrator monitors the quality of system grounding from an electromagnetic and radio frequency interference (EMI/RFI) standpoint. In order to facilitate an electrically conductive ground mass, provide connections to structural steel and interface them to the grounding system.

b. All signal cables shall be run in a ferrous conduit (to provide additional electromagnetic interference protection) from the instrument to the DCS.

c. Diodes shall be provided across all of the digital outputs to limit surges from switch of electromechanical devices (such as motors).

d. Separate power supplies shall be provided for analog inputs and RTUs, and digital outputs.

e. Conduit spacing is required between power and signal/control cables as listed in I.E.E.E Standard 518-1982.

K. MISCELLANEOUS PLANT IMPROVEMENTS

1. *General*: In addition to the residual handling improvements described above, other miscellaneous improvements at the plant as described below shall also be included in the scope of work. The Consultant shall structure the contract documents such that separate add-on pricing shall be provided by the Contractors for each of these four items. The Water Company will determine whether to proceed with the construction of these improvements once bids are received and evaluated.

2. *Raw Water Sample*: The plant's current raw water sample line into the laboratory is tapped at the top of the bluff upstream of two mixing tanks. This sample is not a true raw water sample since polymer is fed at the intake. The Consultant shall, as a minimum, design a line into the river which will provide a sample (and drain) at the intake electrical building. In addition to being able to take a grab sample at this location, an on-line turbidimeter shall also be provided. The line shall be heat traced and/or insulated as necessary. The suction of the line will need to be adequately protected in the river. Redundant pumping units shall be provided and operated such that one will energize if the other should fail. The required flow rate shall be approximately 2-3 gpm. In addition to providing these facilities, the Consultant shall also evaluate the feasibility of pumping the sample to the top of the bluff and tying the new line into the existing line at the mixing tanks. In this case, provisions would need to be made for draining and refilling the line (i.e. clean outs and air release). For the purposes of submitting a lump sum proposal, only the facilities into the electrical building and the evaluation of the feasibility of pumping to the top of the bluff shall be included in the scope of work.

3. *Security Cameras (Three)*: A single security camera currently exists at the intake with a monitor in the plant control room. This camera shall be replaced with a panning camera, and a larger monitor to replace the existing one shall be provided. Two new additional cameras shall also be provided. One shall be located at the top of the bluff which is capable of panning the intake car at rest as

well as the purification units. The second one shall be located such that it can pan the lagoons and settling tanks. Individual monitors located in the plant control room shall be provided for each of these cameras as well.

4. *Settled Water Tap*: Each purification unit currently has five sludge taps which discharge into a sample sink at their respective valve houses. Two of these taps in each tank are not utilized, and one of them in each tank shall be converted into a settled water tap. This would simply consist of extending and turning the sample piping within each purification unit upwards and providing a funnel just below the weir elevation. The taps within the valve house would also need to be adequately labeled.

5. *Incline Car Automation*: A radio controlled incline car is currently available for access to and from the intake. In the winter months, it is necessary to operate this car regularly to keep it from freezing up. It will be necessary to provide the capability to put the operation of the car into automatic mode when necessary.

14. Critique of Design Concept

A copy of the revised Critique of Design Concept follows.

The design concept presented in the request for proposal for the residual solids processing facilities at the Kentucky River Station (KRS) is evaluated here and recommendations are made for the design criteria to be used in the selection and sizing of the residual unit treatment processes.

1. SUMMARY OF DESIGN CONCEPT

The existing residual solids handling practice at the KRS includes withdrawal of solids settled in each of the 10 Hydrotreator purification units to a 12' x 12' x 10' deep well. From the deep well, the solids are pumped to one of the four existing lagoons. Filter backwash wastewater is collected in two 70-ft diameter concrete wash water waste holding tanks (WWWHTs). During high raw water turbidities when frequent filter backwashes are required, the wash water waste can be directed to Lagoons No. 1 or No. 2. Supernatant from the WWWHTs and overflow from the lagoons is pumped back to the Kentucky River. The basis of design of the existing facilities is presented in Table 1.

The basis of design of the proposed residual solids handling facilities is also presented in Table 1. The proposed scheme includes conversion of the existing WWWHTs to gravity thickeners for concentrating the solids settled in the purification units; utilization of the lagoons for handling the filter wash water waste; construction of a new mechanical dewatering facility for further concentrating the thickened sludge to a minimum solids content of 20 percent; and providing auxiliary pumping and piping facilities, chemical feeding, control and electrical systems.

2. DESIGN CRITERIA

Preliminary design criteria for the residual solids handling facilities at the KRS, as described in the RFP, include:

- The projected average residual solids production is 11,870 dry lbs/day and the maximum production 76,663 dry lbs/day. These solids production rates are based on an average plant flow rate of 31.1 MGD, and a plant flow of 24.5 MGD during the maximum solids production; an average and a maximum coagulant (ferric chloride or polyaluminum chloride - Stern PAC) dose of 109.8 and 453.2 lbs/MG, respectively; a polymer dose of 18.5 and 13.2 lbs/MG for the average and maximum turbidity conditions, respectively; an average raw water turbidity of 24.9 NTU and a maximum one of 232 NTU; and a total suspended solids (TSS-as mg/L) to turbidity (as NTU) ratio of 1.5:1. For the estimation of the settled and filter wash water waste solids it is assumed that 80 percent of the solids are removed through clarification and 20 percent through filtration. (This assumption is based upon typical operating parameters.)

- The average daily water production is expected to increase from a current average flow of approximately 31 MGD to at least 35 MGD.

- The currently used pretreatment chemicals include ferric chloride, lime and polymer. The plant is currently investigating replacing these chemicals with SternPAC and polymer. The design will be based upon using ferric chloride.

- The average settled water turbidity is 5 NTU.

- The expected average solids content in the settled sludge is 0.4 percent.

- The expected average solids content in the thickened sludge is 2 percent, which will be the solids concentration pumped to the dewatering units.

- A minimum solids content of 20 percent for the dewatered residual solids is required in order to continue the current practice of disposing residuals on site.

There are no plant data available for the quantity of residual solids generated during water treatment at the KRS. The current residual solids management practice, that includes discharging the residual solids to lagoons and periodic cleaning of the lagoons removing the solids at varying concentrations, makes it difficult to determine the mass of solids produced. Therefore, the quantity of the generated solids has to be estimated based on the raw water quality parameters and the chemical feed rates applied. The residual solids quantities projected in the RFP represent preliminary estimations based on limited amount of data. These quantities are estimated in more detail in the next section of this report based on a broader data basis provided by the Kentucky-American Water Company and American Water Works Service Company.

Kentucky River water samples were collected in March 1995 and analyzed for both turbidity and total suspended solids (TSS). These analyses indicated a TSS/NTU ratio ranging from 0.79 to 2.40 with an average value of 1.41. Generally, the ratio was higher at high raw water turbidity values. Since most of the residual solids at the KRS are generated during high raw water turbidities, an average TSS:NTU ratio of 1.5:1 seems to be appropriate for the estimation of the solids generated at the plant.

Data from the KRS indicate an average raw water turbidity of approximately 35 NTU and an average settled water turbidity of approximately 5 NTU. The data also indicate the settled water turbidity is not necessarily higher during high raw water turbidities. The highest settled water turbidities observed for the period January 1994 through April 1997 occurred when the raw water turbidity was less than 35 NTU. This verifies that a low-turbidity water is more difficult to coagulate than a high-turbidity water, as frequently observed at water treatment plant clarification systems. Therefore, the assumption that the settled solids represent 80 percent of the total solids produced underestimate the settled solids, especially at high raw water turbidities. It would be more realistic to determine the settled solids dry mass as the difference between the total solids production (i.e., raw water solids plus solids from the added chemicals) and the solids escaping the purification units with the clarified water (i.e., the solids that correspond to an average water turbidity of 5 NTU). Based on this approach, the settled solids are estimated to be slightly over than 85 percent of total mass of solids produced at the KRS (the remaining less than 15 percent are removed through filtration).

A mass-balance for solids at the KRS performed by the Kentucky-American Water Company indicated an average solids content of 0.4 percent for the settled sludge. This solids content is lower than that of approximately 2 percent normally observed for iron and aluminum sludges. However, the settled sludge solids content depends on the characteristics of the raw water solids, type and geometry of the settled basins, and sludge withdrawal method. Therefore, the calculated value of 0.4 percent is likely representative of the existing conditions at the KRS.

Generally, gravity thickened aluminum or iron sludges have a solid content ranging from 2 to over than 6 percent, with an average value of approximately 4 percent. Since there are not currently thickeners at the KRS, there are no data available for the solids content in the thickened sludge. The thickened sludge solids content depends, to a degree, on the solids content of the sludge fed to the thickeners. The low solids content of the sludge settled in the Hydrotreators would not allow to obtain thickened sludge solids contents at the higher end of the typical range. However, a 2-percent solids content is still a conservative value.

Solids samples which were collected from the solids well were sent to various manufacturers for evaluating dewatering equipment. The manufacturers reported the solids concentrations of these samples, which ranged between 1.2-percent solids to 2.7-percent. Since these samples were taken directly from the solids well without thickening, these results also confirm the conservative value of 2-percent solids content.

3. RESIDUAL SOLIDS PRODUCTION

Operating data from the KRS over a 40-month period, from January 1994 through April 1997, were summarized and provided to Montgomery Watson by the Kentucky-American Water Company and American Water Works Service Company. These data, which are summarized in Table 2, include also estimates of the mass of residual solids produced at the KRS.

The produced mass of dry solids is calculated based on the daily raw water turbidity values, chemical feed rates, and water production rates according to the equation:

> Dry Mass of Solids, lbs/d = (Flow Rate, MGD) x 8.34 x [(Dry $FeCl_3$ Dose, mg/L) x 0.478 + (SternPAC Dose, mg/L) x 0.158 + (Dry Alum Dose, mg/L) x 0.337 + (Polymer Dose, mg/L) x 1.0 + (Lime Dose, mg/L) x 0.10 + (NTU x 1.5)]

This equation assumes 0.478 lbs of solids are produced per lb of dry ferric chloride added, 0.158 lbs of solids per lb of SternPAC, 0.337 lbs of solids per lb of dry alum, 1 lb of solids per lb of polymer, 0.10 lbs of solids per lb of lime, and a TSS/NTU ratio of 1.5:1.

Table 2 presents the average, maximum and minimum solids production rates calculated using the aforementioned equation. The calculated average solids production rate for the examined period is approximately 14,610 dry lbs/day with a maximum production of 183,640 dry lbs/day and a minimum production of 1,440 dry lbs/day.

The Kentucky-American Water Company is investigating replacing ferric chloride with SternPAC as the primary coagulant to eliminate the addition of lime. Trial tests performed by Sternson (i.e., the SternPAC supplier) at the KRS indicated SternPAC can be effectively used as a primary coagulant at feed doses approximately equal to those of ferric chloride (on a dry weight basis). The mass of solids generated from the SternPAC addition was not determined in these tests. However, Sternson estimated the solids production based on the aluminum content in the commercial product (expressed as Al_2O_3) and assuming that all of the aluminum in the coagulant will precipitate as aluminum hydroxide [$Al(OH)_3$]. The Sternson calculations are described below:

Al_2O_3 content is SternPAC	=	10.3%
Al molecular weight	=	26.98 g/mole
Al_2O_3 molecular weight	=	101.96 g/mole
$Al(OH)_3$ molecular weight	=	78 g/mole

Reaction: $Al_2O_3 + 3H_20$ ------> $2Al(OH)_3$

$Al(OH)_3$/Coagulant = (2 x 78 g $Al(OH)_3$/mole)/(101.96 g Al_2O_3/mole) x 0.103 g Al_2O_3/g Coagulant

= 0.158 g $Al(OH)_3$/g Coagulant

Table 2 also presents the summarized solids production data with ferric chloride replaced by an equal dose of SternPAC using the solids production rates described above. If SternPAC was used as a primary coagulant instead of ferric chloride and use of lime was discontinued, the average daily solids production would be 13,320 dry lbs/day, the maximum 176,522 dry lbs/day and the minimum 1,320 dry lbs/day. This represents an approximately 9-percent reduction in dry solids production as compared to that will ferric chlorine and lime.

NOTE: The information on SternPAC is provided for reference only and will not be used as the basis of design for the dewatering system. These results indicate that the design based on ferric will be the worst case scenario in the event that the plant converts to using SternPAC in lieu of ferric chloride in the future.

However, aluminum does not normally precipitate as an $Al(OH)_3$ crystal. Usually, a complex polymerized compound containing on the average 3 to 4 water molecules bound to aluminum hydroxide [i.e., $Al(OH_3).3H_2O$] is formed as the precipitate ("Handbook - Water Treatment Plant Waste Management, AWWARF, June 1987, p. 87). This chemically bound water increases the sludge quantity, increases the sludge volume and also makes it more difficult to dewater since the chemically bound water can not be removed by normal mechanical methods. The resulting aluminum hydroxide species has a molecular weight of 132 (instead of 78 of that of $Al(OH)_3$). This results in an actual solids production of 2 x 132/102 = 2.59 lbs of solids/lb of Al_2O_3, or 2.59 x 0.103 = 0.267 lbs of solids/lb of coagulant with a 10.3 - percent aluminum content (instead of 0.158 used by Sternson).

The daily solids production rates of the KRS were also calculated using a solids production coefficient of 0.267 lbs/lb of SternPAC added. The new sludge production rates are also summarized in Table 2 and include an average daily production rate of 13,770 lbs/day, a maximum of 178,070 lbs/day and a minimum of 1,410 lbs/day. These rates are approximately 3 percent higher than those calculated by the Sternson coefficient. This is a small difference since most of the solids produced are due to the raw water turbidity and not to the coagulant added. (Note: the calculated dry mass of solids produced as a result of the ferric chloride addition is also likely underestimated because iron also precipitates in the form of $Fe(OH)_3.3H20$ instead of $Fe(OH)_3$, but this is beyond the scope of this evaluation).

4. PROJECTED RESIDUAL SOLIDS PRODUCTION

A series of statistical analyses were performed using the examined 40-month period daily sludge production data. One-day, 2-day, 3-day, 5-day, 7-day, 10-day, etc. running average values were calculated to determine the maximum solids production rates for the respective time interval. The results of these statistical analyses are presented in Figure 1 as the ratio of the maximum solids production for the stated time interval to the average daily solids production for the 40-month period. These ratios represent the solids production peaking factors for the corresponding time interval. Figure 2 presents the best fit curve of a 4th degree polynomial equation through the individual graph points. Based on this best fit polynomial curve, the maximum solids production peaking factors presented in Table 3 are calculated.

The peaking factors calculated from the statistical analyses of the current sludge production rates indicate a maximum daily solids production rate equal to 12.6 times the average daily solids production rate; a maximum 2-day solids production rate equal to 11.6 times the average daily solids production rate, etc.

As shown in Table 3, an average daily solids production of 14,600 dry lbs/day was calculated for the examined 40-month period based on available plant data and using ferric chloride as a primary coagulant. This solids production rate corresponds to an average daily water production rate of 30.6 MGD. Kentucky-American Water Company anticipates the average daily water production to increase to at least 35 MGD. Should this happen, the residual solids production would also increase proportionally to the flow rate increase. Therefore, an increase in the average daily water production rate from 30.6 MGD to 35 MGD would result in an increase in the average residual solids production from 14,600 lbs/d to 14,600 x 35/30.6 = 16,700 lbs/day. Based on this average daily solids production rate and using the calculated peaking factors, the expected maximum solids production for different time intervals (ranging from max-day to the maximum 40-day) are calculated in Table 3. The calculated maximum daily solids production is approximately 210,000 dry lbs/day. The projected maximum sludge production rates for different time intervals are graphically presented in Figure 3.

Table 3 also describes the projected dry mass and volume of the settled sludge. For the calculation of the mass of solids settled in the purification units, it is assumed that the average turbidity in the settled water is 5 NTU and the average mass of solids in the settled water is (35 MGD) x (1.5 TSS/NTU) x (5 NTU) x 8.34 = 2,189 lbs/day. Therefore, the dry mass of settled solids is the total solids mass minus 2,189 lbs/day. The settled sludge volume is calculated based on a 0.4-percent solids content (i.e., 4,000 mg/L).

A distribution analysis of the settled solids production rates was performed using the daily solids production rates for the examined 40-month period adjusted for an average daily flow of 35 MGD and corrected for the mass of solids escaping with the settled water. The results of this analysis are graphically presented in Figure 4. Figure 4 can be used to predict the percent of time the settled solids production rate is expected to be smaller or greater than a certain value. For example, 77 percent of the time the mass of settled solids is expected to be less than 20,000 lbs/day (or 23 percent of the time greater than 20,000 lbs/day). This analysis is useful in the estimate of the quantity of solids that need to be stored or to bypass subsequent residual solids handling unit treatment processes.

Table 3 also describes the projected maximum thickened and dewatered solids production rates. The mass of the thickened solids was based on a 98-percent solids capture efficiency by the gravity thickeners and the volume of the thickened sludge based on a 2-percent solids content. The mass of the dewatered solids was based on a 95-percent solids capture efficiency by the dewatering units and the volume of the dewatered sludge based on a 20-percent solids content.

5. RESIDUAL SOLIDS UNIT PROCESS REQUIREMENTS

Gravity thickening and dewatering are the two major unit treatment processes of the residual solids handling system considered for the KRS.

Gravity thickeners for aluminum sludges are generally designed based on a surface overflow rate (SOR) of 100 to 300 gpd/sf and a solids loading rate (SLR) of 5 to 10 dry lbs/sf-day. A better selection of the design criteria can be made by performing a simple laboratory settling test. This test can be conducted using a transparent calibrated cylinder (preferable 1-liter or larger) filled with settled sludge and mixed to evenly distribute the solids. At time zero, the mixing is stopped and the solids are allowed to settle. Water treatment plant sludges for settling basins will generally settle as a blanket with a well defined interface. By recording the height of this interface with time, a plot can be created. The free settling velocity represents the SOR and can be determined as the slope of the straight line portion of the plot. The ratio of the height of the settled sludge to the initial height could be used to determine the ratio of the solids concentration in the unthickened sludge to that of the thickened sludge; and a TSS analysis of the settled sludge would represent the expected TSS concentration in the thickened sludge.

One or more cylinder settling tests are recommended to be conducted at the KRS using sludge settled in the purification units. This or these tests would indicate the design parameters to be used for sizing the gravity thickeners. In the absence of specific sludge thickening data, a design SOR of 300 gpd/sf and a SLR of 10 lbs/sf-day, both of which represent the highest end of typical design parameters, are preliminary used here to determine the gravity thickener requirements for the KRS. NOTE: Several cylinder settling tests were conducted by KRS with varying results. Due to the difficulty in obtaining repeatable cylinder test results, the SOR of 300 gpd/sf will be used for the gravity thickener requirements.

The thickening and dewatering facilities can be sized either for the expected max-day solid production rates or for the expected production rate over a larger time period (i.e., a lower capacity) with sludge storage facilities for the time periods in which the expected sludge production exceeds the capacity of the thickening and/or dewatering facilities. Stored sludge would then be routed to the dewatering facility when adequate capacity exists; however, long term storage (greater than 3 days) of sludge is not recommended. A preferred alternative to sludge storage is to discharge excess sludge directly to the lagoons, similar to what is done presently.

Sizing the residual solids handling facilities for the projected max-day solids production rates would not require sludge storage because all the sludge would be always processed within the same day it is produced.

For example, sizing the residual solids handling facilities for the projected maximum 2-day solids production would allow the facilities to be able to process approximately 191,500 dry lbs of settled solids per day (Table 3). This capacity would not be sufficient for processing the projected max-day settled solids production of approximately 208,200 dry lbs/day. Therefore, a minimum storage of 16,700 dry lbs must be provided. An alternative would be to discharge these excess solids to the lagoons. Based on the projected settled sludge distribution (obtained from data which lead to the development of Figure 4), a solids production higher than 191,500 dry lbs/day is expected to occur 0.09 percent of the time. The maximum mass of solids than would have to be stored or discharge over the maximum 2-day period is 16,700 lbs or 8,350 lbs/day. On an annual basis, the stored or discharged solids are expected to be 8,350 x 0.0009 x 365 = 2,750 lbs/year.

Using a similar approach, the sludge storage requirements for sizing the residual solids processing facilities for the maximum 3-day, maximum 5-day, max-week, maximum 10-day, maximum 15-day, maximum 20-day, max-month, and maximum 40-day solids production rates are calculated. The detailed calculations for each of these cases are provided in Appendix A. Sizing the dewatering facilities for a capacity equal to that of the thickening facilities would not result in any thickened sludge storage requirements. However, thickened sludge would have to be stored if the dewatering facilities are sized for a capacity smaller than that of the thickening facilities (for example, sizing the thickeners for the projected maximum 15-day solids production and the dewatering facilities for the maximum 20-day or max-month solids production). The calculations for the thickened sludge storage requirements for these two latter cases are also provided in Appendix A. Although storage of thickened sludge is less volume-intensive than storing unthickened sludge, thickened sludge is more difficult to handle.

The settled or thickened sludge storage requirements for each of the examined cases are summarized in Table 4. For the estimate of the thickened sludge storage requirements, it is assumed that the two existing 70-ft diameter thickening tanks can store a maximum sludge volume of 173,000 gallons which corresponds to an average sludge depth of 3 ft (the remainder of the tank volume is occupied by supernatant). Table 4 also includes the total mass of dry solids that would have to be stored for each case on an annual basis or to be discharged to the lagoons if storage is not provided. NOTE: Table 4 has been revised to show the selected design criteria of max-15 day.

The thickening and dewatering facility requirements for each of the examined cases are determined in Appendix B. The thickening unit process requirements are calculated based on a maximum SOR of 300 gpd/sf and a SLR of 10 dry lbs/sf-day. Both of these design parameters result in the same thickener area requirements if the feed sludge has a solids content of 0.4 percent.

Sizing the thickening and dewatering facilities for the projected max-day solids production rate would require a total thickener area of 20,240 sf. The two existing WWWHT's provide a total area of 7693 sf. The additional area can be provided with three additional 75-ft diameter tanks. The dewatering facilities should be able to process 198,400 dry lbs/day. This requires a minimum dewatering capacity of 198,400 dry lbs/day if the dewatering facilities are to be operated 24 hour/day and 7 days/week. However, if the total solids produced are to be processed with one shift per day (a 7-hour per day operation including the start-up and shutdown time), the minimum dewatering capacity required is 680,000 dry lbs/day. In this case, however, an additional 843,000-gallon storage would also be required (a batch tank) to store thickened sludge during the 17-hour period in which the dewatering facilities are not operated, since sludge must be withdrawn regularly from the Hydrotreators.

Using a similar approach, the thickening, thickened sludge storage and dewatering facility requirements for other maximum design loading rates are calculated (Appendix B). The facility requirements for each of the examined cases are summarized in Table 4.

The two existing WWWHTs operated as gravity thickeners can process approximately 77,000 dry lbs of plant solids per day which roughly corresponds to the projected maximum 15-day production rate as indicated in Table 4. If additional thickeners are not provided, there is no need to size the dewatering facilities for a capacity greater than that of the gravity thickeners. The dewatering facilities, however, could be sized for a lower capacity by providing additional thickened sludge storage as discussed previously. For example, sizing the dewatering facilities for 67,000 dry lbs/day (i.e., maximum 20-day solids production) would require a 676,000-gallon thickened sludge storage tank; and sizing for 55,000 dry lbs/day (i.e., max-month solids production) would require a 1,810,000-gallon thickened sludge storage tank (Table 4), both of which are based on full-time operation of the dewatering equipment. NOTE: Based on information provided in the Mechanical Dewatering Evaluation, the dewatering facilities will be sized based upon meeting maximum conditions with full-time operation of the dewatering equipment, and meeting average conditions with one-shift per day for five days a week. This sizing basis is detailed in the project design data section of the design memorandum.

6. WASH WATER WASTE MANAGEMENT

The design concept considers utilization of the existing lagoons for the treatment of the filter wash water waste flow. The approximate volume of each lagoon is: Lagoon No. 1 1.3 MG, Lagoon No. 2 1.7 MG, Lagoon No. 3 1.45 MG and Lagoon No.4 0.45 MG, for a total volume of 4.9 MG for the four lagoons.

Table 2 indicates an average filter wash water flow of 921,600 gpd for the 40-month period examined and a maximum daily flow of 2,420,000 gpd. These flows occurred while the KRS was treating an average daily flow of 30.6 MGD. If the average water production increases to 35 MGD, the average wash water flow is expected to increase to 921,600 x 35/30.6 = 1,054,000 gpd and the maximum washwater flow to 2,768,00 gpd. The KRS data indicate an average turbidity of approximately 5 NTU in the filter influent. This corresponds to a TSS concentration of 7.5 mg/L based on a TSS/NTU ratio of 1.5:1 These solids are to be removed by the filters and will end up in the filter wash water waste. Therefore, the average daily solids content in the filter wash water is expected to be (35 MGD) x (7.5 mg/L) x 8.34 = 2,190 lbs/day (i.e., 13 percent of the average total solids production).

The solids introduced to the lagoons with the filter wash water will settle and concentrate. Assuming that the settled solids will concentrate to a solids content of 5 percent, the volume of sludge that would accumulate in a one-year period would be approximately 1.9 MG. Therefore, a total volume of 4.9 - 1.9 = 3.0 MG would be available for wash water settling. Assuming that one lagoon will always be out-of-service for drying and cleaning, the minimum volume available for settling would be equal to (total lagoon volume) - (volume of settled sludge) - (volume of larger lagoon) + (volume of sludge in larger lagoon) or 4.9 - 1.9 - 1.7 + (1.9 x 1.7/4.9) = 2 MG.

Under normal conditions, the suspended matter in the raw water is already well coagulated and flocculated prior to filtration. Furthermore, additional effective flocculation usually occurs in the filter bed during filtration. Consequently, the backwash waste water contains well flocculated material that settles very well. Usually a settling time of 2 to 3 hours in a backwash clarifier yields a supernatant of nearly 5 NTU. A longer settling time would be required for lagoon treatment because operation could not be controlled as well as in a clarifier due to the geometry, depth flow through velocity, etc., and the possibility for resuspension of settled materials is greater in a lagoon. Using a minimum settling time of 6 hours for the projected maximum wash water waste production of 2.77 MGD, a minimum volume of 2.77 x 6/24 = 0.7 MG would be required for settling. Since the total volume of settling is approximately 2.0 MG, the existing lagoons provide sufficient volume and can be used for treating the filter wash waste before discharge to the Kentucky River.

7. CONCLUSIONS AND RECOMMENDATIONS

The analyses performed above established the residual solids production rates and provided a preliminary estimation of the unit treatment process requirements for the management of residual solids produced during water treatment at the KRS. The actual size and number of the unit processes to be provided depend on the design loads of solids and the process loading criteria to be selected for the residual solids handling facilities.

Option 1 - Provide Dewatering Capacity to Match the Capacity of Converted WWWHTs

The existing WWWHTs, operated as gravity thickeners for concentrating the sludge settled in the Hydrotreator units, can handle approximately 80,000 dry lbs/day. If no additional thickener area is provided, a maximum settled sludge mass of approximately 130,000 dry lbs/day, which corresponds to a maximum daily volume of approximately 3.9 MGD at a solids content of 0.4 percent, would have to be discharged to the lagoons. The lagoon volume available for this waste would be approximately 1.3 MG. Therefore, a detention time of approximately 8 hours would be provided for the settled sludge. This detention time should be sufficient to allow the solids to effectively settle in the lagoons. Thus, additional thickening facilities would not likely be required. On an annual basis, the total mass of settled solids that would be disposed to the lagoons is approximately 3.0 percent of the total annual solids production.

In this case, the dewatering facilities could be sized for a maximum process capacity of approximately 80,000 dry lbs/day or for a smaller capacity. If the dewatering facilities are sized for 80,000 dry lbs/day, all the thickened sludge will be processed at the same day it is produced and no additional storage for the thickened sludge (or discharge of thickened sludge to the lagoons) would be required. For illustrative purposes, this is equivalent to two, 2-meter belt presses based on 24 hr per day operation. A batch tank, however, for temporarily storing the thickened sludge fed to the dewatering facilities would be required if the dewatering facilities are to be operated for a period of less than 24 hours/day. For example, if the dewatering facilities are to be operated for 7 hours per day, a batch tank of 326,000 gallons would be required during the max-day solids production (Table 4).

NOTE: The dewatering facilities will be designed to operate 24 hours per day under maximum conditions, therefore no additional temporary storage for thickened sludge is required. Under average conditions, the dewatering facilities will operate for 7 hours per day. The existing gravity thickeners have sufficient storage for the remaining 17 hours under average conditions. The new thickened sludge holding/mixing tank which will feed the belt filter presses is designed for a capacity of 17 hours of thickened sludge storage under average conditions to provide additional buffering capacity for the gravity thickeners and feeding the belt filter presses.

Option 2 - Provide Dewatering Capacity to Meet Maximum Month Production

NOTE: Since this option was not selected, the text of this section in italics has not been updated from the original submittal.

Another option is to size the dewatering facilities for a lower capacity. Sizing the dewatering facilities for a maximum daily capacity of 55,000 dry lbs/day (i.e., the projected maximum-month production based on 24 hr per day operation) would require a thickened solids mass of 22,000 dry lbs/day (i.e., equal to the difference between the capacity of the thickening and the capacity of the dewatering facilities) to be stored or to be discharged to the lagoons. This excess mass of thickened solids would have a volume of 0.13 MGD at a solids content of 2 percent. Discharging this sludge to the lagoons would not significantly reduce the detention time in the lagoons and it is not expected to adversely impact the lagoon performance. The total mass of dry solids to be discharged to the lagoons on an annual basis is expected to be approximately 6.75 percent of the total annual solids production. Therefore, the dewatering facilities could be sized for a maximum daily capacity less than that of the thickening facilities (i.e., less than 77,000 dry lbs/day).

However, a greater capacity would have to be provided if the dewatering facilities are to be daily operated for a period of less than 24 hours. Operation with one shift per day would require a maximum dewatering process capacity of 190,000 dry lbs/day and a minimum batch tank volume of 234,000 gallons (Table 4).

The preliminary evaluation of the available lagoon capacity performed above indicates that the four existing lagoons provide sufficient capacity to handle excess settled and/or thickened solids. However, if the dewatering facilities are constructed on the site of Lagoon No. 4, the existing lagoon volume may not be adequate. In this case, either additional lagoon or additional sludge storage tanks would have to be provided. NOTE: Since the area near the existing cemetery provides more convenient access and pipe routing, the site of Lagoon No. 4 will not be used for the new dewatering building.

The options for sizing the thickening and dewatering facilities discussed above are recommended for further consideration. A more detailed evaluation of these options would be performed and a more accurate determination of the unit process requirements would be possible after completion of the recommended column settling test(s). These tests would also allow a better understanding of the sludge thickening characteristics and a more precise assessment on the adequacy of the existing lagoons for handling solids in excess of the thickening and dewatering capacity that would be provided.

Additional column testing could also be performed using filter wash water waste to establish the settling characteristics of this stream and to better predict the lagoons requirements and settling performance.

Another issue that would have to be addressed in the selection of the size and number of the dewatering units is reliability criteria (i.e., to install multiple mechanical units and provide the ability to process the design maximum loads with one unit out-of-service).

The recommended procedure for the final selection of the unit treatment processes for managing residual solids at the KRS is:

1. Conduct column settling tests using sludge settled in the purification units and filter wash water waste to evaluate the settling characteristics of these two streams and to determine the design loading criteria for the residual solids handling processes.

2. Using these loading criteria, establish the capacity of the existing WWWHTs operated as gravity thickeners.

3. Determine the excess capacity of the existing lagoons and their ability to receive excess settled and/or thickened solids in addition to filter wash water waste.

4. Based on the estimated capacity of the existing facilities (i.e., lagoons and thickeners), select the maximum design capacity of the dewatering facilities and auxiliary systems (i.e., pumping, piping, storage, etc.).

5. Sending sludge samples to dewatering equipment manufacturers, investigate the performance of various dewatering systems (i.e., centrifuges, belt filter presses, and plate and frame presses) for dewatering KRS sludges and their ability to meet the dewatered sludge solids content objectives.

6. Perform a cost-analysis to determine the type, size and number of dewatering units to be installed at the KRS.

NOTE: This evaluation has been performed and was summarized in an evaluation of mechanical dewatering equipment. Two belt filter presses will be provided and will be sized to handle average conditions with one press operating 7 hours per day, and maximum conditions with both presses operating 24 hours per day.

TABLE 1. BASIS OF DESIGN OF RESIDUAL SOLIDS FACILITIES

A. EXISTING FACILITIES

FLOWS	
Average Daily (Current)	31.1 MGD
Rated Capacity	40 MGD
Raw Water Turbidity (Average)	24.9 NTU
Raw Water Turbidity (Maximum)	232 NTU
Suspended Solids : Turbidity Ratio	1.5 : 1
COAGULANTS	
Type	Ferric Chloride w/ Polymer (past) PACl w/ Polymer (future) Lime (Temporarily)
$FeCl_3$ Dose (Average)	109.8 lbs/MG
$FeCl_3$ Dose (Maximum)	453.2 lbs/MG
Polymer	
PURIFICATION UNITS	
Type	Upflow Sedimentation / Filtration Units
Number	10 Integral Units
Manufacturer	Dorr-Oliver Hydrotreator
DEEP WELL	
Size	12' x 12' x 10' deep
Pumps	Two 10-HP, 690 gpm @ 30' TDH
WASHWATER HOLDING TANKS	
Number of Tanks	2 @ 70' Diam.
Tank No. 1 Volume	250,000 gallons
Tank No. 2 Volume	290,000 gallons
Supernatant Pumps:	
Tank No. 1	Two 50-HP, 2100 gpm @ 60' TDH
Tank No. 2	Three 40-HP, 2100 gpm @ 60' TDH
Sludge Pumps:	
Tank No. 1	Two 15-HP, 350 gpm @ 30' TDH
Tank No. 2	Two 15-HP, 350 gpm @ 30' TDH
SLUDGE LAGOONS	
Number of Lagoons	4
Lagoon No. 1 Volume	1.4 MG
Lagoon No. 2 Volume	1.9 MG
Lagoon No. 3 Volume	1.6 MG

TABLE 1. BASIS OF DESIGN OF RESIDUAL SOLIDS FACILITIES

Lagoon No. 4 Volume	0.5 MG

SUPERNATANT VAULT

Size	12' x 14' x 8' deep
Pumps	Two 40-HP, 1000 gpm @ 88' TDH

CURRENT SLUDGE PRODUCTION

Average	11,870 dry lbs/d @ 31.1 MGD (382 dry lbs/MG)
Maximum	76,663 dry lbs/d @ 24.5 MGD (3,129 dry lbs/MG)

B. PROPOSED IN RFP

FLOWS

Average Daily (Expected Future)	35 MGD
Rated Capacity	40 MGD
Raw Water Turbidity (Average)	24.9 NTU
Raw Water Turbidity (Maximum)	232 NTU
Suspended Solids : Turbidity Ratio	1.5 : 1

COAGULANTS

Type	Ferric Chloride or PACl w/ Polymer.
FeCl3 Dose (Average)	109.8 lbs/MG
FeCl3 Dose (Maximum)	453.2 lbs/MG
Polymer	

PROJECTED SLUDGE PRODUCTION

	Average	Maximum
Plant Flow Rate (MGD)	31.1	24.5
F3Cl3 Dose (lbs/MG)	109.8	453.2
Polymer Dose (lbs/MG)	18.5	13
Raw Water Turbidity (NTU)	24.9	232
TSS:NTU	1.5:1	1.5:1
Total Residuals - Dry weight (lbs/d)	11,870	76.663

SLUDGE THICKENERS (Existing Wash Water Waste Holding Tanks)

Feed (Settled) Sludge Solids Content	0.40%
Average Residual Dry Mass (lbs/d)	9,496
Average Residual Flow @ 0.4% (gpd)	284,000
Maximum Residual Dry Mass (lbs/d)	76,663
Maximum Residual Flow @ 0.4% (gpd)	2,500,000
Surface Overflow Rate	

TABLE 1. BASIS OF DESIGN OF RESIDUAL SOLIDS FACILITIES

WASH WATER WASTE LAGOONS (Existing Sludge Lagoons)

Average Washwater Flow (MGD)	1.1
Average Washwater Dry Solids (lbs/d)	2,374
Maximum Washwater Flow (MGD)	2.5
Concentrated Solids Content	5%

TABLE 2. SUMMARIZED KRS OPERATING DATA

	Maximum	Average	Minimum	No. of Entries	Possible Entries	Max Lookup Date	Min Lookup Date
Water Treated (MGD)	54.92	30.6	16.08	1216	1216	18-Aug-94	21-Mar-97
Wash Water (1,000 gpd)	2420	921.6	90	1216	1216	21-Jan-94	19-May-95
Water Temperature (^{o}F)	83.9	59.6	35	1216	1216	23-Aug-95	20-Jan-94
Rainfall (inches)	3.38	0.1	0	1216	1216	8-Mar-95	1-Jan-94
Raw Turbidity (NTU)	598	35.8	1.4	1216	1216	2-Mar-97	17-Aug-95
Turbidity Settled (NTU)	18	4.8	1.5	1216	1216	21-Jan-94	19-Nov-96
Turbidity Finished (NTU)	1.6	0.1	0	1216	1216	21-Jan-94	27-Jan-94
Ferric Chloride (dry lbs/d)	14225	3777.8	91	1071	1216	22-Jan-94	28-Jan-94
Ferric Chloride (dry ppm)	73.5	16.3	0.4	1071	1216	2-Mar-97	7-Dec-95
PACl (SternPAC, lbs/d)	24158	4920.3	93	179	1216	3-Mar-97	8-Dec-95
PACl (SternPAC, ppm)	83.7	20.6	0.3	179	1216	5-Feb-97	22-Aug-96
Aluminum Sulfate (dry lbs/d)	12949	5875.2	688	19	1216	6-Feb-97	23-Aug-96
Aluminum Sulfate (dry ppm)	69.9	26.9	3.0	19	1216	9-Jan-94	22-Mar-96
Quick Lime (lbs/d)	25659	2491.4	38.4	1015	1216	10-Jan-94	23-Mar-96
Quick Lime (ppm)	132.5	10.9	0.1	1015	1216	2-Mar-97	9-Nov-95
Coagulant Aid Polymer (lbs/d)	2140	396.8	20	1200	1216	3-Mar-97	10-Nov-95
Coagulant Aid Polymer (ppm)	10.5	1.6	0.1	1200	1216	27-Mar-95	24-Aug-94
Other Polymer (ppm)	100	29.0	1	252	1216	28-Mar-95	25-Aug-94
Other Polymer (ppm)	0.5	0.1	0.0	252	1216	30-Apr-96	20-Jan-97
Past Sludge Generation (actual lbs/d)	183640	14611	1440	1216	1216	2-Mar-97	17-Nov-94
Future Sludge Generation (PACl, no lime lbs/d)	176522	13322	1322	1216	1216	2-Mar-97	17-Nov-94
New Sludge Generation Projection (lbs/d)	178067	13772	1412	1216	1216	2-Mar-97	17-Nov-94

TABLE 3. RESIDUAL SOLIDS PROJECTION

Parameter	Peaking Factor	Projected Sludge Production						
		Total	Settled		Thickened		Dewatered	
				(gpd)		(gpd)		(gpd)
		(dry lbs/d)	(dry lbs/d)	(@ 0.4%)	(dry lbs/d)	(@ 2%)	(dry lbs/d)	(@ 20%)
Avg Daily @ 30.6 MGD (w/ Ferric)		14,611	12,697	380,605	12,443	74,599	11,821	7,087
Avg Daily @ 35 MGD (w/ Ferric)	1	16,697	14,507	434,874	14,217	85,235	13,506	8,097
Max Day	12.6	210,378	208,189	6,240,664	204,025	1,223,170	193,824	116,201
Max 2-Day	11.6	193,681	191,492	5,740,165	187,662	1,125,072	178,279	106,882
Max 3-Day	10.7	178,654	176,465	5,289,715	172,936	1,036,784	164,289	98,495
Max 4-Day	9.75	162,792	160,603	4,814,241	157,391	943,591	149,521	89,641
Max 5-Day	9	150,270	148,081	4,438,867	145,119	870,018	137,863	82,652
Max 6-Day	8.3	138,582	136,393	4,088,518	133,665	801,349	126,982	76,128
Max Week	7.7	128,564	126,375	3,788,218	123,847	742,491	117,655	70,537
Max 8-Day	7.2	120,216	118,027	3,537,969	115,666	693,442	109,883	65,877
Max 9-Day	6.75	112,702	110,513	3,312,744	108,303	649,298	102,888	61,683
Max 10-Day	6.3	105,189	103,000	3,087,519	100,940	605,154	95,893	57,490
Max 11-Day	6	100,180	97,991	2,937,370	96,031	575,724	91,229	54,694
Max 12-Day	5.7	95,171	92,982	2,787,220	91,122	546,295	86,566	51,898
Max 13-Day	5.45	90,997	88,807	2,662,095	87,031	521,771	82,680	49,568
Max 14-Day	5.25	87,657	85,468	2,561,995	83,759	502,151	79,571	47,704
Max 15-Day	5.05	84,318	82,129	2,461,895	80,486	482,532	76,462	45,840
Max 16-Day	4.85	80,979	78,790	2,361,796	77,214	462,912	73,353	43,977
Max 17-Day	4.7	78,474	76,285	2,286,721	74,759	448,197	71,021	42,579
Max 18-Day	4.6	76,805	74,615	2,236,671	73,123	438,387	69,467	41,647
Max 19-Day	4.5	75,135	72,946	2,186,621	71,487	428,578	67,912	40,715
Max 20-Day	4.4	73,465	71,276	2,136,571	69,850	418,768	66,358	39,783
Max 21-Day	4.3	71,796	69,606	2,086,521	68,214	408,958	64,804	38,851
Max 22-Day	4.2	70,126	67,937	2,036,471	66,578	399,148	63,249	37,919
Max 23-Day	4.15	69,291	67,102	2,011,446	65,760	394,243	62,472	37,453
Max 24-Day	4.05	67,621	65,432	1,961,396	64,124	384,434	60,917	36,521
Max 25-Day	3.95	65,952	63,763	1,911,346	62,487	374,624	59,363	35,589
Max 26-Day	3.85	64,282	62,093	1,861,297	60,851	364,814	57,808	34,657
Max 27-Day	3.8	63,447	61,258	1,836,272	60,033	359,909	57,031	34,191
Max 28-Day	3.7	61,778	59,588	1,786,222	58,397	350,099	55,477	33,259
Max 29-Day	3.65	60,943	58,754	1,761,197	57,578	345,195	54,700	32,793
Max-Month	3.55	59,273	57,084	1,711,147	55,942	335,385	53,145	31,862
Max 31-Day	3.51	58,605	56,416	1,691,127	55,288	331,461	52,523	31,489
Max 32-Day	3.47	57,937	55,748	1,671,107	54,633	327,537	51,902	31,116
Max 33-Day	3.43	57,270	55,080	1,651,087	53,979	323,613	51,280	30,743
Max 34-Day	3.39	56,602	54,412	1,631,067	53,324	319,689	50,658	30,370
Max 35-Day	3.35	55,934	53,745	1,611,047	52,670	315,765	50,036	29,998
Max 36-Day	3.32	55,433	53,244	1,596,032	52,179	312,822	49,570	29,718
Max 37-Day	3.29	54,932	52,743	1,581,017	51,688	309,879	49,103	29,439
Max 38-Day	3.26	54,431	52,242	1,566,002	51,197	306,936	48,637	29,159
Max 39-Day	3.23	53,930	51,741	1,550,987	50,706	303,993	48,171	28,879
Max 40-Day	3.2	53,429	51,240	1,535,972	50,215	301,051	47,704	28,600

TABLE 4. SUMMARY OF FACILITY REQUIREMENTS

Design Criteria			Thickeners		Dewatering					Storage						
					24 hrs/d		7 hrs/d			Alt. 1 - Sludge Storage (gal)			Alt 2 - Discharge to lagoons			
	Thickening	Dewatering	Existing	New					Storage	Settled	Thickened @ 2%		gal/Event		Annually	
			# @ Diam.	# @ Diam.	lbs/d	gpd	lbs/d	gpd	gal	@ 0.4%	Existing	New	Settled	Thickened	lbs	% of Total
1	Max-Day	Max-Day	2 @ 70′	3 @ 75′	198,400	1,190,000	680,000	4,080,000	843,000	0	173,000	0	0	0	0	0
2	Max 2-Day	Max 2-Day	2 @ 70′	3 @ 70′	183,000	1,100,000	630,000	3,760,000	779,000	470,000	173,000	0	472,000	0	2,585	0.05
3	Max 3-Day	Max 3-Day	2 @ 70′	2 @ 80′	167,500	1,000,000	575,000	3,440,000	708,000	950,000	173,000	0	1,415,000	0	6,430	0.13
4	Max 5-Day	Max 5-Day	2 @ 70′	2 @ 70′	140,000	850,000	485,000	2,900,000	602,000	2,550,000	173,000	0	4,200,000	0	15,340	0.31
5	Max-Week	Max-Week	2 @ 70′	1 @ 80′	121,000	727,000	415,000	2,500,000	515,000	4,250,000	173,000	0	7,550,000	0	37,680	0.76
6	Max 10-Day	Max 10-Day	2 @ 70′	1 @ 60′	100,000	600,000	340,000	2,050,000	425,000	6,605,000	173,000	0	12,740,000	0	76,000	1.54
7	**Max 15-Day**	**Max 15-Day**	**2 @ 70′**	-	**80,500**	**480,000**	**276,000**	**1,650,000**	**342,000**	**9,900,000**	**173,000**	**0**	**20,800,000**	**0**	**161,000**	**3.0**
8	Max 15-Day	Max 20-Day	2 @ 70′		67,000	400,000	230,000	1,380,000	283,000	9,900,000	173,000	676,000	21,000,000	737,000	217,000	4.4
9	Max 15-Day	Max-Month	2 @ 70′	-	55,000	330,000	190,000	1,130,000	234,000	9,900,000	173,000	1,810,000	21,000,000	2,577,000	335,000	6.76

FIGURE 1. PEAKING FACTORS

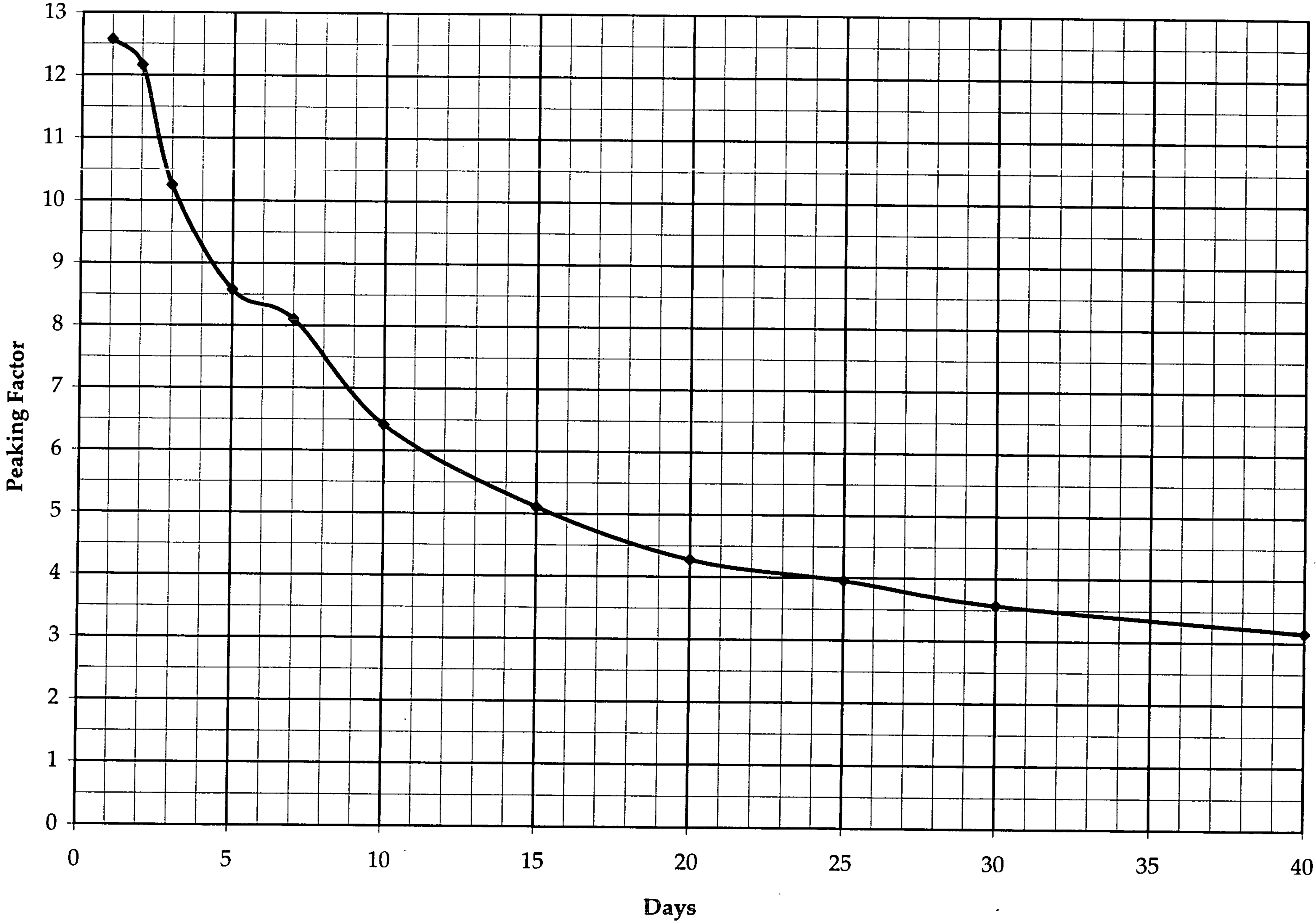


FIGURE 2. PEAKING FACTORS (BEST FIT CURVE)

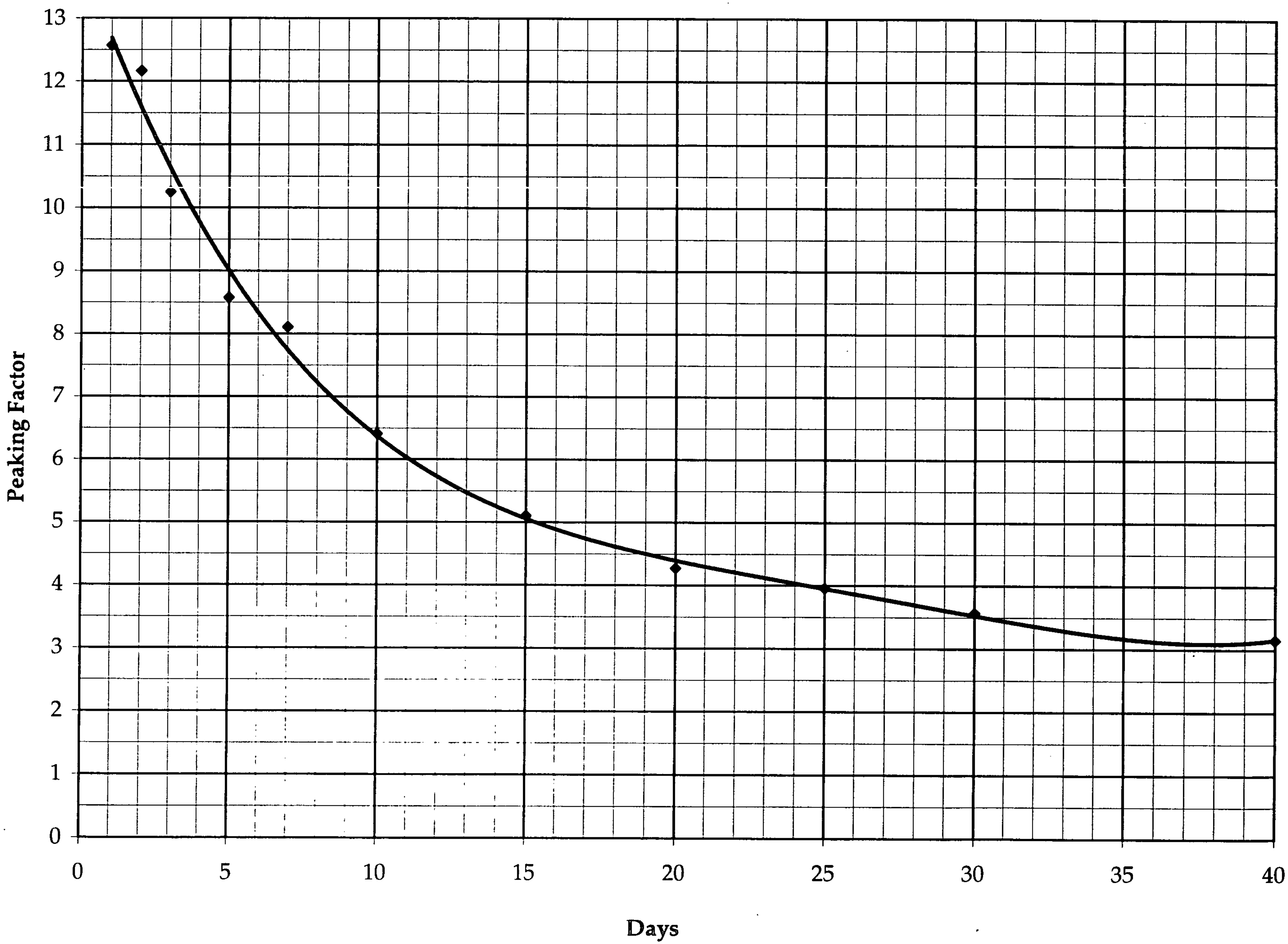


FIGURE 3. PROJECTED MAXIMUM SLUDGE PRODUCTION RATES

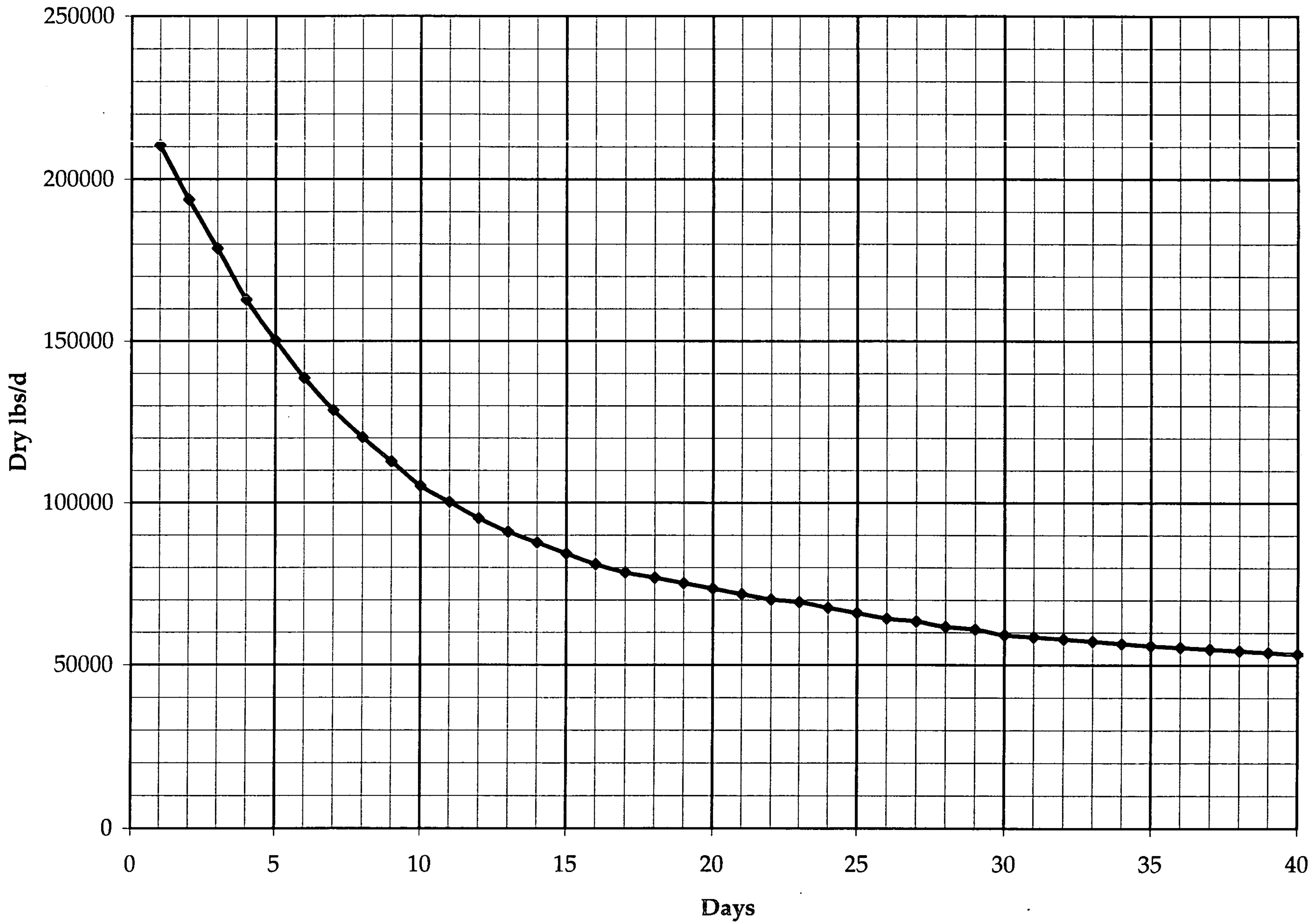
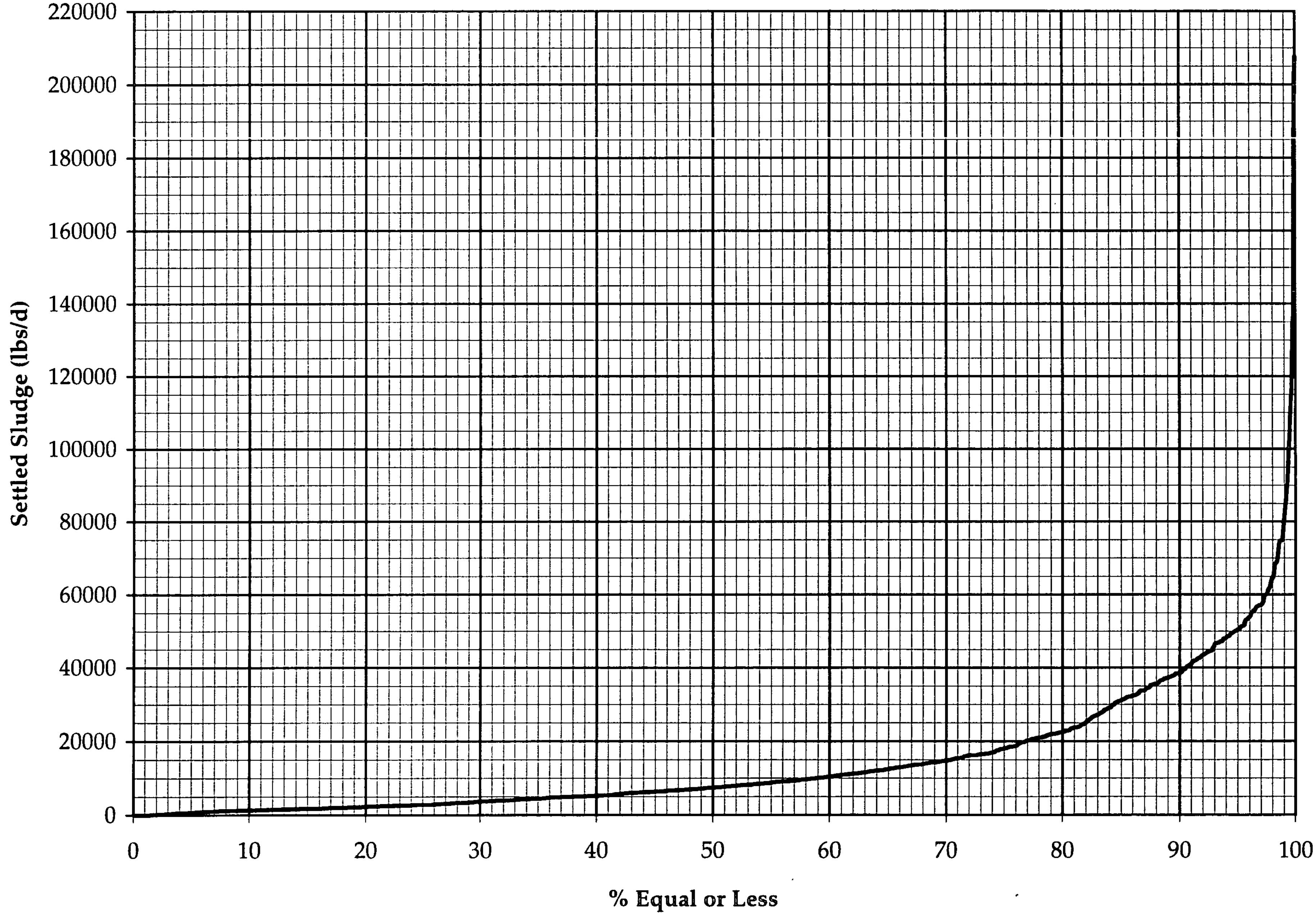


FIGURE 4. PROJECTED SETTLED SLUDGE DISTRIBUTION



Appendix A

STORAGE REQUIREMENTS

Max 2-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs		
1	208189	208189	191492	16697		
2	191492	382984	382984	0		
3	176465	529395	574476	-45081		
4	160603	642412	765968	-123555		
5	148081	740403	957459	-217056		
Storage Required (lbs)				**16697**	(MG @ 0.4%):	**0.500**
Total Storage per Event:				**16697**	(MG @ 0.4%):	**0.500**
Expected Occurrence (percent of time):				0.09%		
Annual Storage or Discharge to Lagoons (lbs):				**2742**	(MG @ 0.4%):	**0.082**
Percent of Total Annual (%)				**0.05**		

Max 3-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs	
1	208189	208189	176465	31724	31724	
2	191492	382984	352930	30054	15027	
3	176465	529395	529395	0	0	
4	160603	642412	705860	-63447		
5	148081	740403	882325	-141922		
Storage Required (lbs)				**31724**	(MG @ 0.4%):	**0.951**
Total Storage per Event:				**46751**	(MG @ 0.4%):	**1.401**
Expected Occurrence (percent of time):				0.11%		
Annual Storage or Discharge to Lagoons (lbs):				**6371**	(MG @ 0.4%):	**0.191**
Percent of Total Annual (%)				**0.12**		

Max 5-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs	
1	208189	208189	148081	60108	60108	
2	191492	382984	296161	86823	43411	
3	176465	529395	444242	85153	28384	
4	160603	642412	592322	50090	12522	
5	148081	740403	740403	0	0	
6	136393	818358	888484	-70126		
7	126375	884625	1036564	-151940		
Storage Required (lbs)				**86823**	(MG @ 0.4%):	**2.603**
Total Storage per Event (lbs):				**144426**	(MG @ 0.4%):	**4.329**
Expected Occurrence (percent of time):				0.15%		
Annual Storage or Discharge to Lagoons (lbs):				**15815**	(MG @ 0.4%):	**0.474**
Percent of Total Annual (%)				**0.30**		

Max Week

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs
1	208189	208189	126375	81814	81814

2	191492	382984	252750	130234	65117
3	176465	529395	379125	150270	50090
4	160603	642412	505500	136913	34228
5	148081	740403	631875	108528	21706
6	136393	818358	758250	60108	10018
7	126375	884625	884625	0	0
8	118027	944213	1011000	-66787	-8348
9	110513	994618	1137375	-142756	-15862
10	103000	1029996	1263750	-233753	
Storage Required (lbs)				**150270**	(MG @ 0.4%): **4.504**
Total Storage per Event (lbs):				**262972**	(MG @ 0.4%): **7.883**
Expected Occurrence (percent of time):				0.28%	
Annual Storage or Discharge to Lagoons (lbs):				**38394**	(MG @ 0.4%): **1.151**
Percent of Total Annual (%)				**0.73**	

Max 10-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs
1	208189	208189	103000	105189	105189
2	191492	382984	205999	176984	88492
3	176465	529395	308999	220396	73465
4	160603	642412	411999	230414	57603
5	148081	740403	514998	225405	45081
6	136393	818358	617998	200360	33393
7	126375	884625	720998	163627	23375
8	118027	944213	823997	120216	15027
9	110513	994618	926997	67621	7513
10	103000	1029996	1029996	0	0
15	82129	1231932	1544995	-313062	
20	71276	1425520	2059993	-634473	
25	61549	1538730	2574991	-1036261	
30	57084	1712516	3089989	-1377474	
40	51240	2049601	4119986	-2070385	
365	14507	5295055	37594871	-32299816	
Storage Required (lbs)				**230414**	(MG @ 0.4%): **6.907**
Total Storage per Event (lbs):				**449140**	(MG @ 0.4%): **13.463**
Expected Occurrence (percent of time):				0.52%	
Annual Storage or Discharge to Lagoons (lbs):				**85247**	(MG @ 0.4%): **2.555**
Percent of Total Annual (%)				**1.61**	

Max 15-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs
1	208189	208189	82129	126060	126060
2	191492	382984	164258	218726	109363
3	176465	529395	246386	283008	94336
4	160603	642412	328515	313897	78474
5	148081	740403	410644	329759	65952
6	136393	818358	492773	325585	54264
7	126375	884625	574902	309723	44246
8	118027	944213	657031	287182	35898
9	110513	994618	739159	255459	28384

10	103000	1029996	821288	208708	20871
11	97991	1077897	903417	174480	15862
12	92982	1115780	985546	130234	10853
13	88807	1154497	1067675	86823	6679
14	85468	1196554	1149804	46751	3339
15	82129	1231932	1231932	0	0
16	78790	1260632	1314061	-53429	-3339
17	76285	1296845	1396190	-99345	-5844
18	74615	1343076	1478319	-135243	-7513
19	72946	1385968	1560448	-174480	-9183
20	71276	1425520	1642577	-217056	-10853
25	63763	1594063	2053221	-459158	
30	57084	1712516	2463865	-751349	
40	51240	2049601	3285153	-1235552	
365	14507	5295055	29977024	-24681969	

Storage Required (lbs) **329759** (MG @ 0.4%): **9.885**
Total Storage per Event (lbs): **694581** (MG @ 0.4%): **20.821**
Expected Occurrence (percent of time): 0.95%
Annual Storage or Discharge to Lagoons (lbs): **160564** (MG @ 0.4%): **4.813**
Percent of Total Annual (%) **3.03**

Max 20-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs
1	208189	208189	71276	136913	136913
2	191492	382984	142552	240432	120216
3	176465	529395	213828	315567	105189
4	160603	642412	285104	357308	89327
5	148081	740403	356380	384023	76805
6	136393	818358	427656	390702	65117
7	126375	884625	498932	385693	55099
8	118027	944213	570208	374005	46751
9	110513	994618	641484	353134	39237
10	103000	1029996	712760	317236	31724
11	97991	1077897	784036	293861	26715
12	92982	1115780	855312	260468	21706
13	88807	1154497	926588	227909	17531
14	85468	1196554	997864	198690	14192
15	82129	1231932	1069140	162792	10853
16	78790	1260632	1140416	120216	7513
17	76285	1296845	1211692	85153	5009
18	74615	1343076	1282968	60108	3339
19	72946	1385968	1354244	31724	1670
20	71276	1425520	1425520	0	0
25	63763	1594063	1781900	-187837	
30	57084	1712516	2138280	-425765	
40	51240	2049601	2851040	-801439	
365	14507	5295055	26015744	-20720689	

Storage Required (lbs) **390702** (MG @ 0.4%): **11.712**
Total Storage per Event (lbs): **874904** (MG @ 0.4%): **26.226**
Expected Occurrence (percent of time): 1.50%
Annual Storage or Discharge to Lagoons (lbs): **239505** (MG @ 0.4%): **7.179**
Percent of Total Annual (%) **4.52**

Max Month

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs
1	208189	208189	57084	151105	151105
2	191492	382984	114168	268816	134408
3	176465	529395	171252	358143	119381
4	160603	642412	228335	414077	103519
5	148081	740403	285419	454984	90997
6	136393	818358	342503	475855	79309
7	126375	884625	399587	485038	69291
8	118027	944213	456671	487542	60943
9	110513	994618	513755	480864	53429
10	103000	1029996	570839	459158	45916
11	97991	1077897	627922	449975	40907
12	92982	1115780	685006	430774	35898
13	88807	1154497	742090	412407	31724
14	85468	1196554	799174	397380	28384
15	82129	1231932	856258	375675	25045
16	78790	1260632	913342	347290	21706
17	76285	1296845	970426	326420	19201
18	74615	1343076	1027509	315567	17531
19	72946	1385968	1084593	301375	15862
20	71276	1425520	1141677	283843	14192
21	69606	1461733	1198761	262972	12522
22	67937	1494607	1255845	238762	10853
23	67102	1543343	1312929	230414	10018
24	65432	1570372	1370013	200360	8348
25	63763	1594063	1427096	166967	6679
26	62093	1614414	1484180	130234	5009
27	61258	1653967	1541264	112702	4174
28	59588	1668474	1598348	70126	2504
29	58754	1703852	1655432	48420	1670
30	57084	1712516	1712516	0	0
40	51240	2049601	2283354	-233753	
365	14507	5295055	20835608	-15540553	

Storage Required (lbs)	**487542**	(MG @ 0.4%):	**14.615**
Total Storage per Event (lbs):	**1220525**	(MG @ 0.4%):	**36.586**
Expected Occurrence (percent of time):	3.00%		
Annual Storage or Discharge to Lagoons (lbs):	**445492**	(MG @ 0.4%):	**13.354**
Percent of Total Annual (%)	**8.41**		

Max 40-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs
1	208189	208189	51240	156949	156949
2	191492	382984	102480	280504	140252
3	176465	529395	153720	375675	125225
4	160603	642412	204960	437452	109363
5	148081	740403	256200	484203	96841
6	136393	818358	307440	510917	85153
7	126375	884625	358680	525944	75135

8	118027	944213	409920	534293	66787
9	110513	994618	461160	533458	59273
10	103000	1029996	512400	517596	51760
11	97991	1077897	563640	514257	46751
12	92982	1115780	614880	500900	41742
13	88807	1154497	666120	488377	37567
14	85468	1196554	717360	479194	34228
15	82129	1231932	768600	463332	30889
16	78790	1260632	819840	440792	27549
17	76285	1296845	871081	425765	25045
18	74615	1343076	922321	420756	23375
19	72946	1385968	973561	412407	21706
20	71276	1425520	1024801	400720	20036
21	69606	1461733	1076041	385693	18366
22	67937	1494607	1127281	367326	16697
23	67102	1543343	1178521	364822	15862
24	65432	1570372	1229761	340612	14192
25	63763	1594063	1281001	313062	12522
26	62093	1614414	1332241	282173	10853
27	61258	1653967	1383481	270486	10018
28	59588	1668474	1434721	233753	8348
29	58754	1703852	1485961	217891	7513
30	57084	1712516	1537201	175315	5844
31	56416	1748896	1588441	160455	5176
32	55748	1783940	1639681	144259	4508
33	55080	1817649	1690921	126728	3840
34	54412	1850021	1742161	107860	3172
35	53745	1881058	1793401	87657	2504
36	53244	1916771	1844641	72130	2004
37	52743	1951481	1895881	55600	1503
38	52242	1985190	1947121	38068	1002
39	51741	2017896	1998361	19535	501
40	51240	2049601	2049601	0	0
365	14507	5295055	18702611	-13407556	-36733

Storage Required (lbs)	**534293**	(MG @ 0.4%):	**16.016**
Total Storage per Event (lbs):	**1420050**	(MG @ 0.4%):	**42.567**
Expected Occurrence (percent of time):	4.70%		
Annual Storage or Discharge to Lagoons (lbs):	**812032**	(MG @ 0.4%):	**24.341**
Percent of Total Annual (%)	**15.34**		

Thickening Max 15-Day / Dewatering Max 20-Day

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Settled Solids lbs/d	Settled Solids to be Stored lbs	Excess Settled Solids lbs	Processed Thickened Solids lbs/d	Thickened Solids to be Stored lbs	Additional Thickened Storage lbs	Excess Thickened Solids lbs
1	208189	208189	82129	126060	126060	71276	10853	-18003	10853
2	191492	382984	164258	218726	109363	142552	21706	-7150	10853
3	176465	529395	246386	283008	94336	213828	32558	3702	10853
4	160603	642412	328515	313897	78474	285104	43411	14555	10853
5	148081	740403	410644	329759	65952	356380	54264	25408	10853
6	136393	818358	492773	325585	54264	427656	65117	36261	10853
7	126375	884625	574902	309723	44246	498932	75970	47114	10853
8	118027	944213	657031	287182	35898	570208	86823	57967	10853
9	110513	994618	739159	255459	28384	641484	97675	68819	10853

10	103000	1029996	821288	208708	20871	712760	108528	79672	10853
11	97991	1077897	903417	174480	15862	784036	119381	90525	10853
12	92982	1115780	985546	130234	10853	855312	130234	101378	10853
13	88807	1154497	1067675	86823	6679	926588	141087	112231	10853
14	85468	1196554	1149804	46751	3339	997864	151940	123084	10853
15	82129	1231932	1231932	0	0	1069140	162792	133936	10853
16	78790	1260632	1314061	-53429	-3339	1140416	120216	91360	7513
17	76285	1296845	1396190	-99345	-5844	1211692	85153	56297	5009
18	74615	1343076	1478319	-135243	-7513	1282968	60108	31252	3339
19	72946	1385968	1560448	-174480	-9183	1354244	31724	2868	1670
20	71276	1425520	1642577	-217056	-10853	1425520	0	-28856	0
25	63763	1594063	2053221	-459158		1781900	-187837	-216693	-7513
30	57084	1712516	2463865	-751349		2138280	-425765	-454621	-14192
40	51240	2049601	3285153	-1235552		2851040	-801439	-830295	
365	14507	5295055	29977024	-24681969		26015744	-20720689	-20749545	

Settled Sludge:

Storage Required (lbs)	**329759**	(MG @ 0.4%):	**9.885**
Total Storage per Event (lbs):	**694581**	(MG @ 0.4%):	**20.821**
Expected Occurrence (percent of time):	0.95%		
Annual Storage or Discharge to Lagoons (lbs):	**160564**	(MG @ 0.4%):	**4.813**
Percent of Total Annual (%)	**3.03**		

Thickened Sludge:

Storage Required (lbs)	**133936**	(MG @ 2%):	**0.803**
Total Storage per Event (lbs):	**143954**	(MG @ 2%):	**0.863**
Expected Occurrence (percent of time):	1.50%		
Annual Storage or Discharge to Lagoons (lbs):	**39407**	(MG @ 0.4%):	**1.181**
Percent of Total Annual (%)	**0.74**		

Thickening Max 15-Day / Dewatering Max-Month

Days	Peak Settled lbs/d	Cumulated Solids lbs/d	Processed Solids lbs/d	Solids to be Stored lbs	Excess Solids lbs	Processed Thickened Solids lbs/d	Thickened Solids to be Stored lbs	Additional Thickened Storage lbs	Excess Thickened Solids lbs
1	208189	208189	82129	126060	126060	57084	25045	-3811	25045
2	191492	382984	164258	218726	109363	114168	50090	21234	25045
3	176465	529395	246386	283008	94336	171252	75135	46279	25045
4	160603	642412	328515	313897	78474	228335	100180	71324	25045
5	148081	740403	410644	329759	65952	285419	125225	96369	25045
6	136393	818358	492773	325585	54264	342503	150270	121414	25045
7	126375	884625	574902	309723	44246	399587	175315	146459	25045
8	118027	944213	657031	287182	35898	456671	200360	171504	25045
9	110513	994618	739159	255459	28384	513755	225405	196549	25045
10	103000	1029996	821288	208708	20871	570839	250450	221594	25045
11	97991	1077897	903417	174480	15862	627922	275495	246639	25045
12	92982	1115780	985546	130234	10853	685006	300540	271684	25045
13	88807	1154497	1067675	86823	6679	742090	325585	296729	25045
14	85468	1196554	1149804	46751	3339	799174	350630	321774	25045
15	82129	1231932	1231932	0	0	856258	375675	346819	25045
16	78790	1260632	1314061	-53429	-3339	913342	347290	318434	21706
17	76285	1296845	1396190	-99345	-5844	970426	326420	297564	19201
18	74615	1343076	1478319	-135243	-7513	1027509	315567	286711	17531
19	72946	1385968	1560448	-174480	-9183	1084593	301375	272519	15862
20	71276	1425520	1642577	-217056	-10853	1141677	283843	254987	14192
21	69606	1461733	1724705	-262972	-12522	1198761	262972	234116	12522

22	67937	1494607	1806834	-312227	-14192	1255845	238762	209906	10853
23	67102	1543343	1888963	-345621	-15027	1312929	230414	201558	10018
24	65432	1570372	1971092	-400720	-16697	1370013	200360	171504	8348
25	63763	1594063	2053221	-459158	-18366	1427096	166967	138111	6679
26	62093	1614414	2135350	-520935	-20036	1484180	130234	101378	5009
27	61258	1653967	2217478	-563512	-20871	1541264	112702	83846	4174
28	59588	1668474	2299607	-631133	-22540	1598348	70126	41270	2504
29	58754	1703852	2381736	-677884	-23375	1655432	48420	19564	1670
30	57084	1712516	2463865	-751349	-25045	1712516	0	-28856	0
40	51240	2049601	3285153	-1235552	-30889	2283354	-233753	-262609	-5844
365	14507	5295055	29977024	-24681969	-67622	20835608	-15540553	-15569409	-42577

Settled Sludge:

Storage Required (lbs) **329759** (MG @ 0.4%): **9.885**

Total Storage per Event (lbs): **694581** (MG @ 0.4%): **20.821**

Expected Occurrence (percent of time): 0.95%

Annual Storage or Discharge to Lagoons (lbs): **160564** (MG @ 0.4%): **4.813**

Percent of Total Annual (%) **3.03**

Thickened Sludge:

Storage Required (lbs) **346819** (MG @ 2%): **2.079**

Total Storage per Event (lbs): **497088** (MG @ 2%): **2.980**

Expected Occurrence (percent of time): 3.00%

Annual Storage or Discharge to Lagoons (lbs): **181437** (MG @ 0.4%): **5.439**

Percent of Total Annual (%) **3.43**

Appendix B

UNIT PROCESS CAPACITY REQUIREMENTS

Projected Maximum Sludge Production:

	Settled		Thickened		Dewatered	
Days	lbs/d	gpd @ 0.4%	(dry lbs/d)	(gpd @ 2%)	(dry lbs/d)	(gpd @ 20%)
1	208188.54	6240663.7	204024.77	1223170.1	193823.53	116201.1584
2	191491.89	5740164.6	187662.05	1125072.3	178278.95	106881.8651
3	176464.91	5289715.4	172935.61	1036784.2	164288.83	98494.50107
4	160603.09	4814241.3	157391.03	943591.29	149521.48	89641.17242
5	148080.6	4438866.9	145118.99	870017.92	137863.04	82651.70242
6	136392.95	4088517.6	133665.09	801349.44	126981.83	76128.19709
7	126374.96	3788218.1	123847.46	742490.75	117655.08	70536.6211
10	102999.65	3087519.4	100939.65	605153.79	95892.67	57489.61045
15	82128.833	2461895.5	80486.256	482531.51	76461.944	45840.49379
20	71276.011	2136571.1	69850.49	418767.93	66357.966	39782.95313
25	63762.518	1911346.5	62487.268	374623.91	59362.904	35589.27113
30	57083.858	1711146.8	55942.181	335384.78	53145.072	31861.5538
40	51240.03	1535972.1	50215.23	301050.54	47704.468	28599.80114
365	14,507	434,874	14,217	85,235	13,506	8,097

Existing Thickener Capacity:

Total Area :	7,700	sf	
Based on 300 gpd/sf:	2.31	MGD	
Based on 10 lb/d-sf:	77,000	lbs/d	
Storage Capacity @ 3':	172,811	gallons	(=28,825 lbs @ 2%)

Size for: Thickeners max 15-day / Dewatering max 15-day:

Thickener Capacity Required:

Based on 300 gpd/sf:	8,206	sf
Based on 10 lb/d-sf:	8,213	sf
Storage Capacity (@ 0.4%):	9,885,000	gallons

Additional Thickeners:

Total Area:	513	sf

No Additional Tanks Required

Dewatering Facility Requirements:

Rated Capacity (7 days/week):

A. 24 hrs/d operation

Solids Loading:	80,486	lbs/d
Flow Loading:	482,532	gpd

A. 7 hrs/d operation

Solids Loading:	275,953	lbs/d

Flow Loading: 1,654,394 gpd

Sludge to be Stored or to be Discharged to the Lagoons:

Per Event:

Per Event:	Settled	694,581 lbs	20.821 MG (@ 0.4%)
	Thickened	0	0
Per Year:	Settled	160,564 lbs	4.813 MG (@ 0.4%)
	Thickened	0	0

99-299

KENTUCKY-AMERICAN WATER COMPANY
LEXINGTON, KENTUCKY

RECEIVED
JUL 9 1999
PUBLIC SERVICE
COMMISSION

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

JUNE 1999

DRAWING FILE NO. 380-575

LIST OF DRAWINGS

MONTGOMERY WATSON
CLEVELAND, OHIO

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
19947
REGISTERED
PROFESSIONAL ENGINEER

RICHARD G. ATOULIKIAN
REGISTERED PROFESSIONAL ENGINEER IN
STATE OF KENTUCKY, LICENSE NO. 19947

- MASONRY
- CAST IRON
- STEEL
- BRONZE
- INSULATION
- GRAVEL
- CONCRETE
- EARTH
- SAND
- ALUMINUM OR METAL DECKING
- CHECKERED PLATE
- SPAN — GRATING
- PLASTIC, RUBBER OR NEOPRENE
- WOOD (FINISH)
- WOOD (ROUGH FRAMING) OR, OPENING OR DEPRESSION IN SLAB OR WALL
- 12x24 — DUCT (FIRST DIMENSION DUCT SIDE SHOWN, SECOND DIMENSION DUCT SIDE NOT SHOWN)
- 24x12 — SUPPLY OR OUTSIDE AIR DUCT (FIRST DIMENSION, DUCT WIDTH)
- 24x12 — RETURN AIR DUCT (FIRST DIMENSION, DUCT WIDTH)
- SIZE / CFM — CEILING SUPPLY DIFFUSER (SIZE IN INCHES)
- SIZE / CFM — CEILING RETURN AIR GRILLE OR REGISTER (SIZE IN INCHES, WIDTH X HEIGHT)
- SIZE / CFM — EXHAUST OR RETURN AIR GRILLE OR REGISTER (SIZE IN INCHES, WIDTH X HEIGHT)
- SIZE / CFM — SUPPLY GRILLE OR REGISTER (SIZE IN INCHES, WIDTH X HEIGHT)
- AIR TURNING VANES IN DUCT
- FH — FIRE HOSE CABINET
- FE — FIRE EXTINGUISHER
- UNIT HEATER
- CENTERLINE
- PROPERTY LINE
- NEW STRUCTURE OR FACILITY
- EXISTING STRUCTURE OR FACILITY (DASHED OR SCREENED)
- FUTURE STRUCTURE OR FACILITY
- NEW FENCE
- EXISTING FENCE
- NEW PIPELINE (CIVIL SHEETS)
- EXISTING PIPELINE (DASHED OR SCREENED)
- LOWER PIPE / TYPICAL YARD PIPE CROSSING / HIGHER PIPE

- 123 — CONTOUR LINE, FINISHED GRADE
- 123 — CONTOUR LINE, EXISTING GRADE
- 123.20 — FINISHED ELEVATION
- (123.20) — EXISTING ELEVATION
- TOP / TOE — CUT OR FILL SLOPE TO BE CONSTRUCTED
- NEW A.C. PAVING
- EXISTING A.C. PAVING (DASHED OR SCREENED)
- RAILING
- FH — FIRE HYDRANT
- MH — MANHOLE
- SD — STORM DRAIN MANHOLE
- SS — SANITARY SEWER MANHOLE
- STRUCTURE UNDERDRAIN COLLECTION INSPECTION WELL
- PCOTG — PRESSURE CLEANOUT TO GRADE
- WCO — WALL CLEANOUT
- FCO — FLOOR CLEANOUT
- COTG — CLEANOUT TO GRADE
- BLOW OFF ASSEMBLY
- HUB DRAIN
- FLOOR DRAIN
- FLOOR SINK
- DRAIN TRAP
- SOIL BORING
- BENCH MARK
- HORIZONTAL AND VERTICAL CONTROL POINT
- VAULT OR JUNCTION STRUCTURE
- CHANGE IN PIPING MATERIAL
- ROUND OR DIAMETER
- SQUARE
- AT
- ANGLE
- 24" RW-RCP — PIPE SIZE, FLUID ABBREVIATION AND TYPE OF PIPE
- 2" UW (2) — PIPE IDENTIFICATION (SEE PIPING SCHEDULE)
- EQUIPMENT DESIGNATION (SEE EQUIPMENT SCHEDULE)
- BACKWATER VALVE
- BACKFLOW PREVENTER
- STOP GATE
- SLIDE GATE
- SLUICE GATE

- GATE VALVE, BURIED WITH VALVE BOX
- BUTTERFLY VALVE, BURIED WITH VALVE BOX
- ECCENTRIC PLUG VALVE, BURIED WITH VALVE BOX
- LUBRICATED PLUG VALVE, BURIED WITH VALVE BOX
- GATE VALVE
- BUTTERFLY VALVE
- ECCENTRIC PLUG VALVE
- LUBRICATED PLUG VALVE
- GLOBE VALVE
- BALL VALVE
- DIAPHRAGM VALVE
- BALL CHECK VALVE
- CHECK VALVE
- PRESSURE REDUCING VALVE
- PRESSURE REGULATING VALVE
- BACK-PRESSURE VALVE
- M / A — MOTOR OPERATOR FOR VALVES (M = ELECTRIC, A = AIR)
- T — TEMPERATURE CONTROL VALVE
- S — SOLENOID VALVE
- MULTIPORT VALVE - 3 WAY
- MULTIPORT VALVE - 4 WAY
- FLOAT OPERATED VALVE
- NEEDLE VALVE
- PRESSURE RELIEF VALVE
- ANGLE VALVE
- HOSE BIBB (H/B)
- B — BUBBLER LEVEL CONTROL
- CENTRIFUGAL OR TURBINE PUMP OR FAN
- METERING PUMP
- BLOWER OR COMPRESSOR
- INJECTOR OR EDUCTOR
- FA — FLAME ARRESTER
- AIR VACUUM AND AIR RELEASE ASSEMBLY
- AIR RELEASE AND ENCLOSURE
- THERMOMETER
- PIPE ANCHOR
- FG — FLOW SIGHT GLASS
- VACUUM REGULATOR/CHECK UNIT

- T — ROOM THERMOSTAT
- G — PRESSURE GAUGE
- G — PRESSURE GAUGE WITH DIAPHRAGM SEAL
- S — PRESSURE SWITCH
- S — PRESSURE SWITCH WITH DIAPHRAGM SEAL
- FLANGED FITTING
- WELDED FITTING
- MECHANICAL-TYPE FITTING (GROOVED)
- SCREWED, SOCKET-WELD, BELL AND SPIGOT OR HUBLESS FITTING
- SLEEVE-TYPE COUPLING
- FLANGED ADAPTER COUPLING
- FLANGED ADAPTER - SET SCREW TYPE
- EXPANSION JOINT
- MECHANICAL TYPE COUPLING
- FLEXIBLE COUPLING
- UNION
- QUICK DISCONNECT COUPLER
- CAPPED END OR PLUGGED END
- BLIND FLANGE
- REDUCER OR INCREASER
- CUT PIPE
- STRAINER OR GAS FILTER
- DRAIN
- FLOW TUBE
- ULTRASONIC METER
- FM — MAGNETIC METER
- DM — DENSITY METER
- PM — PROPELLER METER
- ORIFICE PLATE AND FLANGES
- SD — ROTAMETER
- T — CONDENSATE TRAP
- PIPE SUPPORT (IN PLAN ONLY)
- CB — CATCH BASIN
- PULSATION DAMPENER
- EXPANSION CHAMBER WITH RUPTURE DISC
- RUPTURE DISC

PLAN IDENTIFICATION

PLAN AT FL. EL. 27.0

SCALE: 1/4" = 1'-0"

MATCHLINE IDENTIFICATION

MATCH LINE Y — MATCH LINE DESIGNATOR

(X-DDD) — SHEET NO. CONTINUED ON

SECTION AND DETAIL IDENTIFICATION

SECTION IDENTIFICATION

2 / 00 — SECTION NUMBER; DRAWING ON WHICH SECTION IS SHOWN

SECTION 2 / 00 — DRAWING ON WHICH SECTION IS TAKEN

DETAIL IDENTIFICATION

A / 00 — DETAIL LETTER; SHEET ON WHICH DETAIL IS SHOWN

DETAIL A / 00 — SHEET ON WHICH DETAIL IS CALLED-OUT

STANDARD DETAIL IDENTIFICATION

S-103 — INDICATES STANDARD DETAIL

DETAIL S-103 — INDICATES STANDARD DETAIL ON STANDARD DRAWINGS SEE STANDARD DETAILS

NOTE:
IF PLAN AND SECTION (OR DETAIL CALL-OUT AND DETAIL) ARE SHOWN ON THE SAME DRAWING, DRAWING NUMBER IS REPLACED BY A LINE.

DATE	REVISIONS

STATE OF KENTUCKY — RICHARD GEORGE ATOLIKIAN — 19947 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

GENERAL
GENERAL SYMBOLS AND NOTES

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-002

A	AIR
AA	AQUEOUS AMMONIA
AB	ANCHOR BOLT (CAST IN PLACE)
ABBR	ABBREVIATION
ABS	ABSOLUTE TEMPERATURE
AC	ACTIVATED CARBON, ASPHALTIC CONCRETE, OR ALTERNATING CURRENT
A/C	AIR CONDITIONING
ACOUS	ACOUSTIC OR ACOUSTICAL
ACP	ASPHALTIC CONCRETE PAVEMENT OR ASBESTOS CEMENT PIPE
AD	AREA DRAIN
ADJ	ADJUSTABLE
AE	ANALYZER
AER	AERATION
AL	ALUMINUM OR ALUM
ALT	ALTERNATE, ALTERNATING
ALUM	ALUMINUM
AMB	AMBIENT
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE (FORMERLY A.S.A.)
API	AMERICAN PETROLEUM INSTITUTE
APPD	APPROVED
APPROX	APPROXIMATE
ARCH	ARCHITECTURAL
ASA	AMERICAN STANDARDS ASSOCIATION (NOW ANSI)
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIAL
ASSY	ASSEMBLY
AT	ACOUSTICAL TILE
ATM	ATMOSPHERE
AVAR	AIR VACUUM AND AIR RELEASE VALVE
AW	FILTER AIR WASH
AWWA	AMERICAN WATER WORKS ASSOCIATION
BC	BEGIN CURVE, BOLT CIRCLE OR BETWEEN CENTERS
BCR	BEGIN CURB RETURN
BD	BOARD
BF	BLIND FLANGE
BFP	BACK FLOW PREVENTER
BHP	BRAKE HORSEPOWER
BLDG	BUILDING
BLD FLG	BLIND FLANGE
BLK	BLACK OR BLOCK
BLKG	BLOCKING
BM	BEAM OR BENCH MARK
B/N	BETWEEN
BO	BLOW-OFF ASSEMBLY
BOD	BIOCHEMICAL OXYGEN DEMAND
BOT	BOTTOM
BPV	BACK PRESSURE VALVE
BRK	BRICK
B & S	BELL AND SPIGOT
BSMT	BASEMENT
BT	BOLT
BTU	BRITISH THERMAL UNIT
BV	BUTTERFLY VALVE
BVC	BEGIN VERTICAL CURVE
BW	FILTER BACKWASH
BWV	BACKWASH VALVE
C	CENTIGRADE
CA	CONCRETE ANCHOR (DRILLED)
CAB	CABINET
CAP	CAPACITY
CAW	CHANNEL AGITATION WATER
CB	CATCH BASIN OR CHALK BOARD
CC	CENTER TO CENTER
CD	CEILING DIFFUSER, CHEMICAL DRAIN OR VENT
CLR	CLEAR
CEM	CEMENT
CER	CERAMIC
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHEM	CHEMICAL
CHG	CHANGE
CHKD PL	CHECKERED PLATE
CI	CAST IRON
CJ	CONSTRUCTION JOINT
CL	CHLORINE GAS, CHLORINATOR, CHAIN LINK, CLEARANCE OR CENTERLINE
CLC	CHEMICAL LINE CONTAINMENT
CLG	CEILING
CLOS	CLOSET
CLR	CLEAR
CLS	CHLORINE SOLUTION
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CLV	CLORINE GAS UNDER VACUUM
CM	CENTIMETER
CML	CEMENT MORTAR LINED AND COATED
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
COMP	COMPRESSOR
CONC	CONCRETE OR CONCENTRIC
COND	CONDENSER OR CONDENSATE
CONN	CONNECTION
CONSTR	CONSTRUCTION OR CONSTRUCT
CONT	CONTINUED OR CONTINUOUS
CONTR	CONTRACTOR
COTG	CLEAN-OUT TO GRADE
CPLG	COUPLING
CPV	CHEMICAL PIPE VAULT
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CAUSTIC SODA OR CAST STEEL
CT	CERAMIC TILE
CTR	CENTER
CTSK	COUNTERSUNK
CU	COPPER OR CUBIC
CWR	CHILLED WATER RETURN
CWS	CHILLED WATER SUPPLY
CV	CHECK VALVE
CYL	CYLINDER
d	PENNY
DBL	DOUBLE
DC	DIRECT CURRENT
DET	DETAIL
DF	DRINKING FOUNTAIN OR DOUGLAS FIR
DG	DOOR GRILLE
DI	DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL
DIAPH	DIAPHRAGM
DISCH	DISCHARGE
DISP	DISPENSER
DN	DOWN OR DECANT
DO	DISSOLVED OXYGEN, DITTO (MEMBER SIZE REPEATS)
DR	DOOR OR DRAIN
DS	DRENCH SHOWER AND EYE WASH
DW	DEMINERALIZED WATER
DWG	DRAWING
DIFF	DIFFUSER OR DIFFERENTIAL

E	EAST
EA	EACH
EC	END CURVE
ECC	ECCENTRIC
ECR	END CURB RETURN
EE	ENGINE EXHAUST
EF	EACH FACE OR EXHAUST FAN
EFF	EFFLUENT
EG	EXHAUST GRILLE OR EXISTING GRADE
EJ	EXPANSION JOINT
EL	ELEVATION
ELEC	ELECTRICAL OR ELECTRONIC
ENG	ENGINE
ENCL	ENCLOSURE
ENT	ENTRANCE
EPT	ETHYLENE PROPYLENE
EQ	EQUAL
EQUIP	EQUIPMENT
EVAP	EVAPORATOR
EVC	END VERTICAL CURVE
EW	EACH WAY OR EYE WASH
EWR	ENGINE WATER RETURN
EWS	ENGINE WATER SUPPLY
EXH	EXHAUST
EX-HY	EXTRA HEAVY
EXIST	EXISTING
EXP JT	EXPANSION JOINT
EXT	EXTERIOR OR EXTENSION
EXTR	EXTRUDED
F	FAHRENHEIT, FAN, FERRIC OR FINISH
FABR	FABRICATION, FABRICATE OR FABRICATED
FAI	FRESH AIR INTAKE
FB	FLAT BAR, FLOOR BEAM OR FIELD BOOK
FC	FERRIC CHLORIDE
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FDR	FEEDER
FE	FIRE EXTINGUISHER, FINAL EFFLUENT OR FLOW ELEMENT
FEM	FEMALE (PIPE THREAD)
FF	FLAT FACE OR FAR FACE
F TO F	FACE TO FACE
FG	FINISHED GRADE
FGD	FILTER GALLERY DRAIN
FH	FIRE HYDRANT
FIG	FIGURE
FIN	FINISHED
FIX	FIXTURE
FL	FLOWLINE OR FLOOR
FLEX	FLEXIBLE
FLG	FLANGE OR FLOORING
FLGD	FLANGED
FLOCC	FLOCCULATOR OR FLOCCULATION
FLR	FLOOR
FM	FACTORY MUTUAL (LAB. APPROVED)
FMH	FLEXIBLE METAL HOSE
FND	FOUNDATION
FOC	FACE OF CONCRETE
FOM	FACE OF MASONRY
FOR	FUEL OIL RETURN
FOS	FACE OF STUDS OR FUEL OIL SUPPLY
FOW	FACE OF WALL
FPC	FLEXIBLE PIPE COUPLING
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FR	FRAME
FRP	FIBERGLASS REINFORCED PLASTIC
FS	FAR SIDE, FLOOR SINK, FINISHED SURFACE, FORGED STEEL FROTH SPRAY OR FACTOR OF SAFETY
FSP	FIRE PROTECTION SPRINKLER SYSTEM
FSW	FILTER SURFACE WASHWATER
FT	FEET OR FOOT
FT. LB	FOOT-POUND
FTG	FOOTING
FTW	FILTER TO WASTE
FUT	FUTURE
FW	FILTERED WATER
FWR	FILTER-TO-WASTE RECOVERY
G	GATE
GA	GAGE OR GAUGE
GAL	GALLON
GALV	GALVANIZED
GEN	GENERAL OR GENERATOR
GFA	GROOVED FLANGE ADAPTER
GI	GALVANIZED IRON
GL	GLASS
GL/BM	GLUE LAMINATED BEAM
GLV	GLOBE VALVE
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GRD	GRADE OR GROUND
GR BRK	GRADE BREAK OR GRADE CHANGE
GRTG	GRATING
GV	GATE VALVE
GYP	GYPSUM
HAS	HEADED ANCHOR STUD
HB	HOSE BIBB
HD	HUB DRAIN
HDPE	HIGH DENSITY POLYPROPYLENE
HDR	HEADER
HDW	HARDWARE
HEX	HEXAGONAL
Hg	MERCURY
HGR	HANGER
HGT	HEIGHT
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HORSEPOWER OR HIGH PRESSURE
H/P	HIGH POINT
HR	HEATING WATER RETURN, HOUR OR HANDRAIL
HS	HEATING WATER SUPPLY
HTG	HEATING
HTR	HEATER
H & V	HEATING AND VENTILATING
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWL	HIGH WATER LEVEL
HWD	HARDWOOD
HWO	HANDWHEEL OPERATED
HV	HORIZONTAL AND VERTICAL CONTROL POINT OR HAND VALVE
HYD	HYDRAULIC OR HYDRANT
HWR	DOMESTIC HOT WATER RETURN
HWS	DOMESTIC HOT WATER SUPPLY

IA	INSTRUMENT AIR
ID	INSIDE DIAMETER
IF	INSIDE FACE
IN	INCH
INFL	INFLUENT
IN. LB	INCH-POUND
INSL	INSULATION OR INSULATED
INSTR	INSTRUMENT
INT	INTERIOR
INV	INVERT ELEVATION
IP	IRON PIPE
IPS	IRON PIPE SIZE
IRRG	IRRIGATION
JAN	JANITOR
JT	JOINT
K	KELVIN, KILO OR KARAT
KG	KILOGRAM
KM	KILOMETER
KS	KITCHEN SINK
KV	KILOVOLT
KW	KILOWATT
KWH	KILOWATT HOUR
L/P	LOW POINT
L	LITER OR LENGTH
LA	LIQUID ALUM
LAB	LABORATORY
LAM	LAMINATED
LAV	LAVATORY
LB	POUND
LDG	LANDING
LEV	LEVEL
LEV	LEVEL
LG	LENGTH OR LONG
LF	LINER FEET
LT	LEFT OR LIGHT
LWL	LOW WATER LEVEL
LWR	LOWER
LLV	LONG LEG VERTICAL
LS	LAB SINK
LSP	LANDSCAPING SPRINKLER SYSTEM
M	METER OR MALE (PIPE THREAD)
MB	MACHINE BOLT
MAG	MAGNETIC
MAN	MANUAL
MACH	MACHINE
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
ME	MISCELLANEOUS EQUIPMENT
MECH	MECHANICAL
MED	MEDIUM
MEMB	MEMBRANE
MFR	MANUFACTURER
MFR'D	MANUFACTURED
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MI	MALLEABLE IRON
MICRON	1/1,000,000 METER
MIL	MILITARY, 1/1,000 INCH
MIN	MINIMUM OR MINUTE
MIR	MIRROR
MISC	MISCELLANEOUS
MK	MARK
MO	MOTOR OPERATED OR MANSONRY OPENING
MOD	MODEL OR MODIFICATION
MS	MOP SINK
MTC	MECHANICAL-TYPE COUPLING
MTD	MOUNTED
MTG	MOUNTING
MTL	MATERIAL OR METAL
MTR	MOTOR
MX	MIXER
N	NORTH
NBS	NATIONAL BUREAU OF STANDARDS
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NF	NEAR FACE
NG	NATURAL GRADE OR NATURAL GAS
NIC	NOT IN CONTRACT
NO	NUMBER OR NORMALLY OPEN
NOM	NOMINAL
NPS	NOMINAL PIPE SIZE (FORMERLY I.P.S.)
NPT	NATIONAL PIPE THREAD
NRS	NON-RISING STEM
NS	NEAR SIDE
NTS	NOT TO SCALE
OC	OVER-CROSSING OR ON CENTER
OD	OUTSIDE DIAMETER OR OVERALL DIMENSION
OF	OVERFLOW OR OUTSIDE FACE
OFF	OFFICE
OFOS	OUTSIDE FACE OF STRUCTURE
OH	OVER HEAD
OPER	OPERATOR OR OPERATING
OPNG	OPENING
OS & Y	OUTSIDE SCREW AND YOKE
OWG	OIL, WATER, GAS
OZ	OUNCE
P/S	POLE AND SHELF
P	POLE, PAGE, PIPE OR PUMP
PA	PLANT AIR
PART	PARTITION
PAVMT	PAVEMENT
PB	POLYBUTYLENE
PC	PRIMARY CLARIFIER OR PORTLAND CEMENT
PCC	PORTLAND CEMENT CONCRETE
PCOTG	PRESSURE CLEANOUT TO GRADE
PD	PLANT DRAIN
PE	PLANT EFFLUENT, POLYELECTROLYTE POLYMER OR POLYETHYLENE
PEC	POLYMER-CATIONIC
PG	PRESSURE GAGE
pH	HYDROGEN ION CONCENTRATION
PI	PLANT INFLUENT OR POINT OF INTERSECTION
PL	PLATE, PROPERTY LINE OR PLACE
PLAS	PLASTER OR PLASTIC
PLYWD	PLYWOOD
PNEU	PNEUMATIC
PNL	PANEL
PM	PRESSED METAL
PO	PLANT OVERFLOW
PP	POWER POLE OR POLYPROPYLENE
PLT	PLANT
PPD	POUNDS PER DAY
PPH	POUNDS PER HOUR
PPM	PARTS PER MILLION

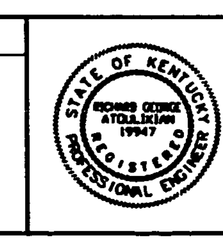
PR	PAIR
PRCT	PRECAST
PREFAB	PREFABRICATED
PRESS	PRESSURE
PRV	PRESSURE REGULATING, RELIEF OR REDUCING VALVE
PS	PRESSURE SWITCH
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAUGE
PT	PAINT
PTDF	PRESSURE TREATED DOUGLAS FIR
PTFE	POLYTETRAFLUOROETHYLENE (TEFLON®)
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVDF	POLYVINYLIDENE FLUORIDE (KYNAR®)
PW	POTABLE WATER
QT	QUARRY TILE
QTY	QUANTITY
R	RADIUS, RISER, RETURN OR RATE OF SLOPE
RAG	RETURN AIR GRILLE
RC	REINFORCED CONCRETE
RCC	ROLLER COMPACTED CONCRETE
RCCP	REINFORCED CONCRETE CYLINDER PIPE
RCP	REINFORCED CONCRETE PIPE
RD	ROOF DRAIN, ROUND, OR ROAD
RDWD	REDWOOD
RECIRC	RECIRCULATED
RED	REDUCER OR REDUCING
REF	REFERENCE OR REFER
REG	REGULATING
REIN	REINFORCE OR REINFORCED
REQD	REQUIRED
RESIL	RESILENT
REV	REVISION
RFG	ROOFING
RF	ROOF OR RAISED FACE
RM	ROOM
RO	ROUGH OPENING
RPM	REVOLUTIONS PER MINUTE OR REINFORCED PLASTIC MORTAR
RR	RAILROAD
RS	RISING STEM
RT	RIGHT
RTP	REINFORCED THERMOSETTING PLASTIC
R/W	RIGHT OF WAY
RW	REDWOOD OR RAW WATER
RWL	RAINWATER LEADER
S4S	SURFACED 4 SIDES
SA	SAMPLE LINE
S	SOUTH, SCUM, SINK, SECOND, SLOPE OR SANITARY SEWER M.H.
SA	SAMPLE
SAR	SAMPLE RETURN
SBR	STYRENE BUTADENE (RUBBER)
SBY	STANDBY
SC	SLUDGE CAKE, SPARE CHEMICAL OR SECONDARY CLARIFIER
SCAV	SLUDGE COMBINATION AIR/COMBINATION VACUUM VALVE
SCD	SCREWED
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SD	SANITARY DRAIN AND VENT OR STORM DRAIN MH
SDR	STORM DRAINS
SEC	SECONDARY
SECT	SECTION
SER	SERIES
SETT	SETTLING
SFA	SULFURIC ACID
SHR	SHOWER
SHT	SHEET OR SHELF
SHTG	SHEATHING
SIM	SIMILAR
SL	SLUDGE OR SLOPE
SOLN	SOLUTION
SLC	SLUDGE COLLECTION
SLD	SLUDGE DECANT RETURN
SLDG	SLIDING
SLV	SHORT LEG VERTICAL
SP	STATIC PRESSURE OR SPARE POLYMER
SPD	SUMP PUMP DISCHARGE
SPECS	SPECIFICATIONS
SPECF	SPECIFIED
SQ	SQUARE
SOF	SLUDGE OVERFLOW
SS	SANITARY SEWER, STAINLESS STEEL OR SERVICE SINK
SSU	SECONDS SAYBOLT UNIVERSAL
STA	STATION
STC	SLEEVE-TYPE COUPLING
STD	STANDARD
STL	STEEL
STM	STEAM
STN	STAINLESS
STN STL	STAINLESS STEEL
STRUCT	STRUCTURAL OR STRUCTURE
SU	STRUCTURAL UNDERDRAIN
SUC	STRUCTURAL UNDERDRAIN COLLECTOR
SUCT	SUCTION
SV	SOLENOID VALVE
SW	SETTLED WATER
SWR	SIDEWALL REGISTER
SYM	SYMMETRICAL OR SYMBOL
SYS	SYSTEM

TAS	THREADED ANCHOR STUD
T	THERMOSTAT, TREAD OF STAIR, TANGENT, TOP OR TANK
TB	TACK BOARD
T & B	TOP AND BOTTOM
TBE	THREAD BOTH ENDS
TBM	TEMPORARY BENCH MARK
TC	TOP OF CURB
TEMP	TEMPERATURE OR TEMPORARY
T & G	TONGUE AND GROOVE
TG	TOP OF GRATE
THK	THICK OR THICKNESS
THR	THRESHOLD
THR'D	THREADED
TOC	TOP OF CURB/CONCRETE
TOE	THREAD ONE END
TOL	TOILET
TP	TELEPHONE POLE, TELEGRAPH POLE, TRAP PRIMER OR TOP OF PAVEMENT
TRANS	TRANSITION OR TRANSMITTER
TSB	TOP SET BASE
TV	THERMOSTATIC VALVE OR TELEVISION
TW	TOP OF WALL, THERMOMETER WELL OR TREATED WATER
TYP	TYPICAL
UB	UNION BONNET
UC	UNDER-CROSSING
UG	UNDERGROUND
UGC	UNDERGROUND CONDUIT
UH	UNIT HEATER
UL	UNDERWRITERS LABORATORIES
UNO	UNLESS NOTED OTHERWISE
UR	URINAL
UW	UTILITY WATER
V	VACUUM, VALVE, VERTICAL, VENT, VOLT OR VOLUME
VAR	VARIES OR VARIABLE
VCP	VITRIFIED CLAY PIPE
VERT	VERTICAL
VOL	VOLUME
VTC	VENT TO CEILING
VTR	VENT THROUGH ROOF
VWC	VINYL WALL COVERING
W	WEST OR WASTE
W/	WITH
WC	WATER COLUMN OR WATER CLOSET
WCO	WALL CLEANOUT
WD	WOOD
WH	WATER HEATER
WI	WROUGHT IRON
W/O	WITHOUT
WOG	WATER, OIL OR GAS WORKING PRESSURE
WP	WATER PROOFING OR WORK POINT
WS	WATER SURFACE
WSTP	WATER STOP
WT	WEIGHT
WW	FILTERED WASTE WASHWATER
WWM	WELDED WIRE MESH
WWP	WATER WORKING PRESSURE
WWR	FILTERED WASTE WASHWATER RECOVERY
WYE	"Y" FITTING
XS	EXTRA STRONG
XXS	DOUBLE EXTRA STRONG
YD	YARD
YR	YEAR
Z	ZERO OR ZONE
ZN	ZINC

NOTES:

1. SEE SHEET 380-575-004 FOR PIPE SCHEDULE.
2. SEE SHEET 380-575-005 FOR ADDITIONAL PROCESS AND EQUIPMENT ABBREVIATIONS.
3. ADDITIONAL HEATING, VENTILATING AND AIR CONDITIONING ABBREVIATIONS SHOWN ON HVAC SHEETS.
4. ELECTRICAL ABBREVIATIONS SHOWN ON ELECTRICAL SHEETS.
5. INSTRUMENTATION ABBREVIATIONS SHOWN ON INSTRUMENTATION SHEETS.

DATE	REVISIONS



WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

GENERAL
GENERAL ABBREVIATIONS

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-003

PIPING MATERIAL SCHEDULE (SEE NOTE 4)

GROUP NO.	PIPE (SEE NOTE 13)	FITTINGS	VALVES, 4 INCHES AND SMALLER (SEE NOTE 1, NOTE 11 AND NOTE 14)
1	STEEL, ASTM A120, SCHEDULE 40, BLACK WELDED.	2-1/2 INCH AND SMALLER, MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, BLACK, 150 PSI OR STEEL, ANSI B16.9, BUTT-WELDED. 3 INCH AND LARGER, CAST IRON, ANSI B16.1, 125 PSI FLANGED OR MECHANICAL COUPLINGS.	SEE SPECIFICATIONS
2	STEEL, ASTM A120, SCHEDULE 40 WELDED, GALVANIZED.	2-1/2 INCH AND SMALLER, MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, GALVANIZED 150 PSI. 3 INCH AND LARGER, CAST IRON, ANSI B16.1, 125 PSI FLANGED OR MECHANICAL COUPLINGS.	ECCENTRIC PLUG, SYNTHETIC RUBBER FACED, GATE, AWWA C500. BUTTERFLY, AWWA, FLANGED.
3	STEEL, ASTM A106, SCHEDULE 80, SEAMLESS, BLACK.	FORGED STEEL, ANSI B16.11, SOCKET WELDED OR THREADED, BLACK, 2000 PSI, OR STEEL, ANSI B16.9, BUTT-WELDED, SCHEDULE 80.	CAST IRON, LUBRICATED PLUG
4	SAME AS GROUP NO. 1	CAST IRON, ANSI B16.12, THREADED, DRAINAGE PATTERN.	--------
5	WELDED STEEL, AWWA C200, UNLINED.	WELDED STEEL, FABRICATED, AWWA C200, UNLINED.	AS INDICATED ON DRAWINGS
6	STEEL, ASTM A106, OR A53, SCHEDULE 40, SEAMLESS, BLACK.	STEEL, ANSI B16.9, BUTT-WELDED. CAST IRON, ANSI B16.1, 125 PSI, FLANGED. FORGED STEEL, SOCKET WELDED, ANSI B16.11, 2000 PSI OR STEEL, ANSI B16.5, 150 PSI FLANGED.	CAST IRON, FLANGED, LUBRICATED PLUG
7	SAME AS GROUP NO. 2.	MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, GALVANIZED, 300 PSI.	BRONZE THREADED, GLOBE
8	WELDED STEEL, AWWA C200. - MORTAR LINED	WELDED STEEL, AWWA C200, FABRICATED - MORTARLINED	AS INDICATED ON DRAWINGS.
8E	CEMENT MORTAR - EPOXY LINED (WELDED STEEL, AWWA C200)	WELDED STEEL, AWWA C200, FABRICATED - EPOXY COATED MORTAR LINED	AS INDICATED ON DRAWINGS.
9	SAME AS GROUP NO. 1.	2-1/2 INCH AND SMALLER, MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, BLACK, 150 PSI. 3 INCH AND LARGER, STEEL, ANSI B16.9, BUTT-WELDED	ECCENTRIC PLUG
10	SAME AS GROUP NO. 3.	1-1/4 INCH AND SMALLER, FORGED STEEL, ANSI B16.11, SOCKET WELDED, BLACK, 3000 PSI, WITH FLANGED AMMONIA UNIONS. 1-1/2 INCH AND LARGER, STEEL, ANSI B16.9, BUTT-WELDED OR FLANGED, SCHEDULE 80	SEMI-PLUG AND YOKE TYPE OR BALL FOR CHLORINE SERVICE, FORGED CARBON STEEL
11	DUCTILE IRON, ANSI A21.51, (AWWA C151) OR CAST IRON ANSI A21.6, 150 PSI, BELL AND SPIGOT, MECHANICAL JOINTS, MECHANICAL COUPLINGS, OR 125 PSI FLANGED (TYPICAL SERVICE - WATER LINES)	DUCTILE IRON OR CAST IRON, ANSI A21.10, OR AWWA C110, BELL AND SPIGOT, MECHANICAL COUPLINGS, FLANGED OR MECHANICAL JOINTS, 250 PSI, (PRESSURE RATING) 12 INCHES AND SMALLER, 150 PSI, (PRESSURE RATING) 14 INCHES AND LARGER, WITH 125 PSI ANSI B16.1 FLANGES.	GATE, AWWA C500, 'O' RING SEALS, MECHANICAL JOINTS ENDS, BUTTERFLY, AWWA. ECCENTRIC PLUG
12	CAST IRON SOIL, ANSI/ASTM A-74, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS. AT THE OPTION OF THE CONTRACTOR, DUCTILE IRON (GROUP NO. 11) MAY BE SUBSTITUTED	CAST IRON SOIL, ANSI/ASTM A-74, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS. AT THE OPTION OF THE CONTRACTOR, DUCTILE IRON (GROUP NO. 11) MAY BE SUBSTITUTED.	AS INDICATED ON DRAWINGS.
13	CORROSION RESISTANT (HIGH SILICON CONTENT) CAST IRON, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS.	CORROSION RESISTANT (HIGH SILICON CONTENT) CAST IRON, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS.	--------
14	STAINLESS STEEL, TYPE 316, ASTM A312, SCHEDULE 40S.	STAINLESS STEEL, TYPE 316 ANSI B16.3, SCREWED, 150 PSI, ANSI B16.9, BUTT-WELDED, SCHEDULE 40S, OR 150 PSI FLANGED.	STAINLESS STEEL, BALL, FLANGED AS SHOWN ON DRAWINGS.
15	STAINLESS STEEL, TYPE 316, ASTM A312, SCHEDULE 10S, (SCHEDULE 20 FOR BURIED PIPE)	STAINLESS STEEL, TYPE 316 ANSI B16.9 BUTT-WELDED SCHEDULE 10S OR 150 PSI FLANGED. SEE NOTE 22	STAINLESS STEEL, AS INDICATED ON DRAWINGS.
16	POLYVINYL CHLORIDE, SCHEDULE 80, NORMAL IMPACT. ASTM D1785 (SEE NOTE 21)	POLYVINYL CHLORIDE, SCHEDULE 80, NORMAL IMPACT, SOCKET SOLVENT WELD JOINTS, ASTM D2467.	POLYVINYL CHLORIDE, BALL, DIAPHRAGM, BUTTERFLY, BALL OR LIFT CHECK.
17	POLYPROPYLENE, ASTM D2146, SCHEDULE 40, WITH HEAT FUSED JOINTS.	POLYPROPYLENE, SCHEDULE 40, DRAINAGE TYPE WITH HEAT FUSED SOCKET JOINTS.	--------
18	FIBERGLASS REINFORCED PLASTIC, ASTM D2996, FILAMENT-WOUND, SOCKET AND SPIGOT ENDS, ADHESIVE BONDED.	FIBERGLASS REINFORCED PLASTIC, FILAMENT-WOUND, SOCKET ENDS, ADHESIVE BONDED, OR FIBERGLASS FLANGED.	PLASTIC LINED, FLANGED. FLANGES TO MATCH 150 PSI ANSI B16.5 DIMENSIONS, OR AS INDICATED ON DRAWINGS.
19	POLYVINYL CHLORIDE PRESSURE PIPE AWWA C-900 (SEE NOTE 21)	AS SPECIFIED	SAME AS GROUP NO. 11.
22	REINFORCED CONCRETE, ASTM C76, BELL AND SPIGOT JOINTS. (TYPICAL SERVICE-CULVERTS)	SAME AS GROUP NO. 8	--------
23	H.D.P.E. PROFILE WALL LOW PRESSURE PIPE (WHEN SPECIFIED ON DRAWINGS AS OPTION)	AS SPECIFIED	AS SPECIFIED
24	COPPER, ASTM B88, TYPE K, SOFT TEMPERED WHERE BURIED, TYPE L HARD TEMPERED WHERE EXPOSED.	WROUGHT COPPER OR CAST BRONZE, ANSI B16.22, SOLDER JOINT, 150 PSI, OR COMPRESSION FITTINGS. (FOR OXYGEN PIPING USE SILVER SOLDER, FOR COMPRESSED AIR PIPING USE 95-5 TIN-ANTIMONY SOLDER).	BRONZE, SOLDER JOINT
25	POLYVINYL CHLORIDE PRESSURE PIPE AWWA C905 WITH BELL AND SPIGOT JOINTS.	DUCTILE IRON, 150 PSI, FOR POLYVINYL CHLORIDE PIPE, AWWA C110 CEMENT MORTAR LINED, AWWA C104	--------
26	NOT USED		
27	POLYVINYL CHLORIDE GRAVITY SEWER PIPE, ASTM D3034, BELL AND SPIGOT.	POLYVINYL CHLORIDE, ANSI/ASTM D3034, BELL AND/OR SPIGOT.	--------
28	STAINLESS STEEL TUBING 1/2 INCH AND SMALLER, TYPE 316 ASTM A 632	AS SPECIFIED	AS SPECIFIED
29	HIGH DENSITY POLYETHYLENE	AS SPECIFIED	--------
30	PVC (POLYVINYL CHLORIDE) SOLVENT WELDED, PERFORATED, SCHEDULE 40.	AS SPECIFIED	--------
31	REINFORCED CONCRETE CYLINDER PIPE EPOXY LINED AWWA C300	AS SPECIFIED	AS SPECIFIED
32	STAINLESS STEEL SCHEDULE 40 TYPE 304L SCHEDULE 40,	BUTT WELDED ANSI B. 16. 9, 150 PSI FLANGED WHERE NECESSARY.	STAINLESS STEEL, BALL VALVE FLANGED AS SHOWN ON DRAWINGS.
33	CPVC (CHLORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT WELDED, SCHEDULE 80.	SIMILAR TO GROUP 16 EXCEPT CPVC INSTEAD OF PVC.	SIMILAR TO GROUP 16 EXCEPT CPVC INSTEAD OF PVC.
34	PVDF (POLYVINYLIDENE FLOURIDE) PRESSURE PIPE, HEAT FUSION CONNECTIONS, SCHEDULE 80	AS SPECIFIED	AS SPECIFIED
35	PVDF HEAT FUSED DOUBLE CONTAINED PIPE	AS SPECIFIED	AS SPECIFIED
36	TEFLON LINED STEEL PIPING	AS SPECIFIED	AS SPECIFIED
37	PVC SOLVENT WELDED DOUBLE CONTAINED PIPE	AS SPECIFIED	AS SPECIFIED
38	FRP DOUBLE CONTAINED PIPE	AS SPECIFIED	AS SPECIFIED
39	PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT WELDED, SCH 40	PVC DRAIN FITTINGS, STM D-2665	--------
40	PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, THREADED, SCH 80	AS SPECIFIED	--------

NOTES

NOTE 1
SEE SPECIFICATIONS FOR MANUFACTURERS.

NOTE 2
LEAKAGE ALLOWANCE IS AS FOLLOWS:
(A) PIPES SO DESIGNATED SHALL SHOW ZERO LEAKAGE.
(B) PIPES SO DESIGNATED SHALL SHOW ZERO LEAKAGE FOR UNBURIED PIPE AND NOT MORE THAN 0.002 GALLON PER HOUR PER INCH DIAMETER PER 100 FEET OF BURIED PIPE.
(C) PIPES SO DESIGNATED SHALL NOT SHOW A LEAKAGE OF MORE THAN 0.15 GALLON PER HOUR PER INCH OF DIAMETER PER 100 FEET OF PIPE.
(D) PIPES SO DESIGNATED SHALL NOT SHOW A LOSS OF PRESSURE OF MORE THAN 5 PERCENT.
(E) PIPES SO DESIGNATED SHALL NOT SHOW A LOSS OF VACUUM OF MORE THAN 4 INCHES MERCURY COLUMN.

NOTE 3
FOR FIELD TEST PROCEDURES AND ADDITIONAL TEST REQUIREMENTS, SEE PIPING SECTION OF SPECIFICATIONS.

NOTE 4
ANY DEVIATION FROM THE PIPING MATERIALS OR FIELD TEST REQUIREMENTS SHOWN WILL BE NOTED IN THE SPECIFICATIONS OR ON THE DRAWINGS.

NOTE 5
PIPING GROUP NUMBER SHOWN THUS SHALL BE INSULATED, SEE PIPING SECTION OF SPECIFICATIONS FOR INSULATING MATERIALS.

NOTE 6
STATIC WATER TEST WITH SURFACE 5 FEET ABOVE HIGH POINT OF PIPE.

NOTE 7
INSPECTION AND TESTING SHALL BE IN ACCORDANCE WITH APPLICABLE PLUMBING CODE.

NOTE 8
NO APPARENT LEAKS UNDER NORMAL OPERATING CONDITIONS.

NOTE 9
INSPECTION AND TESTING SHALL BE IN ACCORDANCE WITH APPLICABLE NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS.

NOTE 10
PIPING MATERIALS SHALL BE IN ACCORDANCE WITH NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS.

NOTE 11
FOR VALVES 6 INCHES AND LARGER SEE VALVE SCHEDULE. FOR SPECIAL VALVES SEE SPECIFICATIONS.

NOTE 12
CHANGE IN PIPING MATERIAL GROUP NUMBER IS INDICATED THUS:

NOTE 13
FOR PIPE LINING AND COATING, SEE SPECIFICATIONS.

NOTE 14
EXPOSED PIPING SHALL BE PAINTED IN ACCORDANCE WITH SPECIFICATIONS. COLORS TO BE SELECTED BY OWNER.

NOTE 15
PIPING MATERIAL SHALL BE NON-ABRASIVE FLEXIBLE RUBBER HOSE AND QUICK CONNECTION COUPLINGS WITH GROUP NO.1 AT EQUIPMENT.

NOTE 16
VALVES 2-1/2 INCH AND SMALLER MAY HAVE SCREWED ENDS VALVES 3 INCH AND LARGER SHALL HAVE FLANGED ENDS, UNLESS OTHERWISE SHOWN OR SPECIFIED.

NOTE 17
ALL JOINTS TO BE WELDED UNLESS OTHERWISE NOTED ON THE DRAWINGS.

NOTE 18
NOT USED

NOTE 19
WHERE MATERIAL GROUP IS NOT SHOWN ON THE DRAWINGS, USE MATERIALS AS SHOWN IN THE PIPING SCHEDULE

NOTE 20
THE BURIED PIPING MATERIAL DESIGNATION FOR CHEMICAL LINES REFERS TO PIPING MATERIAL IN THE CHEMICAL LINE CONTAINMENT SYSTEM.

NOTE 21
PIPE GROUP NO. 16 (SCH 80 PVC) ALLOWABLE FOR BURIED 2 1/2 " OR 3" PIPING. USE GROUP NO. 19 FOR 4" AND ABOVE.

NOTE 22
FITTINGS & SPECIALS MAY BE FABRICATED. FOR MAT'L 15, IN ACCORDANCE WITH THE CRITERIA SHOWN IN SPEC SECTION 02573 2.3.

LIST OF SAMPLE LINES

PIPE DESIGNATION	SAMPLE POINT

TYPICAL PIPE DESIGNATION:

2" UW (24)

PIPE DIAMETER — FLUID ABBREVIATION — MATERIAL GROUP NUMBER (SEE NOTE 19)

DATE	REVISIONS

STATE OF KENTUCKY
19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

GENERAL
PIPING SCHEDULE

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-004

PROCESS ABBREVIATIONS

AC	ACTIVATED CARBON
AIR	AIR
AL	ALUM/POLYMER
AS	AIR SCOUR
BPOL	BELT FILTER PRESS POLYMER
CA	COMPRESSED AIR
CLG	CHLORINE GAS
CLL	CHLORINE LIQUID
CLS	CHLORINE SOLUTION
DRN	DRAIN
FP	FILTER PRESSATE
G	GAS
GPOL	GRAVITY THICKENER POLYMER
GTS	GRAVITY THICKENER SUPERNATANT
GWPOL	GRAVITY THICKENER/WASH WATER WASTE POLYMER
LS	LAGOON SUPERNATANT
LSR	LAGOON SUPERNATANT RETURN
OF	OVERFLOW
PE	PLANT EFFLUENT
PW	PLANT WATER
RW	RAW WATER
SAN	SANITARY
SC	SLUDGE CAKE
SN	SUPERNATANT
SR	SLUDGE RECIRCULATION
SS	SETTLED SLUDGE
STO	STORM
TS	THICKENED SLUDGE
V	VACUUM
VT	VENT
W	FINISHED WATER
WPOL	WASTE WASH WATER POLYMER
WW	WASH WATER
WWW	WASTE WASH WATER

EQUIPMENT ABBREVIATIONS

ACU	AUTOMATIC CHANGEOVER UNIT
ANA	ANALYZER
B	BIN
BFP	BELT FILTER PRESS
CHL	CHLORINATOR
COMP	COMPRESSOR
CON	CONVEYOR
D	DAMPER
DIT	DENSITY INDICATING TRANSMITTER
EVAP	EVAPORATOR
EXP	EXPANSION CHAMBER
FDR	FEEDER
FIT	FLOW INDICATING TRANSMITTER
FM	FLOW METER
FN	FAN
G	GATE
H	HOPPER
INJ	INJECTOR
LIT	LEVEL INDICATING TRANSMITTER
MX	MIXER
P	PUMP
PBS	POLYMER BLENDING SYSTEM
PIT	PRESSURE INDICATING TRANSMITTER
REC	RECEIVER
SC	SLUDGE COLLECTOR
STR	STRAINER
T	TANK
TUR	TURBIDIMETER
V	VALVE
WSC	WEIGH SCALE
X	OTHER

NEW EQUIPMENT DESIGNATION

YYYY – EEEE – TS.DD

PROCESS ABBREVIATION (SEE THIS SHEET)
SUBSYSTEM NO. (SEE THIS SHEET)
EQUIPMENT ABBREVIATION (SEE SCHEDULE) THIS SHEET)
EQUIPMENT NO.
TRAIN NO. (SEE THIS SHEET)

NEW PIPING DESIGNATION

AA" YYYY (XX)

SIZE
PROCESS ABBREVIATION
MATERIAL NO. CODE (SEE PIPE MATERIAL SCHEDULE)

EXAMPLE:

A NEW 12 INCH DIAMETER PIPE MADE OF DUCTILE IRON CARRYING NON POTABLE WATER.

12" NPW (11)

NEW VALVE DESIGNATION

(FOR VALVES 6" AND LARGER AND ALL VALVES WITH OPERATORS)

YYYY – OV – TS.DD

PROCESS ABBREVIATION (SEE THIS SHEET)
SUBSYSTEM (SEE THIS SHEET)
VALVE NO.
TRAIN NO. (SEE THIS SHEET)
V=VALVE (SEE VALVE SCHEDULE ON SHEET M-2 FOR VALVE TYPE)
VALVE OPERATOR

S = SOLENOID
E = ELECTRIC
H = HAND
C = CHECK
A = AIR
X = OTHER

EXAMPLE:

A SOLENOID VALVE THAT IS MOTOR OPERATED ON A PLANT WATER LINE

PW – SV – 00.01

SYSTEM TRAIN (T)

0 – NO TRAIN AFFILIATION
1– BELT FILTER PRESS NO. 1
2– BELT FILTER PRESS NO. 2

SUBSYSTEM NO. (S)

0 – NO SUBSYSTEM AFFILIATION

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
19947
REGISTERED
PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

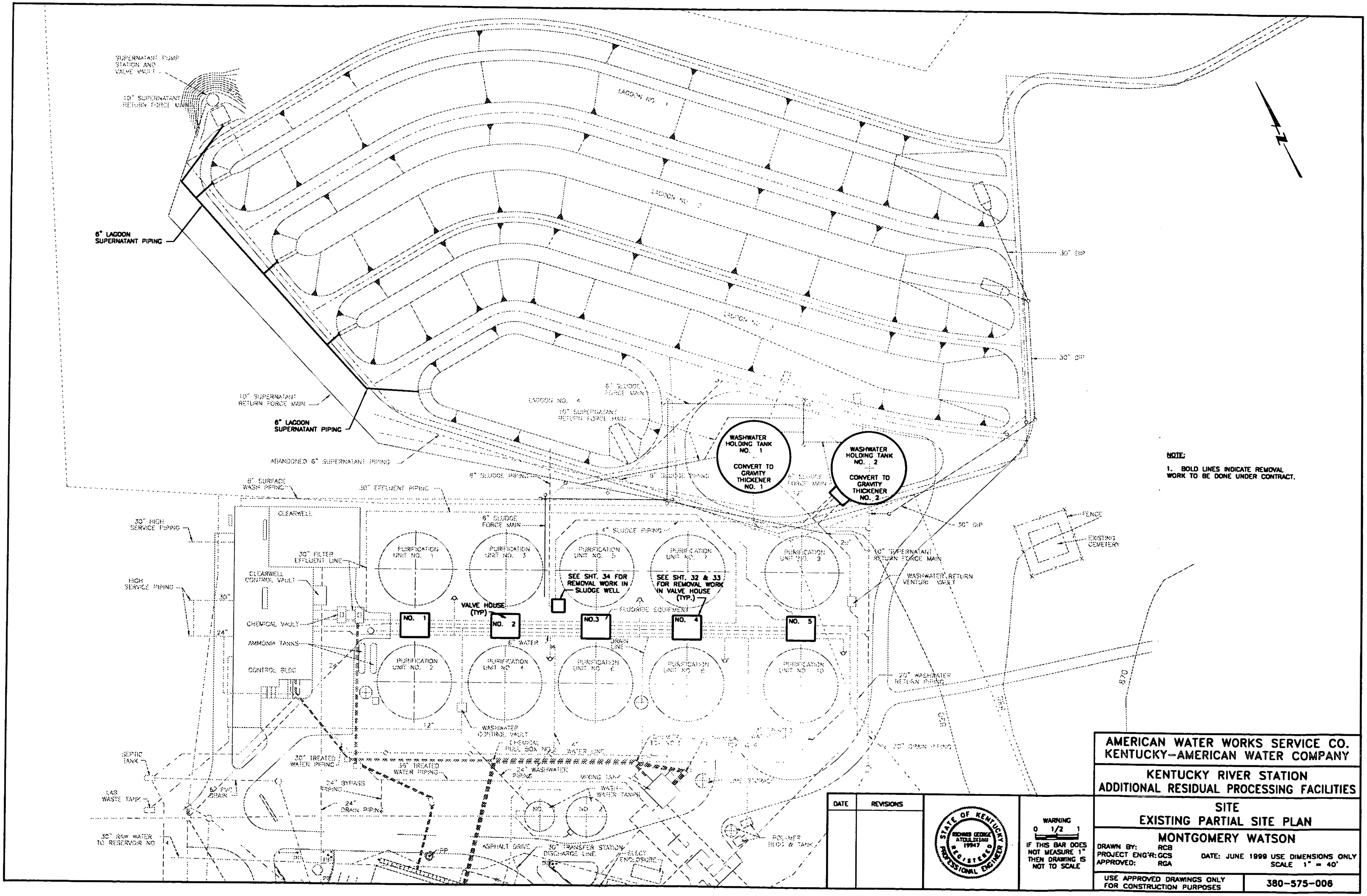
GENERAL
PROCESS AND EQUIPMENT ABBREVIATIONS

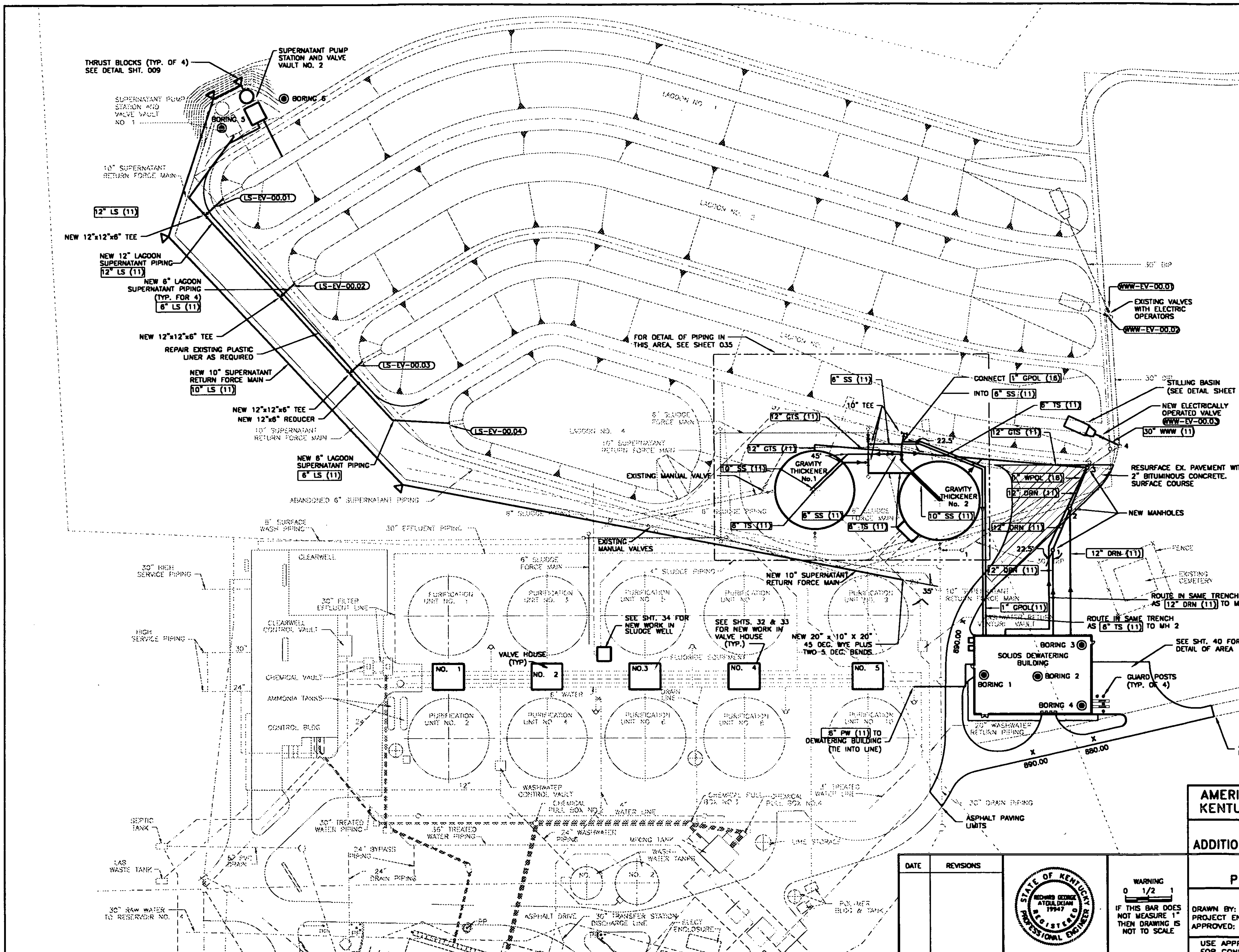
MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-005


SUPERNATANT PUMP STATION AND VALVE VAULT
10" SUPERNATANT RETURN FORCE MAIN
6" LAGOON SUPERNATANT PIPING
10" SUPERNATANT RETURN FORCE MAIN
6" LAGOON SUPERNATANT PIPING
ABANDONED 6" SUPERNATANT PIPING
LAGOON NO. 1
LAGOON NO. 2
LAGOON NO. 3
LAGOON NO. 4
8" SLUDGE FORCE MAIN
10" SUPERNATANT RETURN FORCE MAIN
30" DIP
30" DIP
30" DIP
WASHWATER HOLDING TANK NO. 1
CONVERT TO GRAVITY THICKENER NO. 1
WASHWATER HOLDING TANK NO. 2
CONVERT TO GRAVITY THICKENER NO. 2
NOTE:
1. BOLD LINES INDICATE REMOVAL WORK TO BE DONE UNDER CONTRACT.
FENCE
EXISTING CEMETERY
8" SURFACE WASH PIPING
30" EFFLUENT PIPING
8" SLUDGE PIPING
8" SLUDGE PIPING
6" SLUDGE FORCE MAIN
4" SLUDGE PIPING
30" HIGH SERVICE PIPING
HIGH SERVICE PIPING
CLEARWELL
30" FILTER EFFLUENT LINE
CLEARWELL CONTROL VAULT
CHEMICAL VAULT
AMMONIA TANKS
CONTROL BLDG
PURIFICATION UNIT NO. 1
PURIFICATION UNIT NO. 2
PURIFICATION UNIT NO. 3
PURIFICATION UNIT NO. 4
PURIFICATION UNIT NO. 5
PURIFICATION UNIT NO. 6
PURIFICATION UNIT NO. 7
PURIFICATION UNIT NO. 8
PURIFICATION UNIT NO. 9
PURIFICATION UNIT NO. 10
SEE SHT. 34 FOR REMOVAL WORK IN SLUDGE WELL
SEE SHT. 32 & 33 FOR REMOVAL WORK IN VALVE HOUSE (TYP.)
VALVE HOUSE (TYP)
NO. 1
NO. 2
NO.3
NO. 4
NO. 5
FLUORIDE EQUIPMENT
6" WATER
DRAIN LINE
10" SUPERNATANT RETURN FORCE MAIN
WASHWATER RETURN VENTURI VAULT
20" WASHWATER RETURN PIPING
870
WASHWATER CONTROL VAULT
CHEMICAL PULL BOX NO. 2
4" WATER LINE
20" DRAIN PIPING
SEPTIC TANK
LAB WASTE TANK
30" RAW WATER TO RESERVOIR NO. 4
30" TREATED WATER PIPING
36" TREATED WATER PIPING
24" WASHWATER PIPING
24" BYPASS PIPING
24" DRAIN PIPING
6" PVC DRAIN
MIXING TANK
WASH WATER TANKS
NO. 1
NO. 2
ASPHALT DRIVE
30" TRANSFER STATION DISCHARGE LINE
ELECT. ENCLOSURE
POLYMER BLDG & TANK
AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES
SITE
EXISTING PARTIAL SITE PLAN
MONTGOMERY WATSON
DRAWN BY: RCB
PROJECT ENG'R: GCS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE 1" = 40'
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES
380-575-006
DATE
REVISIONS
STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
19947
REGISTERED
PROFESSIONAL ENGINEER
WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE



MANHOLE SCHEDULE				
No.	SERVICE	NEW/EX.	INVERT IN	INVERT OUT
1	LSR	EX.	–	–
2	WPOL	NEW	875.75	875.25
3	DRN	NEW	881.73	875.25
4	DRAIN	NEW	878.95	878.45
5	DRAIN	NEW	877.68	877.18

NOTES:

1. DRAWING BASED ON RECORD DRAWINGS BY OTHERS. CONTRACTOR IS REQUIRED TO PERFORM EXPLANATORY EXCAVATIONS IN ORDER TO VERIFY THE EXACT LOCATIONS OF ALL UNDERGROUND STRUCTURES, UTILITIES AND PIPING PRIOR TO SUBMITTING SHOP DRAWINGS. NOT ALL EXISTING PIPING, UTILITIES, ETC. MAY BE SHOWN. AT A MINIMUM EXPLORATORY EXCAVATIONS SHALL BE PERFORMED AT ALL PIPING TIE-IN LOCATIONS AND AT ALL PIPE CROSSING LOCATIONS IN ORDER TO DETERMINE THE EXACT ELEVATION AND LOCATION OF EXISTING PIPING.

2. EXISTING VERTICAL TURBINE PUMPS SHALL BE REMOVED FROM WASH WATER WASTE HOLDING TANKS (WWWHT) AS SHOWN. RELOCATE TWO PUMPS FROM WWWHT NO. 2 TO NEW SUPERNATANT RETURN VAULT NO. 2. THE REMAINING VERTICAL TURBINE PUMP FROM WWWHT NO. 2 AND TWO ADDITIONAL VERTICAL TURBINE PUMPS FROM WWWHT NO. 1 SHALL BE SALVAGED AND TURNED OVER TO THE OWNER.

3. CONTRACTOR LAYDOWN AREA SHALL BE COORDINATED BY THE CONTRACTOR WITH THE OWNER.

4. NEW WORK SHOWN ON THIS SHEET INDICATED BY DARKENED/ BOLD LINE TYPE.

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
17947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

SITE
PROPOSED PARTIAL SITE PLAN

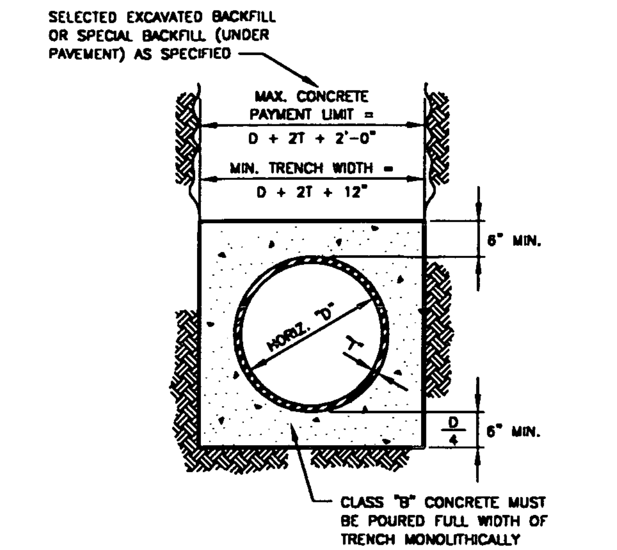
MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: GCS
APPROVED: RGA

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE 1" = 40'

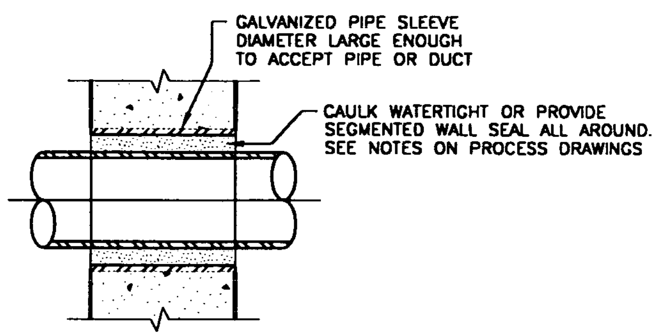
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

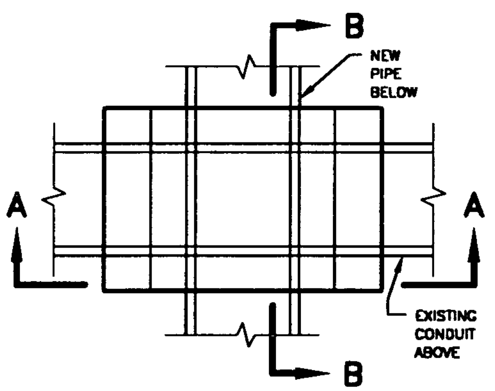
380-575-007



TYPICAL CONCRETE ENCASEMENT DETAIL

NO SCALE

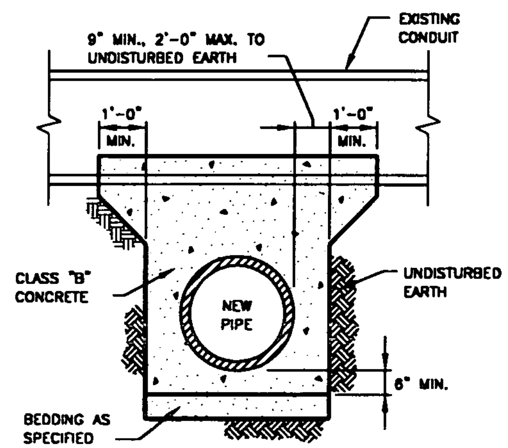




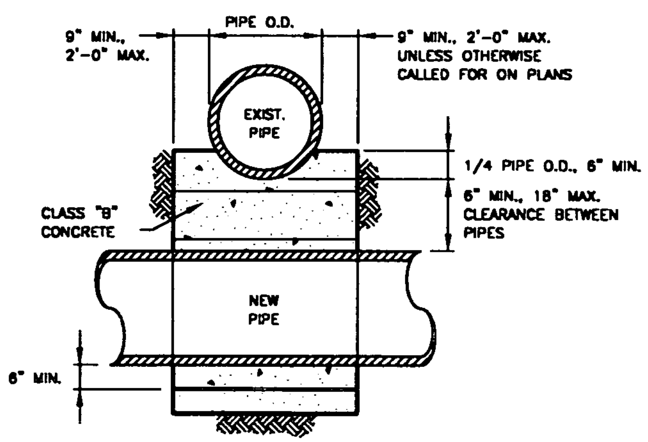
PLAN

NOTES:

1. CONCRETE ENCASEMENT AND CRADLE REQUIRED WHEN PIPE CLEARANCE IS LESS THAN 18".
2. DO NOT ENCASE JOINTS IN CONCRETE.



SECTION A – A

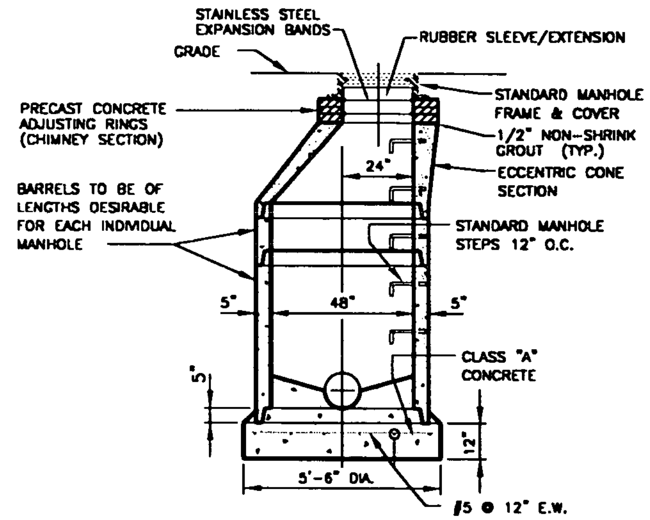


SECTION B – B

SUPPORT DETAILS FOR EXISTING CONDUIT CROSSING PIPE TRENCH

NO SCALE

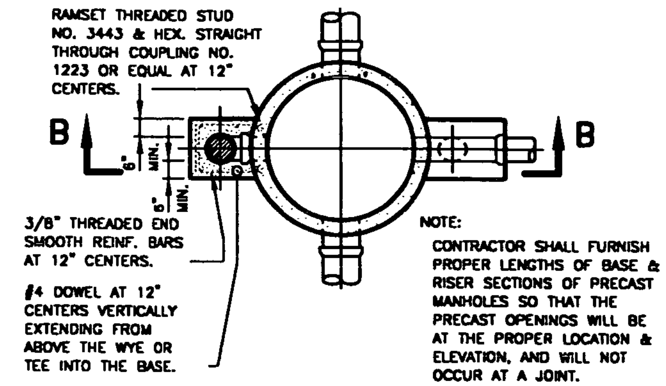
TO SPAN CHIMNEY HEIGHTS OF:
0-4 1/2" - CHIMNEY SEAL ONLY
4 1/2"-9" - SEAL +7" EXTENSION
9"-12" - SEAL+10" EXTENSION
OVER 12" - SEAL+MULT. EXTENSIONS



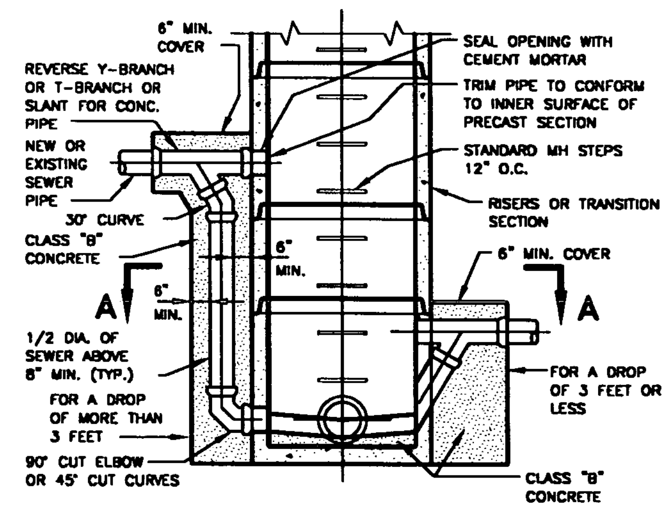
POURED IN PLACE CONCRETE BASE

PRECAST MANHOLE DETAIL

NO SCALE



SECTION A–A



SECTION B–B

TYPICAL PRECAST CONCRETE DROP MANHOLE (MH 3 ONLY)

NO SCALE

DATE	REVISIONS

STATE OF KENTUCKY REGISTERED PROFESSIONAL ENGINEER RICHARD GEORGE ATOULIKIAN 19947

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

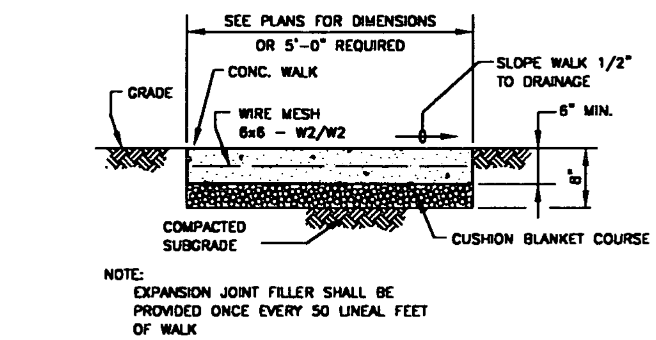
SITE
MISCELLANEOUS DETAILS

MONTGOMERY WATSON

DRAWN BY: MP
PROJECT ENG'R: GS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY SCALE AS SHOWN

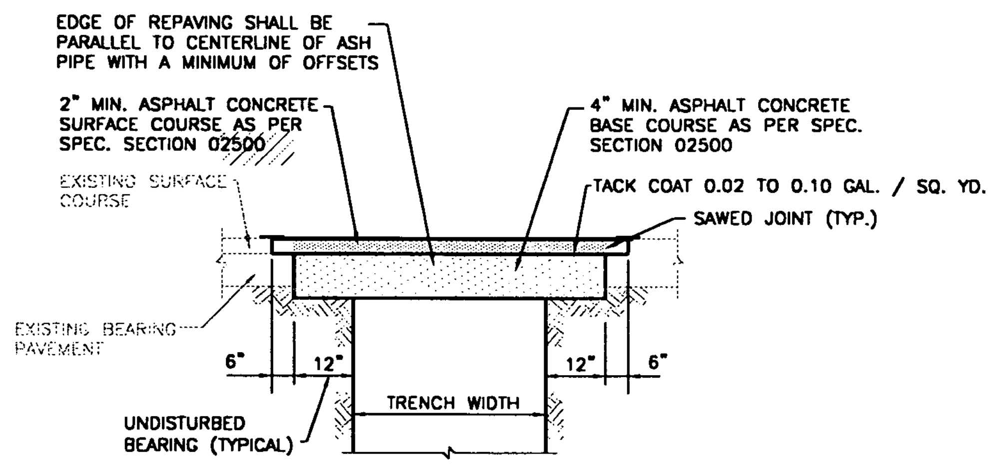
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-008



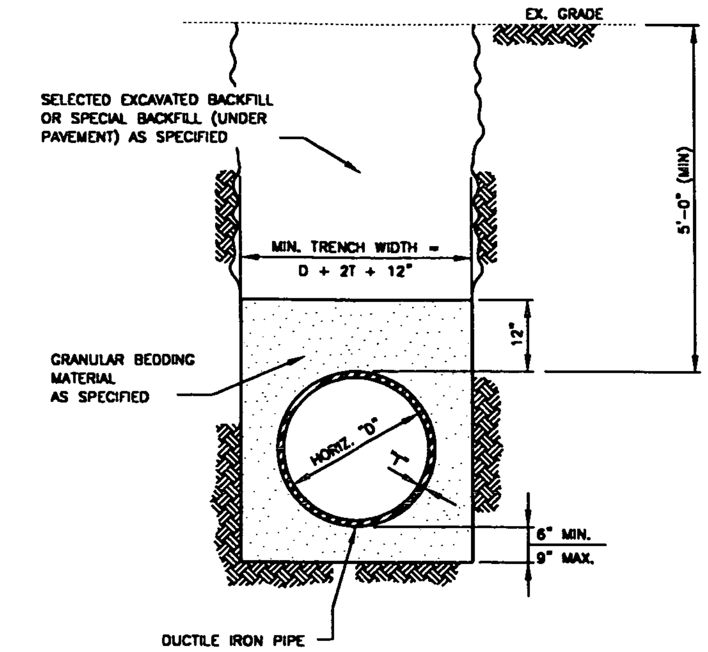
CONCRETE WALK DETAIL

NO SCALE



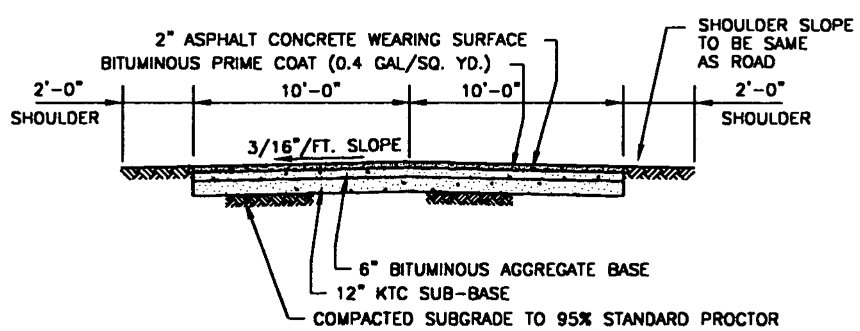
DETAIL FOR RESTORING ASPHALT CONCRETE PAVEMENT ON NON-RIGID BASE

NOT TO SCALE



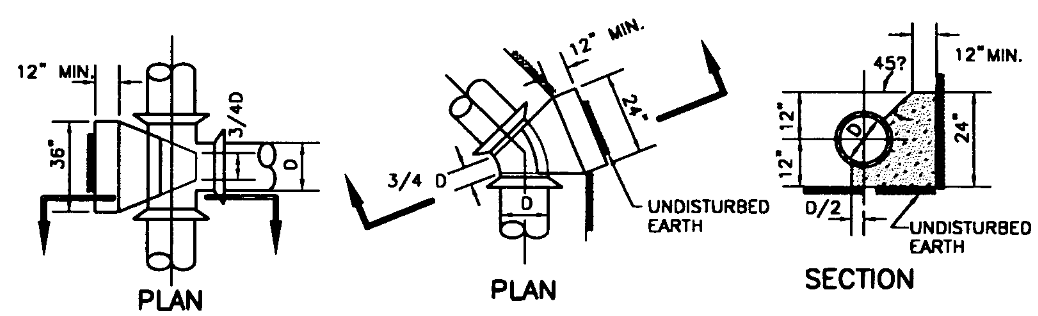
TRENCH AND BACKFILL DETAIL FOR PIPE

NO SCALE



ASPHALT CONCRETE ROADWAY DETAIL

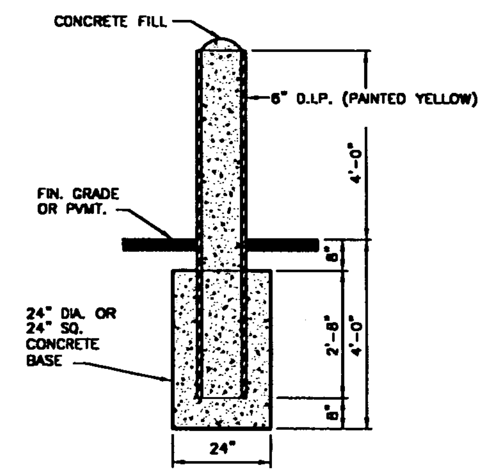
NO SCALE



NOTE: THIS DETAIL TO BE APPLIED TO ALL HORIZONTAL BENDS OF MORE THAN 10° AND BEHIND ALL TEES OF PIPE LINES WHERE TEST PRESSURE IS HIGHER THAN 30 P.S.I. FOR SMALLER PIPE AND/OR LOWER PRESSURES.

DETAILED THRUST BLOCK

NO SCALE



GUARD POST DETAIL

NO SCALE

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

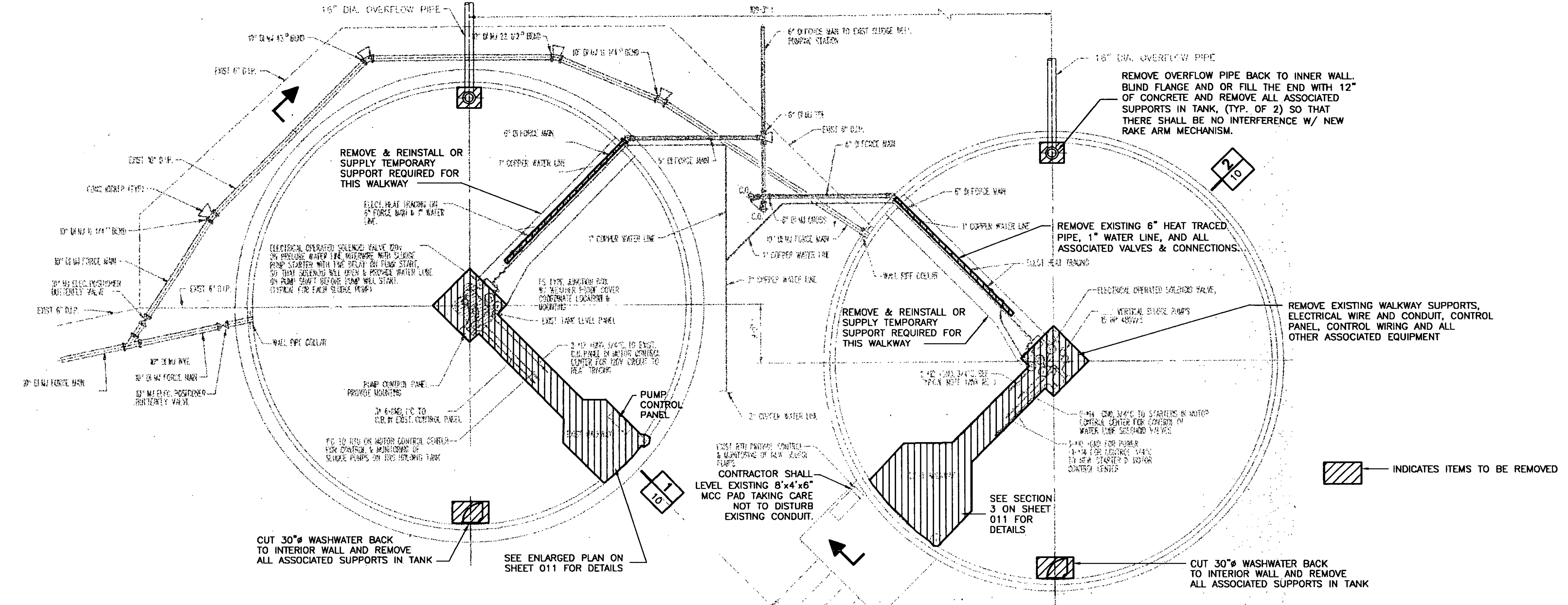
SITE
MISCELLANEOUS DETAILS

MONTGOMERY WATSON

DRAWN BY: MP
PROJECT ENG'R: GS
APPROVED: RCA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-009



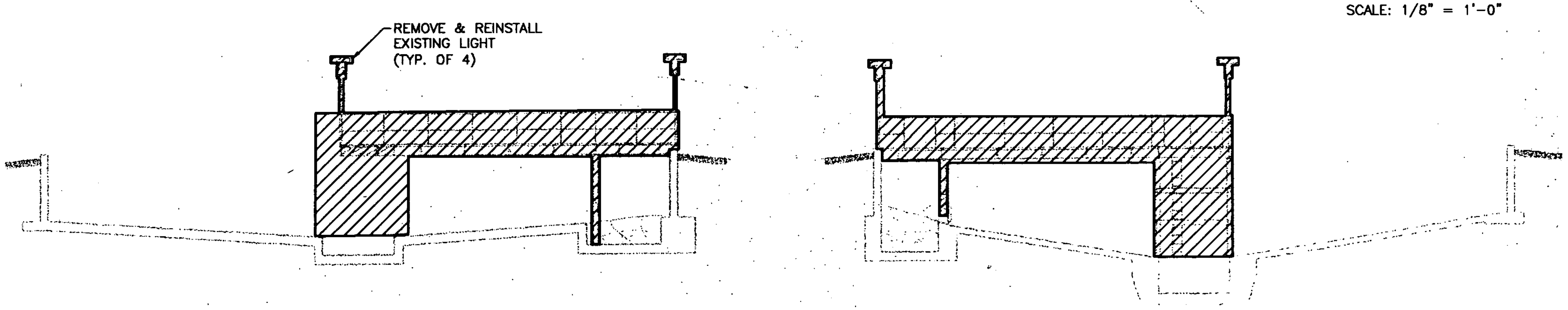
WASHWATER HOLDING TANK NO. 1
SCALE: 1/8" = 1'-0"

WASHWATER HOLDING TANK NO. 2
SCALE: 1/8" = 1'-0"

NOTES:

1. CONTRACTOR SHALL FIELD VERIFY ALL REMOVAL ITEMS REQUIRED FOR INSTALLATION OF NEW GT EQUIPMENT.

2. CONTRACTOR SHALL FIELD VERIFY THAT ALL EXISTING PIPING WITHIN THE TANKS HAS BEEN CUT FLUSH WITH THE INTERIOR WALL SO THAT THERE WILL BE NO INTERFERENCE WITH THE RAKE ARM. ANY PIPING EXTENDING INTO THE TANKS SHALL BE CUT FLUSH WITH THE INTERIOR WALL OF THE TANKS.



SECTION 1/10
SCALE: 1/8" = 1'-0"

NOTE:
SEE SHEET 011 FOR EXISTING SUPERNATANT PUMP LOCATIONS.

SECTION 2/10
SCALE: 1/8" = 1'-0"

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

DEMOLITION
WASHWATER WASTE HOLDING TANKS (1 OF 2)

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: BJK
APPROVED: RGA

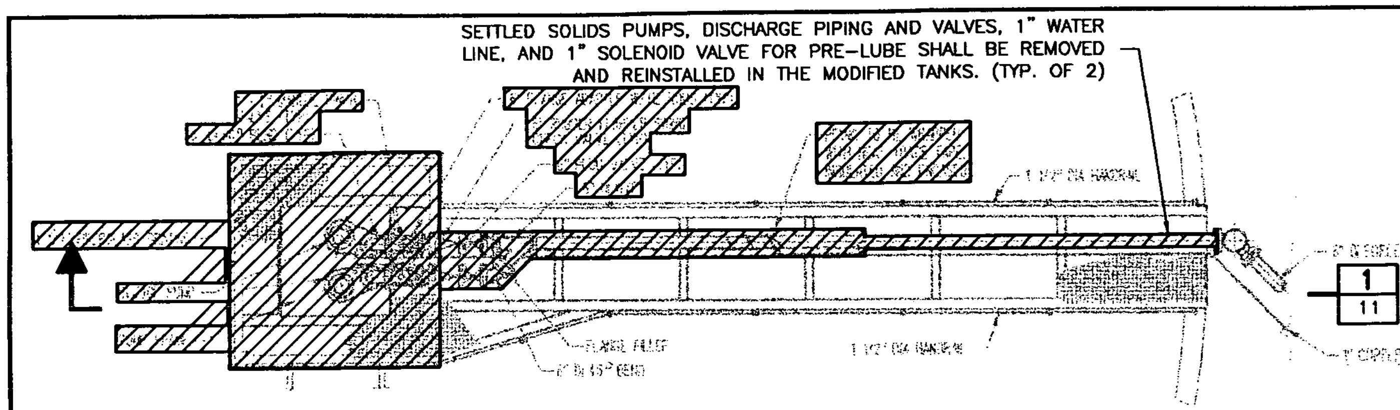
DATE: JUNE 1999

USE DIMENSIONS ONLY
SCALE AS SHOWN

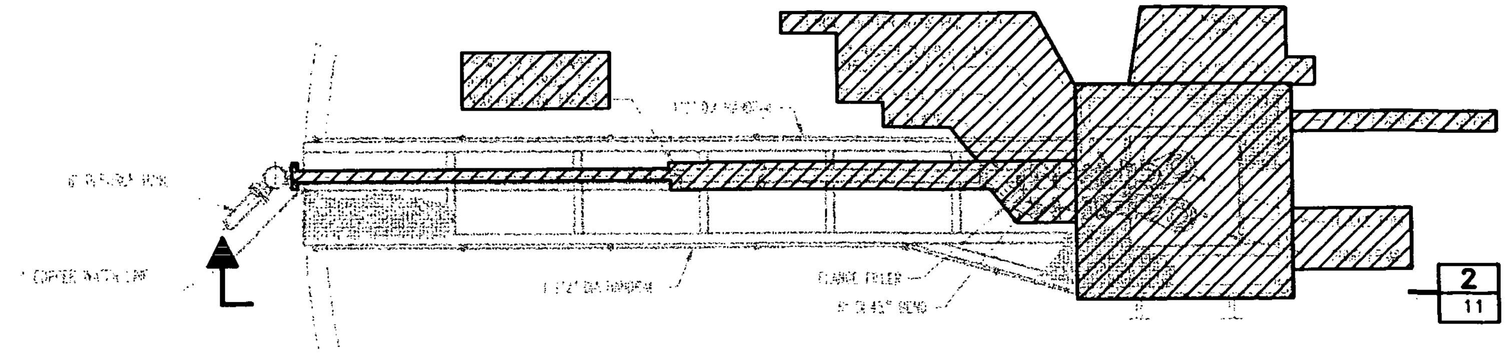
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-010

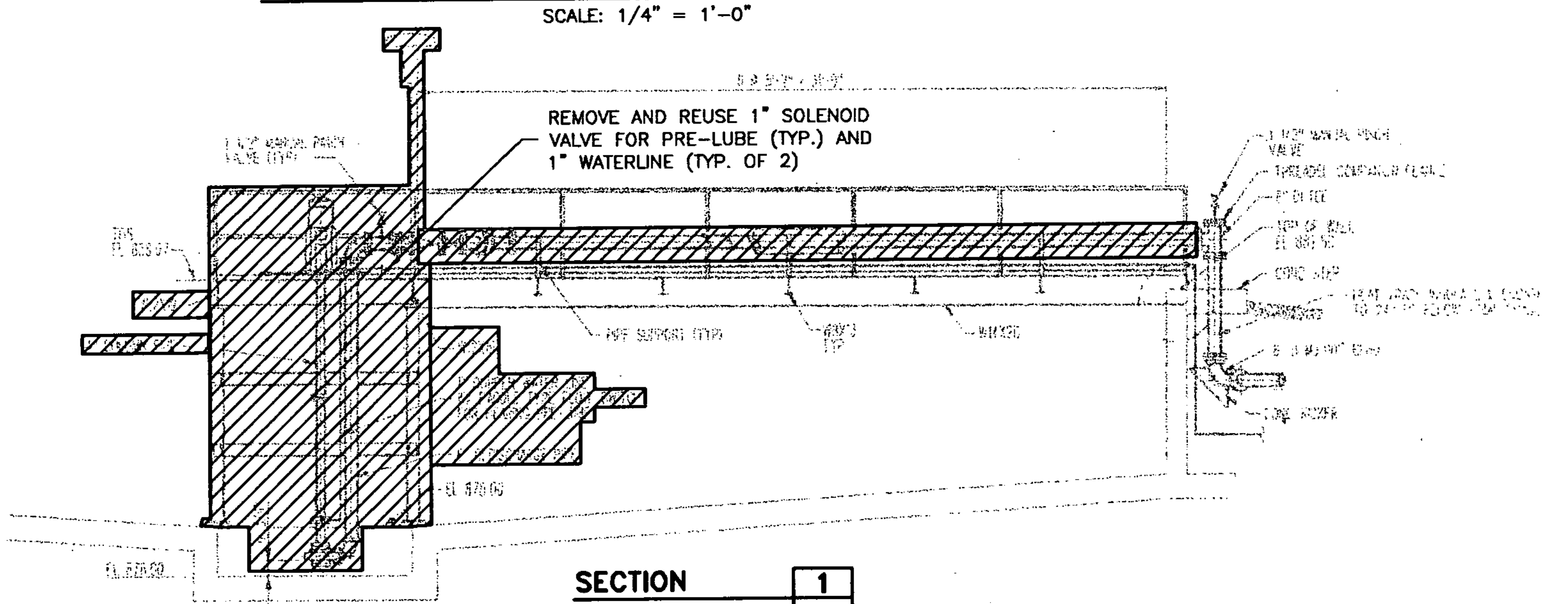
[redacted]



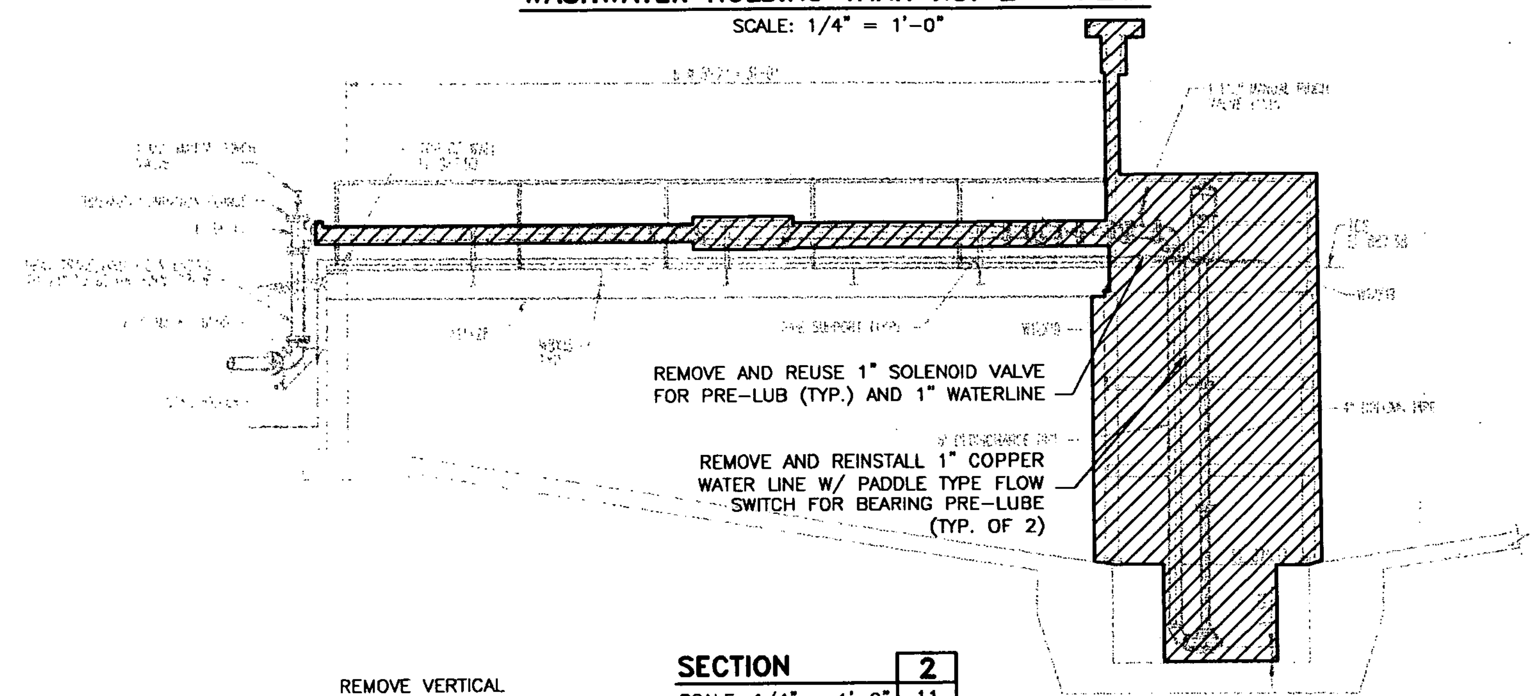
WASHWATER HOLDING TANK NO. 1 – PLAN
SCALE: 1/4" = 1'-0"



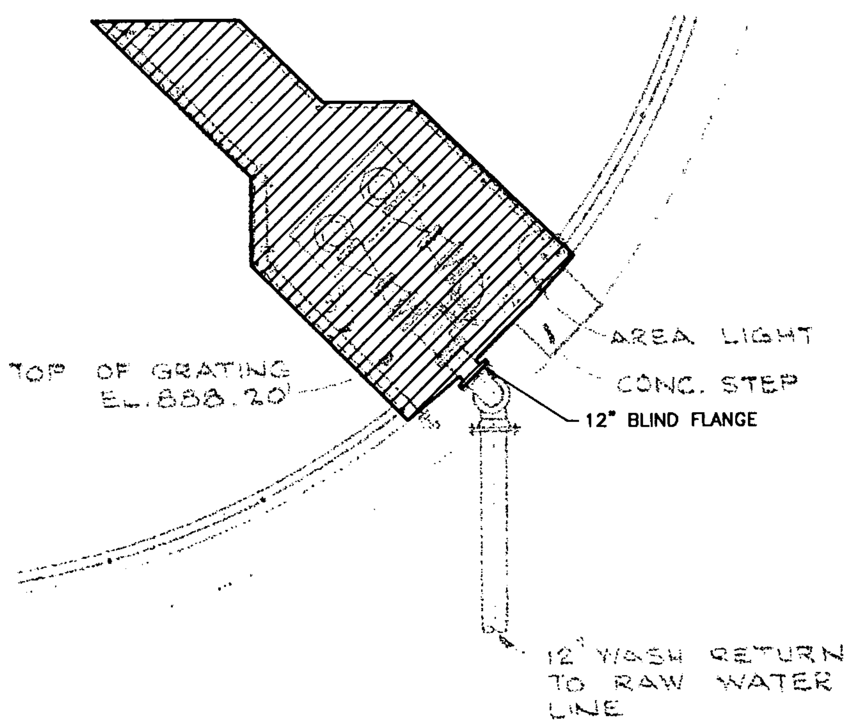
WASHWATER HOLDING TANK NO. 2 – PLAN
SCALE: 1/4" = 1'-0"



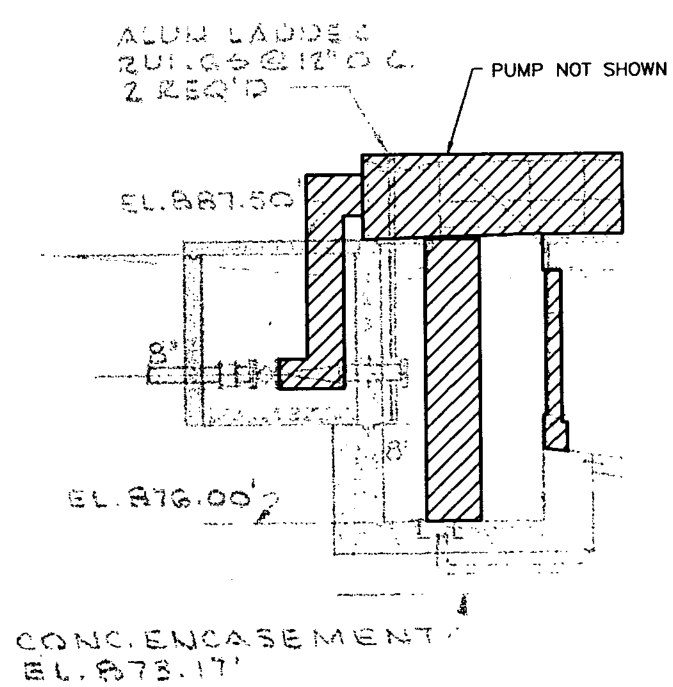
SECTION 1/11
SCALE: 1/4" = 1'-0"



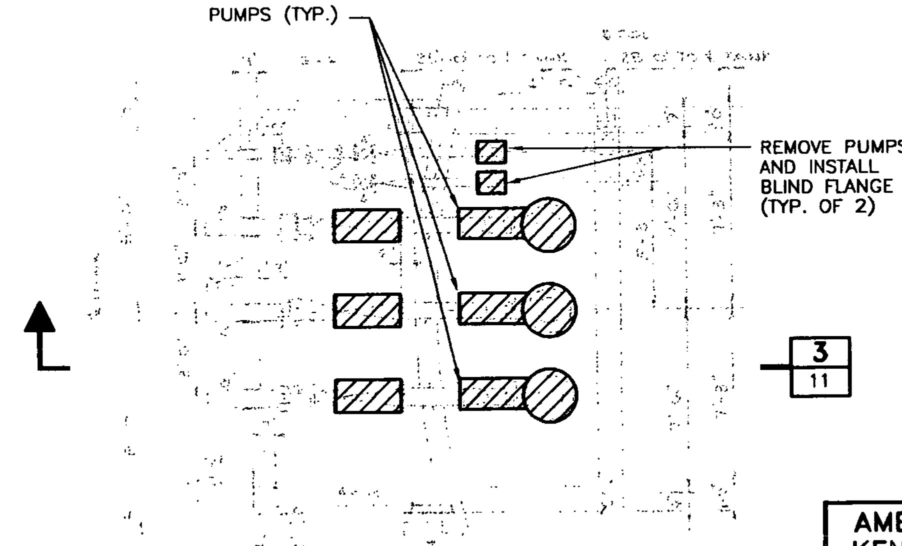
SECTION 2/11
SCALE: 1/4" = 1'-0"



EXISTING ACCESS BRIDGE DETAIL FOR WASHWATER HOLDING TANK NO. 1 – PLAN AT EL. 890.0
SCALE: 1/4" = 1'-0"



SECTION 3/11
SCALE: 1/4" = 1'-0"



EXISTING SUPERNATANT PUMPS FOR WASHWATER HOLDING TANK No. 2
SCALE: 1/4" = 1'-0"

NOTES:

1. CONTRACTOR SHALL FIELD VERIFY THAT ALL EXISTING PIPING WITHIN THE TANKS HAS BEEN CUT FLUSH WITH THE INTERIOR WALL SO THAT THERE WILL BE NO INTERFERENCE WITH THE RAKE ARM. ANY PIPING EXTENDING INTO THE TANKS SHALL BE CUT FLUSH WITH THE INTERIOR WALL OF THE TANKS TO AVOID INTERFERENCES.

2. EXISTING VERTICAL TURBINE PUMPS SHALL BE REMOVED AS SHOWN. RELOCATE TWO PUMPS FROM WASHWATER HOLDING TANK No. 2 TO SUPERNATANT RETURN VAULT No. 2. THE REMAINING PUMP FROM WASHWATER HOLDING TANK No. 2 AND THE TWO EXISTING PUMPS FROM WASHWATER HOLDING TANK No. 1 SHALL BE SALVAGED AND TURNED OVER TO THE OWNER.

DATE	REVISIONS

STATE OF KENTUCKY — RICHARD GEORGE ATOULDIAN 19947 — REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

DEMOLITION
WASHWATER WASTE HOLDING TANKS (2 OF 2)

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: BJK
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-011

GENERAL NOTES

GENERAL

STRUCTURAL DIMENSIONS CONTROLLED BY OR RELATED TO MECHANICAL OR ELECTRICAL EQUIPMENT SHALL BE COORDINATED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

MECHANICAL AND ELECTRICAL EQUIPMENT SUPPORTS, ANCHORAGES, OPENINGS, RECESSES AND REVEALS NOT SHOWN ON THE STRUCTURAL DRAWINGS BUT REQUIRED BY OTHER CONTRACT DRAWINGS, SHALL BE PROVIDED FOR PRIOR TO PLACING CONCRETE.

STRUCTURAL DRAWINGS SHALL BE USED IN COORDINATION WITH MECHANICAL, ELECTRICAL, ARCHITECTURAL, CIVIL DRAWINGS AND SHOP DRAWINGS PROVIDED BY MANUFACTURES OF EQUIPMENT.

STRUCTURES HAVE BEEN DESIGNED FOR OPERATIONAL LOADS ON THE COMPLETED STRUCTURES. DURING CONSTRUCTION, THE STRUCTURES SHALL BE PROTECTED BY BRACING AND BALANCING WHEREVER EXCESSIVE CONSTRUCTION LOADS MAY OCCUR.

UNLESS OTHERWISE SHOWN, ON ALL STRUCTURAL DRAWINGS THE FINISH GRADE AROUND STRUCTURES IS SHOWN THUS ,INDICATING EITHER GROUND SURFACE, TOP OF CONCRETE SLAB OR AC PAVEMENT. FOR DETAILS OF FINISH SURFACES SEE CIVIL AND ARCHITECTURAL DRAWINGS.

UNLESS OTHERWISE SHOWN ON THE DRAWINGS CONCRETE COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS:

- FOR CONCRETE PLACED AGAINST EARTH AND IN CHEMICAL STORAGE AREAS ________ 3"
- FOR SURFACES IN CONTACT WITH WATER OR WEATHER AND FORMED SURFACES IN CONTACT WITH EARTH ________ 2"
- FOR CONCRETE NOT EXPOSED TO WEATHER, OR IN CONTACT WITH WATER OR EARTH ________ 1 1/2"

UNLESS OTHERWISE NOTED, WALLS AND SLABS SHOWN WITH A SINGLE LAYER OF REINFORCEMENT SHALL HAVE THAT REINFORCEMENT CENTERED

STRUCTURAL STEEL

STEEL CONSTRUCTION SHALL CONFORM TO THE SPECIFICATIONS AND STANDARDS AS CONTAINED IN THE LATEST EDITION OF THE AISC STEEL CONSTRUCTION MANUAL.

ALL STRUCTURAL SHAPES, BARS, PLATES AND SHEETS SHALL BE OF STEEL MEETING ASTM A-36 SPECIFICATIONS.

ALL WELDING SHALL BE BY THE SHIELDED ARC METHOD AND SHALL CONFORM TO AWS CODE FOR ARC AND GAS WELDING IN BUILDING CONSTRUCTION. QUALIFICATIONS OF WELDERS SHALL BE IN ACCORDANCE WITH THE SPECIFICATIONS FOR STANDARD QUALIFICATION PROCEDURE OF THE AWS.

ALL FIELD CONNECTION BOLTS SHALL BE 7/8" DIA. ASTM TYPE A325.

BEAM CONNECTIONS EXCEPT AS OTHERWISE SHOWN SPECIFIED OR REQUIRED SHALL BE AMERICAN INSTITUTE OF STEEL CONSTRUCTION TABLE II STANDARD BEAM CONNECTIONS AS SHOWN IN THE NINTH EDITION OF THE AISC MANUAL. SHOP CONNECTION MAY BE BOLTED.

LINTELS FOR EXTERIOR AND INTERIOR NOT SHOWN OR NOTED SHALL BE ONE 3-1/2" X 3-1/2" X 5/16" ANGLE FOR 4" OF WALL THICKNESS UP TO 5'-0" CLEAR OPENING. THE SIZE OF THE LINTEL FOR OPENING LARGER THAN 5'-0" SHALL BE AS DIRECTED BY THE ENGINEER. ALL LINTELS MUST EXTEND 8" BEARING IN THE WALL.

MASONRY

CONCRETE BLOCK MASONRY SHALL BE LIGHTWEIGHT, HOLLOW UNITS CONFORMING TO ASTM C 90, TYPE 1. SIZE OF UNITS, COLOR AND TEXTURE SHALL BE PER THE SPECIFICATIONS.

GROUT CELLS OF CONCRETE BLOCK MASONRY AS NOTED ON DRAWINGS.

BAR LAPS SHALL BE 48 BAR DIAMETERS UNLESS OTHERWISE NOTED.

MORTAR SHALL BE IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS

GROUT SHALL BE IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED, SPECIAL INSPECTION SHALL BE PROVIDED FOR ALL MASONRY WORK.

THE COMBINED MASONRY ASSEMBLAGE COMPRESSIVE STRENGTH AT 28 DAYS SHALL BE A MINIMUM OF f'm = 1,500 PSI.

REINFORCEMENT SHALL BE TIED OR OTHERWISE SECURED IN POSITION PRIOR TO GROUTING.

ALL INTERNAL AND EXTERNAL MASONARY WALLS SHALL HAVE #5@40" REINF AND #5@40" DOWELS FROM THE SUBSTRUCTURE. DOWELS LENGTH = 4'-0" (TYPICAL ALL VERTICAL REINFORCEMENTS UNLESS OTHERWISE NOTED).

VERTICAL REINFORCEMENT (#5 DOWELD TO SUBSTRUCTURE) SHALL BE PROVIDED CONTINUOUSLY FROM SUPPORT TO SUPPORT AT EACH CORNER, AT EACH SIDE OF EACH OPENING AND AT THE ENDS OF WALLS.

VERTICAL REINFORCEMENTS FOR EXTERNAL WALLS SHALL EXTEND INTO PARAPETS. INTERNAL WALL REINF. SHALL EXTEND INTO BOND BEAMS TYP.

CONCRETE (EXCEPT PRECAST CONCRETE)

UNLESS OTHERWISE NOTED OR SPECIFIED, ALL STRUCTURAL CONCRETE SHALL DEVELOP A MINIMUM COMPRESSIVE STRENGTH OF 4000 PSI IN 28 DAYS.

REINFORCEMENT STEEL SHALL BE DEFORMED BARS CONFORMING IN QUALITY TO THE REQUIREMENTS OF ASTM A-615, "SPECIFICATIONS FOR DEFORMED BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT", GRADE 60

COLUMN SPIRALS SHALL CONFORM TO ASTM A-82, "SPECIFICATION FOR COLD-DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT".

ALL DETAILING, FABRICATION AND PLACING OF REINFORCING BARS, UNLESS OTHERWISE INDICATED, SHALL BE IN ACCORDANCE WITH ACI-315, "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES", LATEST EDITION.

TOLERANCES IN PLACING REINFORCEMENT SHALL BE:

- 3/8 INCH FOR MEMBERS WITH D • 8 INCHES
- 1/2 INCH FOR MEMBERS WITH D > 8 INCHES

ALL KEYWAYS IN CONSTRUCTION JOINTS, WHERE SHOWN, SHALL BE ROUGH AND THOROUGHLY CLEANED FOR BOND.

DOWELS, PIPE, WATERSTOPS AND OTHER INSTALLED MATERIALS AND ACCESSORIES SHALL BE HELD SECURELY IN POSITION WHILE CONCRETE IS BEING PLACED.

UNLESS OTHERWISE INDICATED, ASIDE FROM NORMAL ACCESSORIES USED TO HOLD REINFORCING BARS FIRMLY IN POSITION, THE FOLLOWING SHALL BE ADDED:

A) IN SLABS #5 RISER BARS AT 36 INCHES OC MAXIMUM TO SUPPORT TOP REINFORCING BARS.

B) IN WALLS WITH 2 CURTAINS #3 U OR Z SHAPE SPACERS AT 6 FEET OC EACH WAY.

METAL CLIPS OR SUPPORTS SHALL NOT BE PLACED IN CONTACT WITH THE FORMS OR THE SUBGRADE. CONCRETE BLOCKS (OR DOBIES) SUPPORTING BARS ON SUBGRADE SHALL BE IN SUFFICIENT NUMBERS TO SUPPORT THE BARS WITHOUT SETTLEMENT, BUT IN NO CASE SHALL SUCH SUPPORT BE CONTINUOUS.

DOWELS SHALL BE WIRED OR OTHERWISE HELD IN POSITION. THEY SHALL NOT BE SHOVED INTO FRESHLY PLACED CONCRETE.

UNLESS OTHERWISE INDICATED ON THE DRAWINGS, LAPS OF REINFORCEMENT SHALL BE AS SHOWN ON DETAIL S-143.

REINFORCING BARS AND ACCESSORIES SHALL NOT BE IN CONTACT WITH AND PIPE, PIPE FLANGE OR METAL PARTS EMBEDDED IN CONCRETE, A MINIMUM OF 2 INCHES CLEARANCE SHALL BE PROVIDED AT ALL TIMES.

ALUMINUM

ALUMINUM CONSTRUCTION SHALL BE IN ACCORDANCE WITH AMERICAN SOCIETY OF CIVIL ENGINEERS SPECIFICATIONS FOR STRUCTURES OF ALUMINUM ALLOY 6061-T6. ALUMINUM SURFACES SHALL BE PREVENTED FROM COMING IN DIRECT CONTACT WITH CONCRETE OR WITH METALS NOT COMPATIBLE WITH ALUMINUM, USING METHODS DESCRIBED IN THE SPECIFICATIONS.

TESTING HYDRAULIC STRUCTURES

WHEN FILLING THE STRUCTURES WITH WATER FOR THE TEST REQUIRED IN THE SPECIFICATIONS, ALL VARIOUS BASINS LOCATED IN THE SAME STRUCTURE SHALL BE FILLED SIMULTANEOUSLY AT THE SAME RATE IN ORDER TO KEEP THE SAME LEVEL IN EACH BASIN.

STRUCTURAL STANDARD DETAILS

DETAILS ON SHEETS ST-20 THRU ST-23 ARE PART OF MONTGOMERY WATSON'S STRUCTURAL STANDARD DETAILS.

THESE DETAILS ARE TO BE USED WHEN REFERRED TO OR WHEN NO OTHER MORE RESTRICTIVE OR DIFFERENT DETAILS ARE SHOWN ON THE DRAWINGS.

STRUCTURAL

1. DESIGN IN ACCORDANCE WITH THE 1996 EDITION OF THE BOCA BUILDING CODE, EXCEPT WHERE OTHER APPLICABLE CODES ARE MORE RESTRICTIVE.

LOADINGS

1 WIND LOADS (BOCA 1609.0)
BASIC WIND SPEED 70 MPH, EXPOSURE C, IMPORTANCE FACTOR = 1.0

2 SNOW LOADS (BOCA 1608.0)
GROUND SNOW LOAD Pg - 25 psf.
IMPORTANCE FACTOR = 1.0
SNOW EXPOSURE FACTOR = 0.90

3 ADD DRIFT LOADING PER BOCA 1996, SECTION 1608.7 OR ANSI A58
DRIFT LOADING SHALL BE CALCULATED CASE BY CASE.

4 DEAD LOAD (SMALL PIPING, CEILING, ELECT., PLUMB) = 30 PSF

5 HVAC LOADS AND PIPING GREATER THAN 3" TO BE ADDED TO DEAD LOADS

6 MONORAIL LOADS INCLUDING 20% IMPACT = SEE SPECS

LOCATION OF ALL CONSTRUCTION JOINTS SHALL BE AS APPROVED BY THE ENGINEER. ALL CONSTRUCTION JOINTS LOCATED ON THE DRAWINGS OR REQUIRED FOR CONSTRUCTION, BUT NOT SHOWN ON THE DRAWINGS, SHALL HAVE A 6" FLATSTRIP WATERSTOP, IF IN MEMBERS IN CONTACT WITH WATER. IN ADDITION, JOINTS IN ALL SLABS COVERED WITH WATER, SHALL HAVE BOTH A 6" FLATSTRIP WATERSTOP AND A SEALANT GROOVE.

ABBREVIATIONS

ALUM.	ALUMINUM
AS REQ'D	AS REQUIRED
CJ	CONSTRUCTION JOINT
DET	DETAIL
DN	DOWN
EWEF	EACH WAY EACH FACE
EW	EACH WAY
EWT&B	EACH WAY TOP AND BOTTOM
EW BOT	EACH WAY BOTTOM
EF	EACH FACE
EJ	EXPANSION JOINT
FS	FAR SIDE
H.P.	HIGH POINT
L.P.	LOW POINT
NS	NEAR SIDE
PL	PLATE
REINF	REINFORCEMENT
SECT	SECTION
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
W.S.	WATER STOP

LINTELS AND BOND BEAMS

1 STEEL LINTELS AND MASONRY LINTELS ARE SHOWN ON THE ARCH. DRAWINGS

2 CAST IN PLACE REINFORCED CONCRETE BOND BEAMS ARE SHOWN ON THE ARCH. SECTIONS

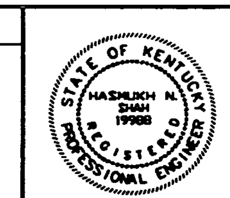
FOUNDATION

1. DEWATERING BUILDING TO BE SUPPORTED ON BEDROCK THROUGH A SYSTEM OF DRILLED CAISSONS DESIGNED FOR A NET ALLOWABLE BEARING VALUE OF 20000 POUNDS PER SQUARE FOOT.

2. LAGOON SUPERNATANT RETURN VAULT TO BE SUPPORTED ON SPREAD FOOTING.

3.AS PER GEOTECHNICAL REPORT NET ALLOWABLE SOIL BEARING VALUE OF 2000 PSF.

DATE	REVISIONS



WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

STRUCTURAL
GENERAL NOTES AND ABBREVIATIONS

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RCA
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES | 380-575-012

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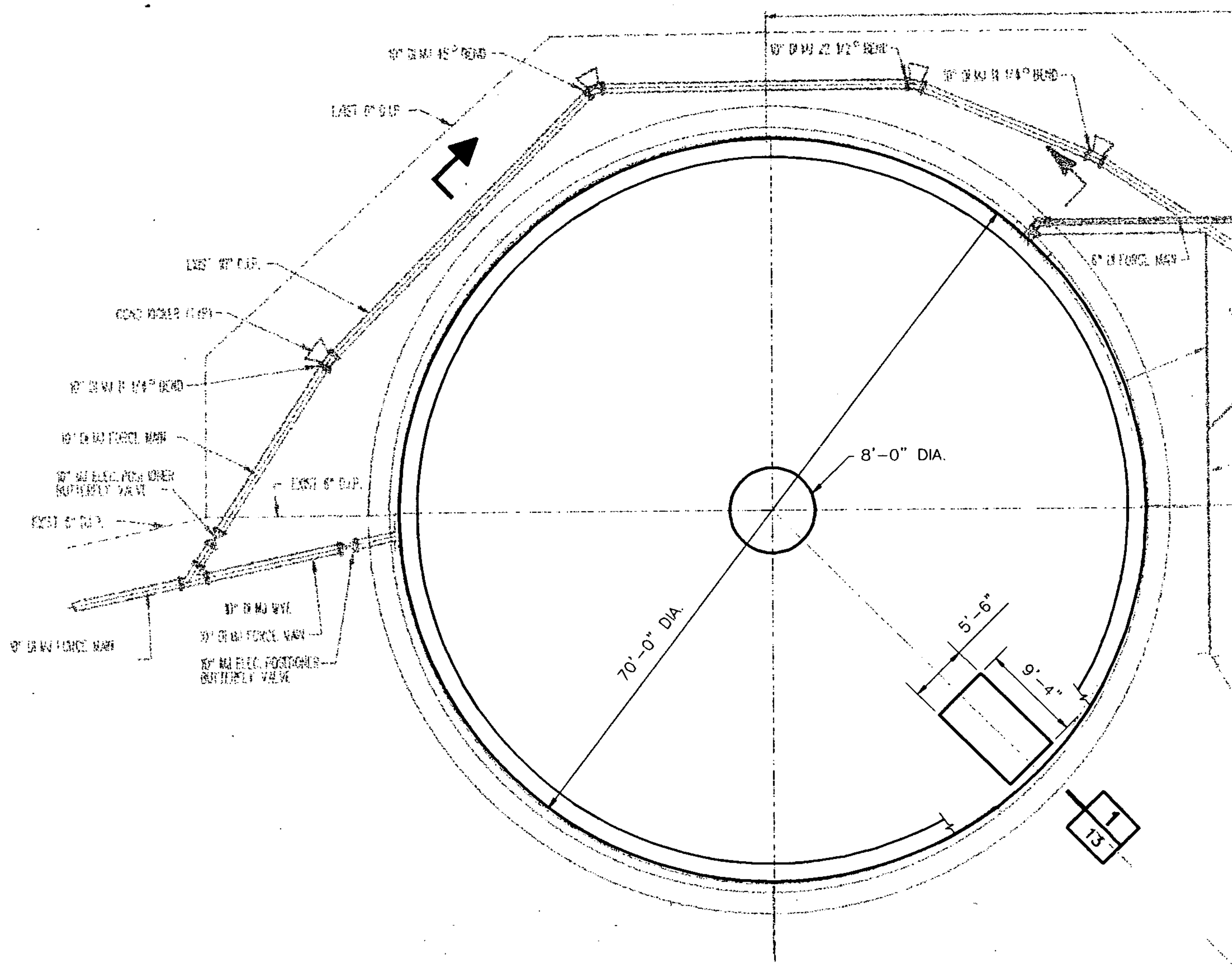
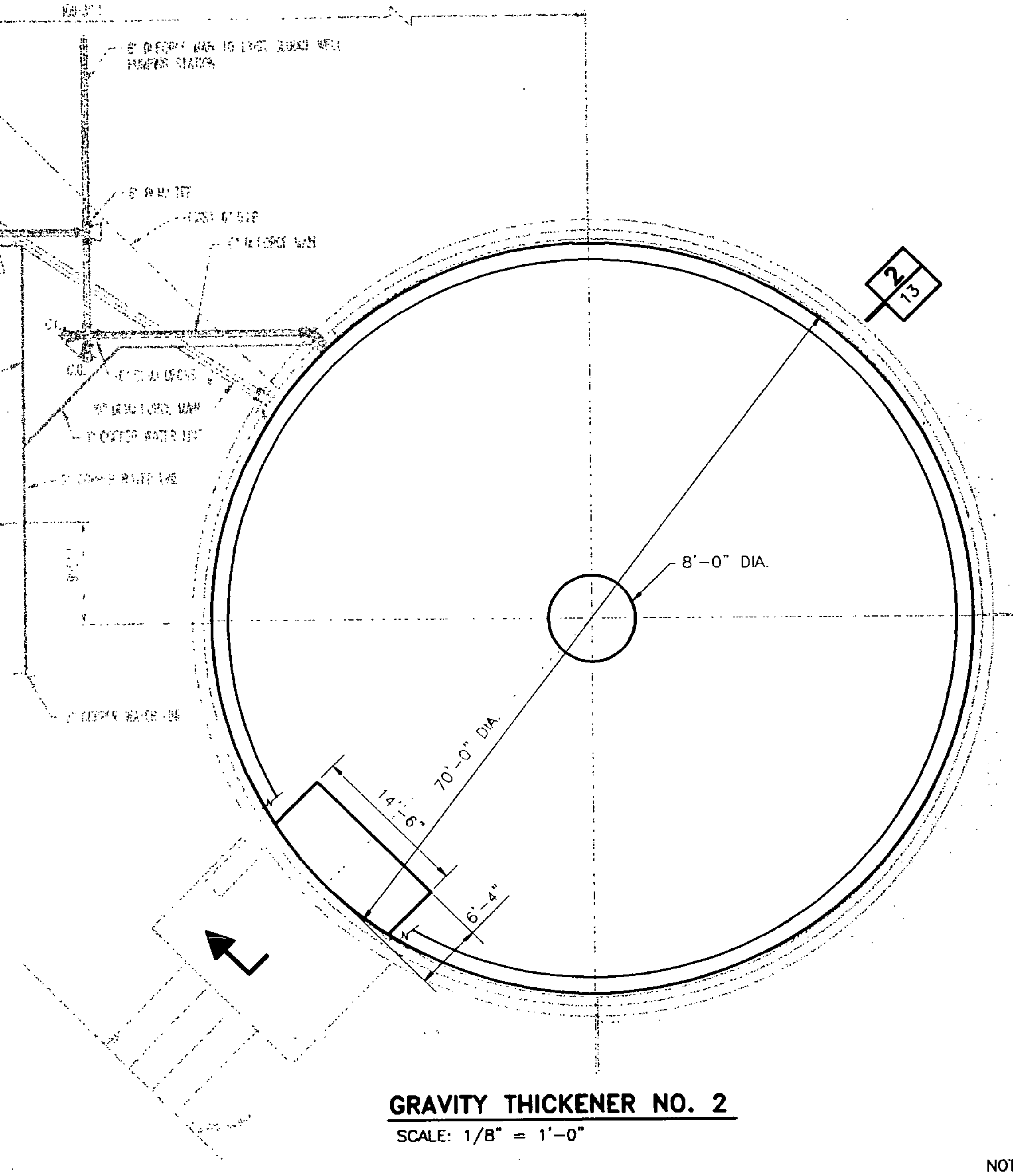


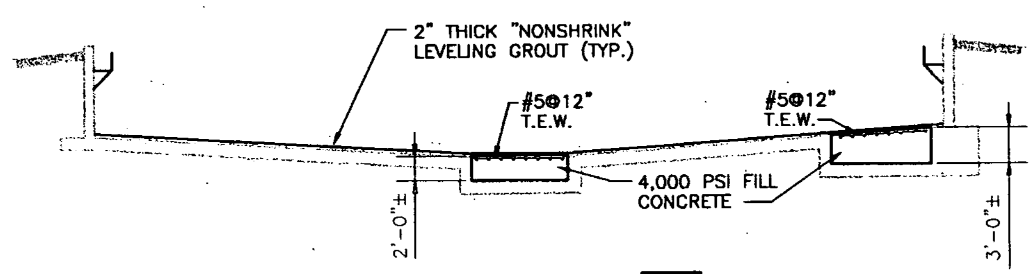
GRAVITY THICKENER NO. 1
SCALE: 1/8" = 1'-0"



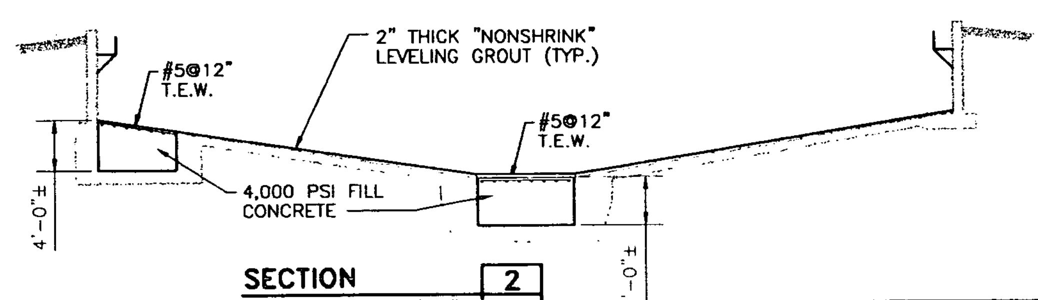
GRAVITY THICKENER NO. 2
SCALE: 1/8" = 1'-0"

NOTES:

1. ROUGHEN AND CLEAN EXISTING CONCRETE SURFACE.
2. PROVIDE WELDCRETE OR EQUAL AS BONDING COMPOUND.
3. POUR NEW CONCRETE OR GROUT AS SHOWN ON DRAWING.
4. SEE SHEET 035 FOR RACK ARM AND ACCESS WALKWAYS.



SECTION 1/13
SCALE: 1/8" = 1'-0"



SECTION 2/13
SCALE: 1/8" = 1'-0"

DATE	REVISIONS

STATE OF KENTUCKY — HASMUKH N. SHAH 19988 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

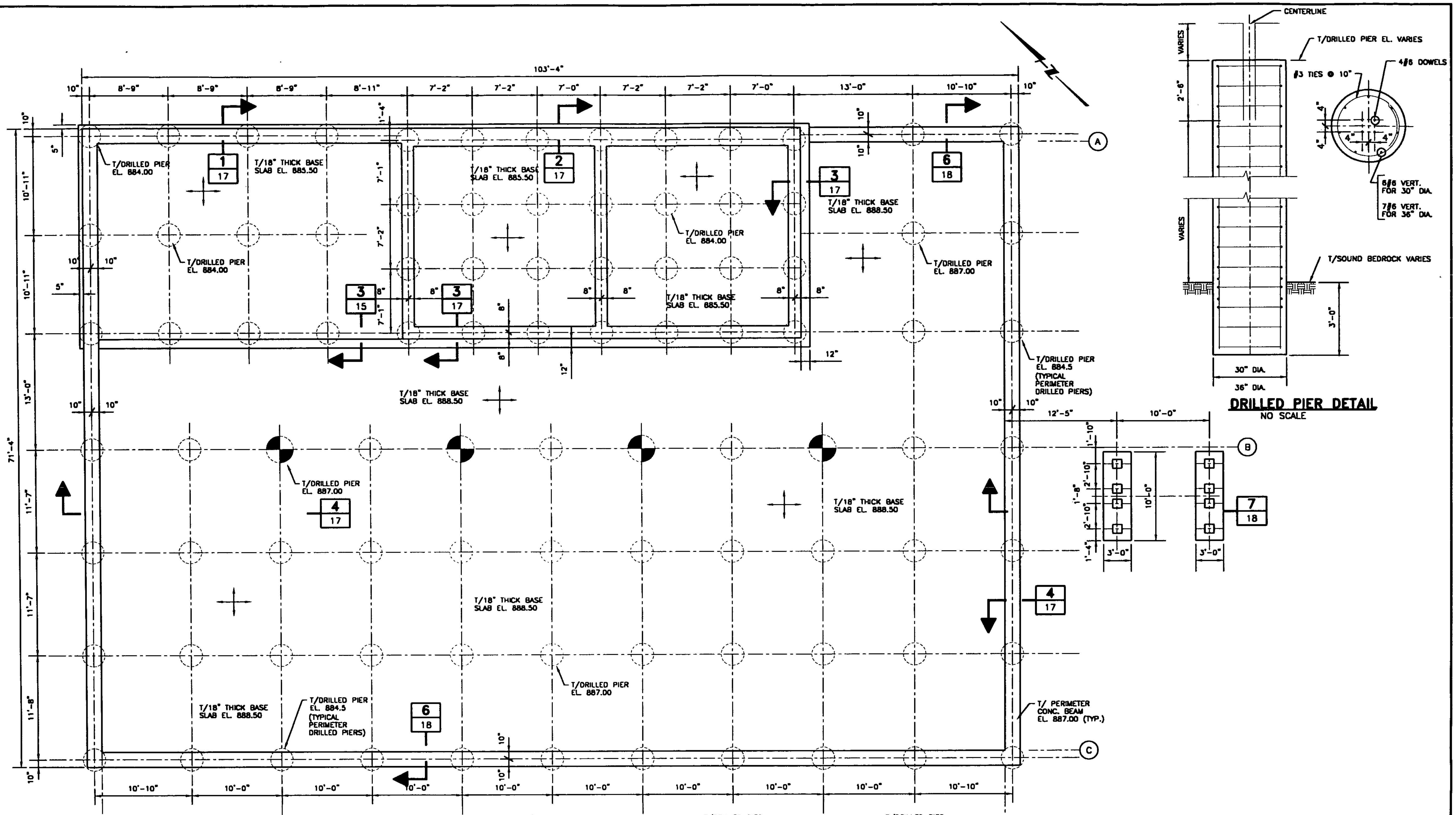
STRUCTURAL
GRAVITY THICKENERS

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-013



DRILLED PIER DETAIL
NO SCALE

FOUNDATION & DRILLED PIERS PLAN
SCALE: 3/16" = 1'-0"

3'-0" DIAMETER DRILLED PIER

2'-6" DIAMETER DRILLED PIER

DATE	REVISIONS

STATE OF KENTUCKY
HASMUKH N. SHAH
19968
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

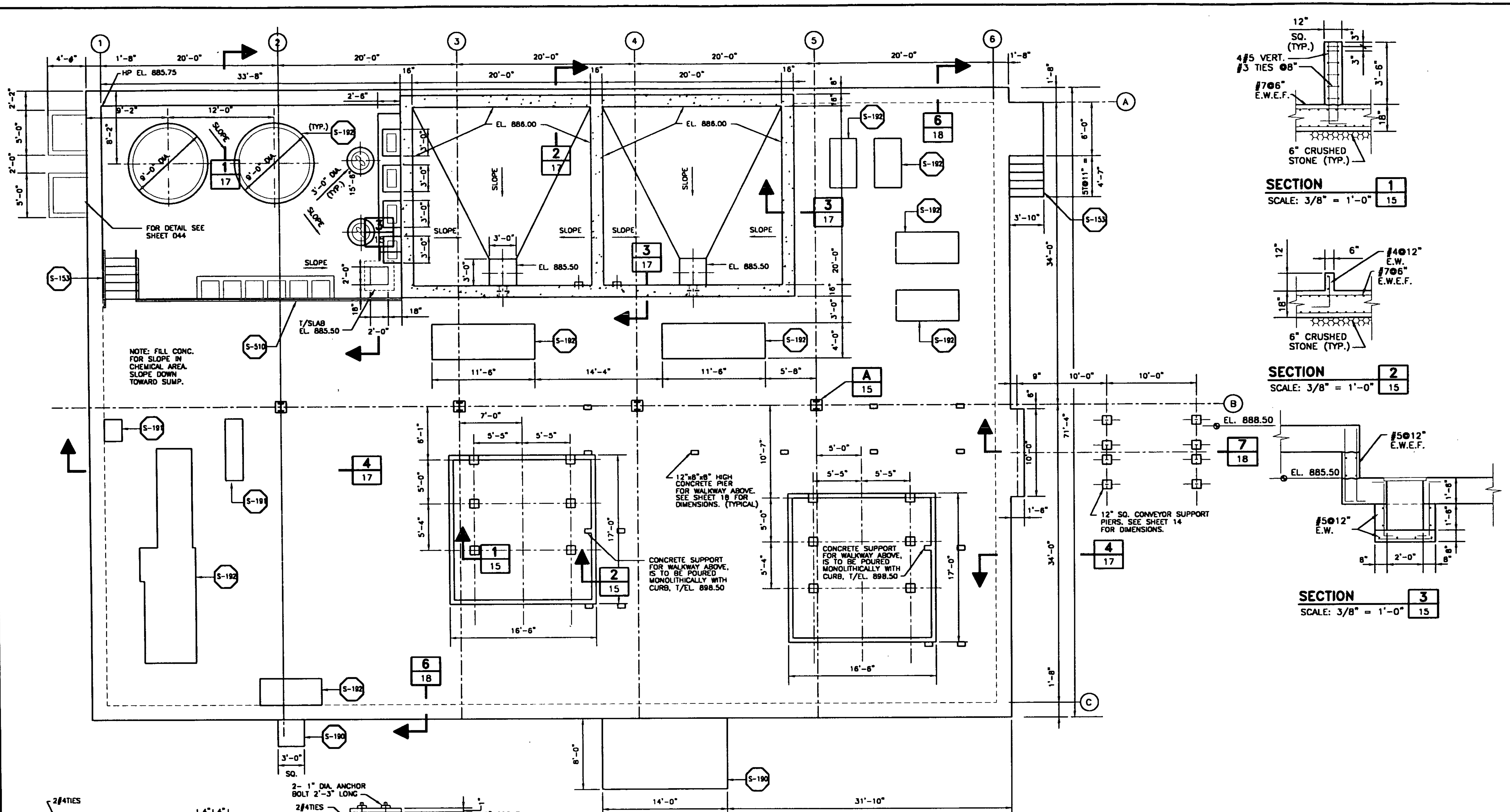
STRUCTURAL
DEWATERING BUILDING FOUNDATION PLAN

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

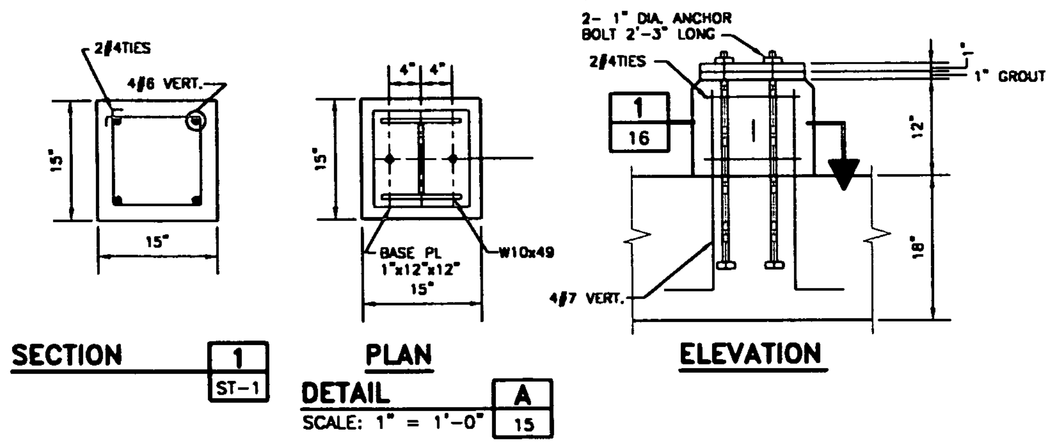
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-014



FLOOR PLAN - EL. 888.50

SCALE: 3/16" = 1'-0"



NOTES:

1. CONVEYOR SUPPORTS INSIDE THE BUILDING ARE APPROXIMATELY 10'-0" O.C. - ARE NOT SHOWN.
2. PROVIDE 8"x8"x8" CONCRETE PIER FOR CONVEYOR SUPPORT.

DATE	REVISIONS

STATE OF KENTUCKY — HASMUKH N. SHAH 19988 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

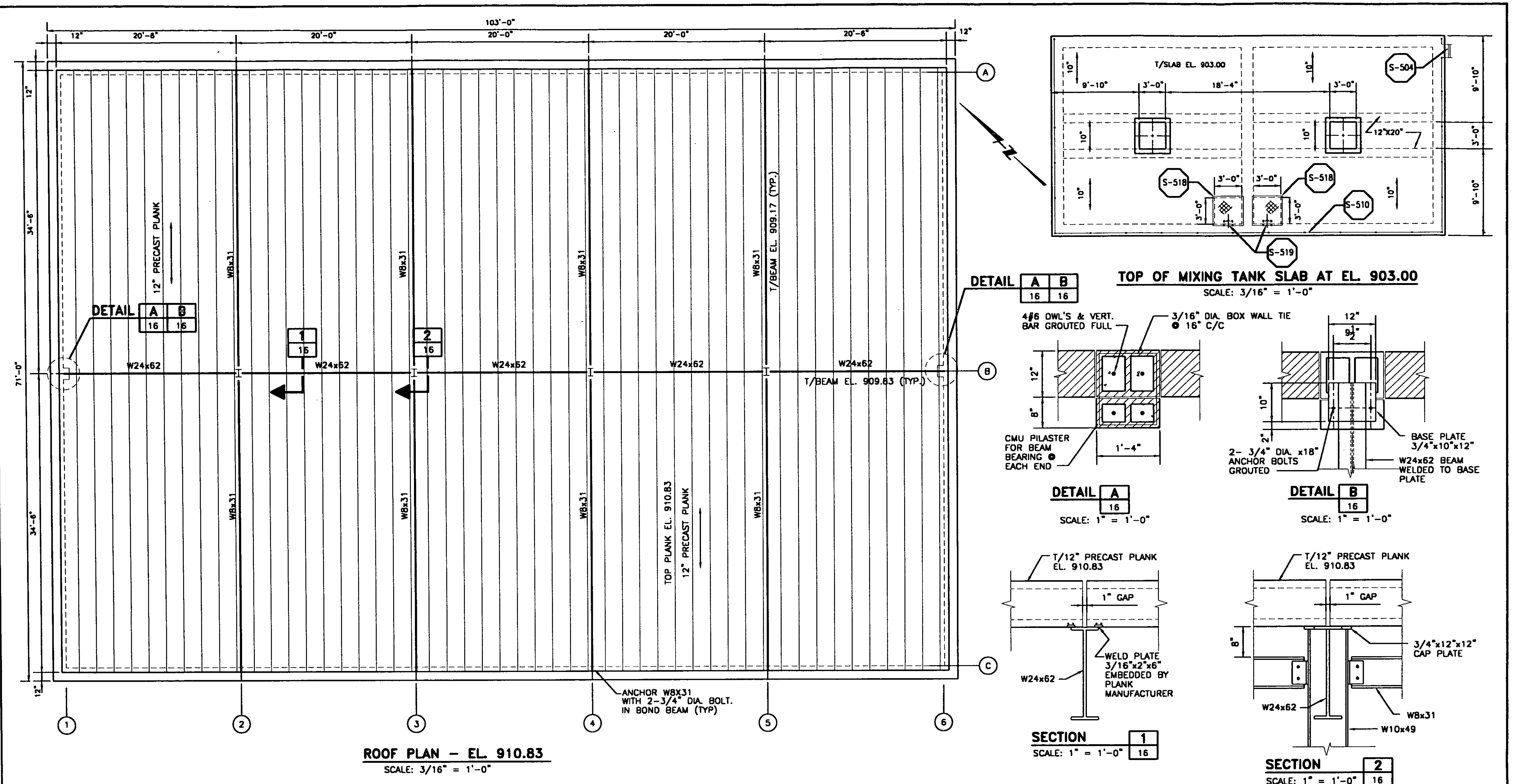
STRUCTURAL
DEWATERING BUILDING FLOOR PLAN AND DETAILS

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-015



NOTE :

1 EACH PLANK HAVE ANCHORED CONNECTION AT ONE END & SLIDING CONNECTION OTHER END. AS PER PLANK MANUFACTURER RECOMMENDATION.

2 PROVIDE ANCHORED AND SLIDING CONNECTION ALTERNATE END.

DATE	REVISIONS

STATE OF KENTUCKY HASMUKH N. SHAH 19988 REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

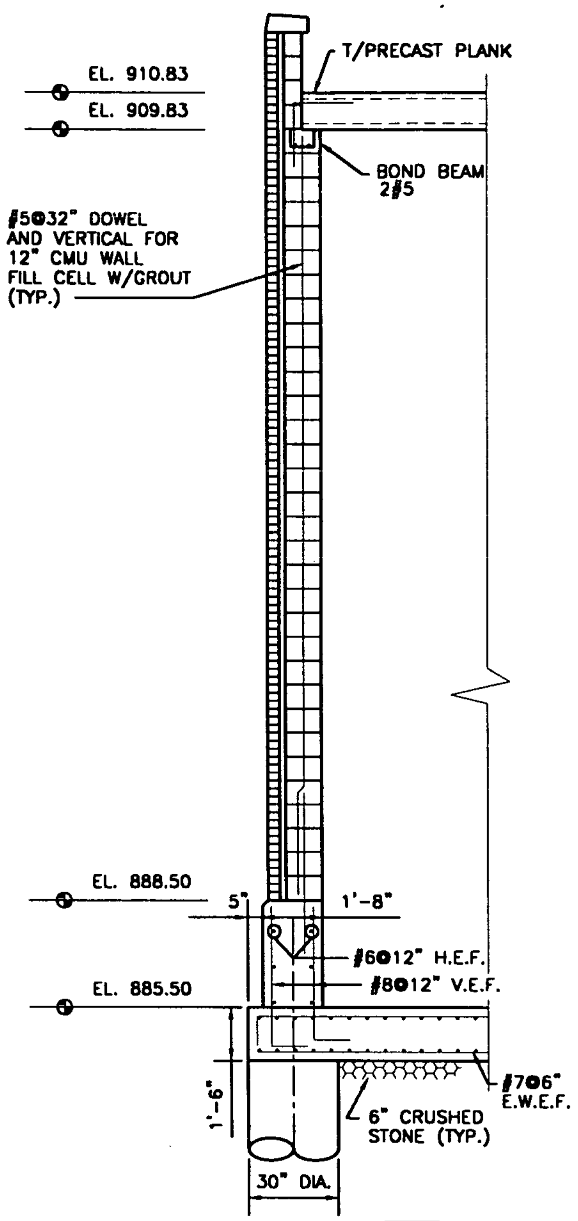
STRUCTURAL
DEWATERING BUILDING ROOF PLAN

MONTGOMERY WATSON

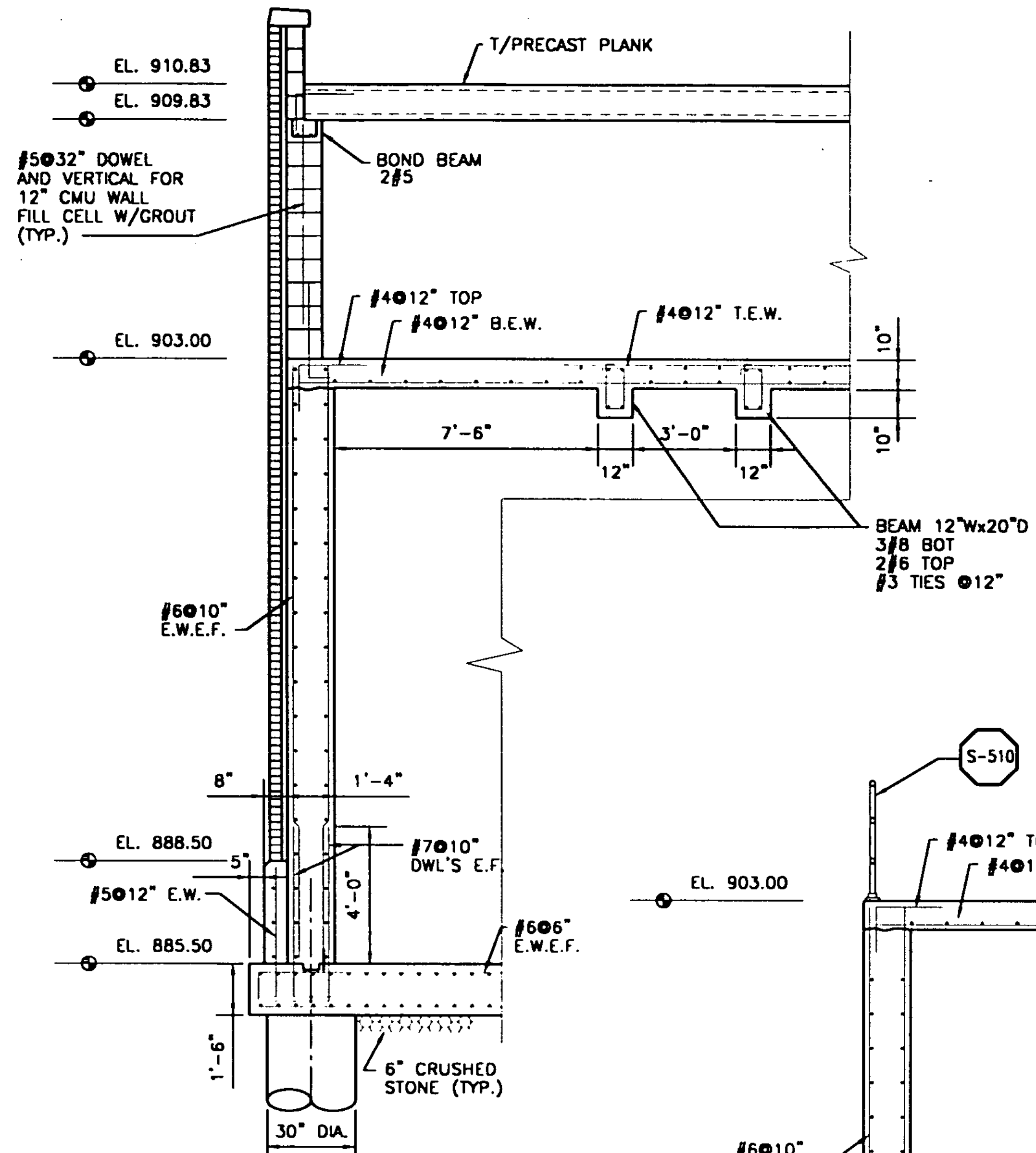
DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RGA
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

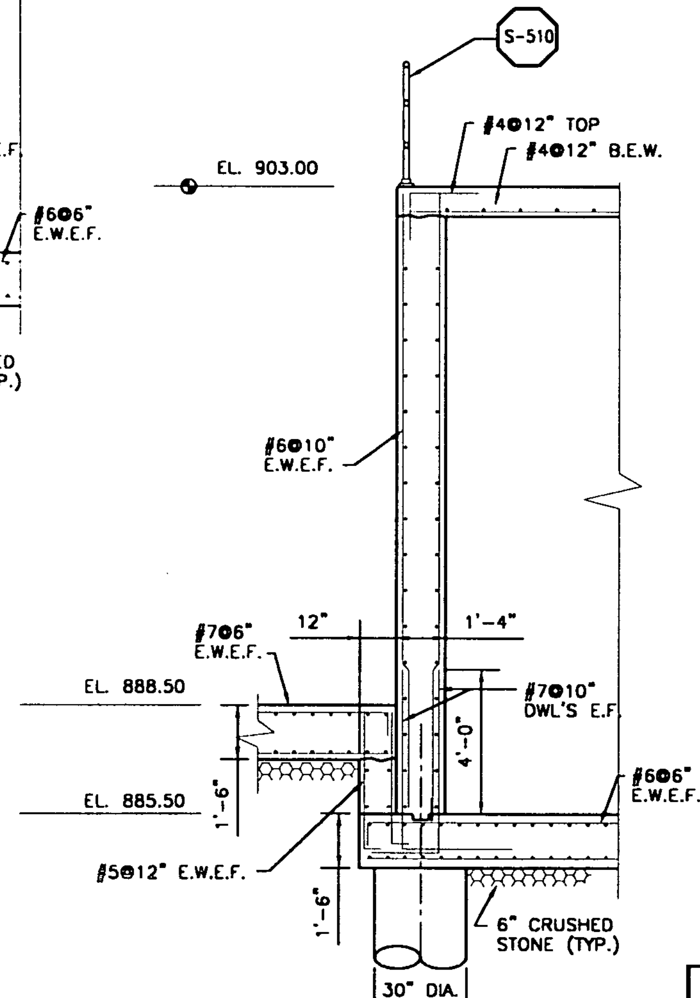
380-575-016



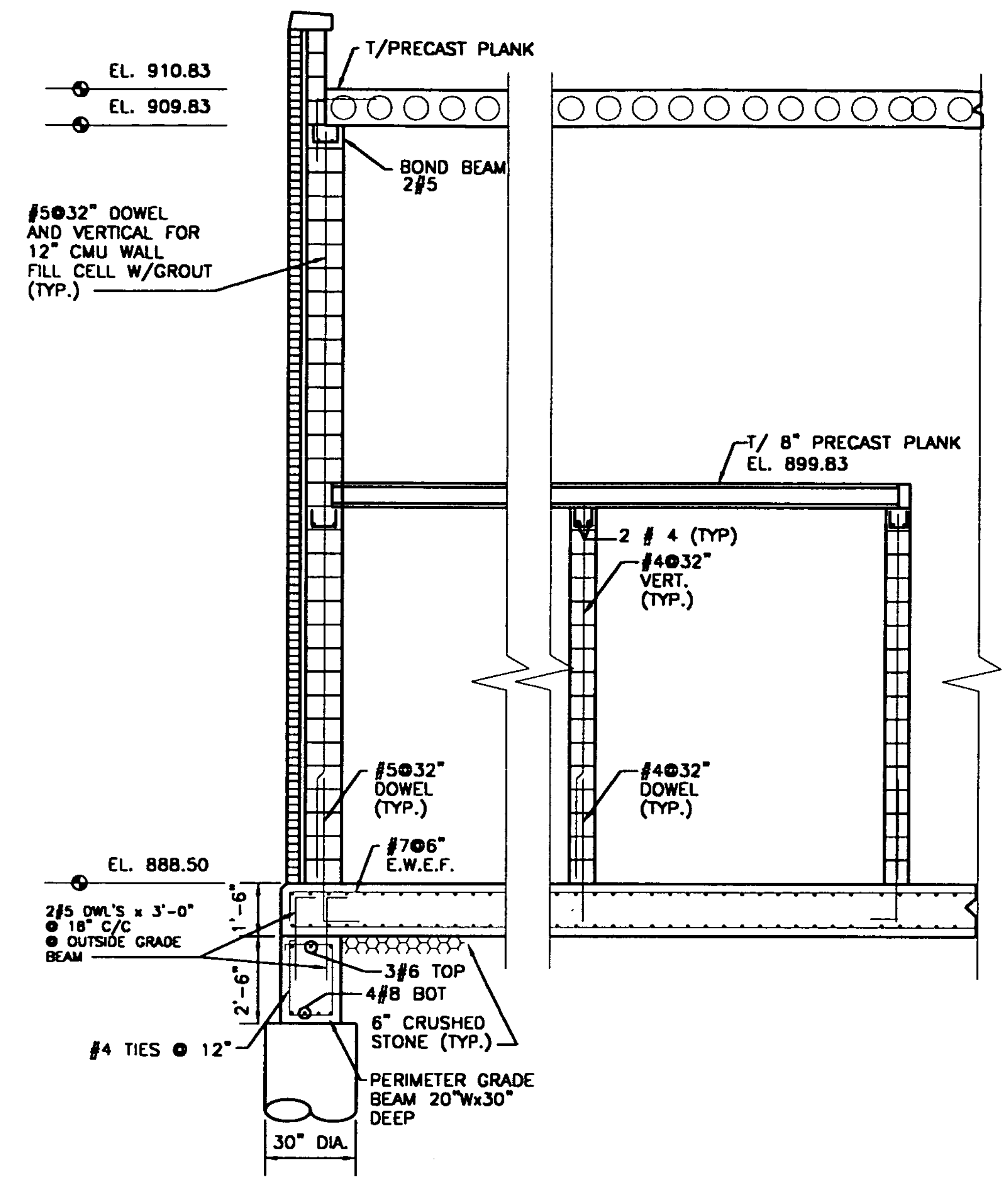
SECTION 1/14
SCALE: 3/8" = 1'-0"



SECTION 2/14
SCALE: 3/8" = 1'-0"



SECTION 3/14
SCALE: 3/8" = 1'-0"



SECTION 4/14
SCALE: 3/8" = 1'-0"

DATE	REVISIONS

STATE OF KENTUCKY · HASHLBCH N. SHAH 19988 · REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

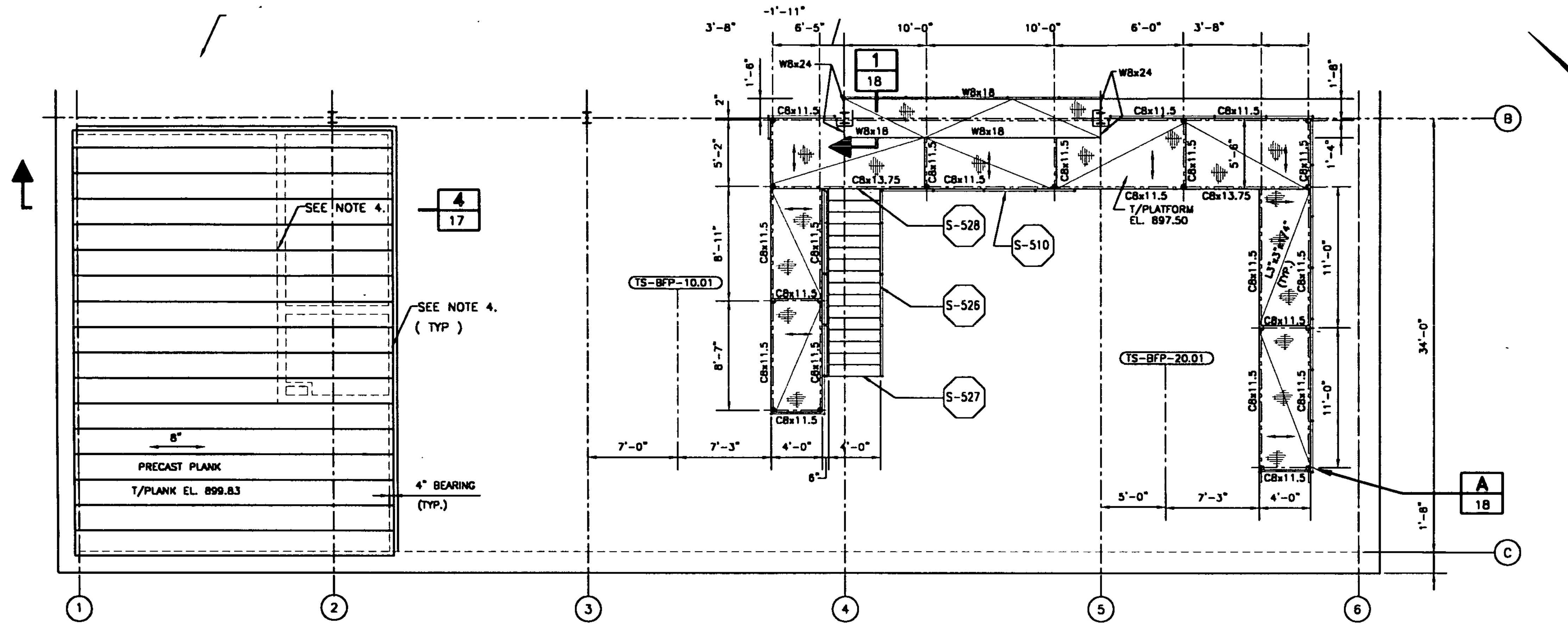
STRUCTURAL
DEWATERING BUILDING SECTIONS

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RGA
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-017

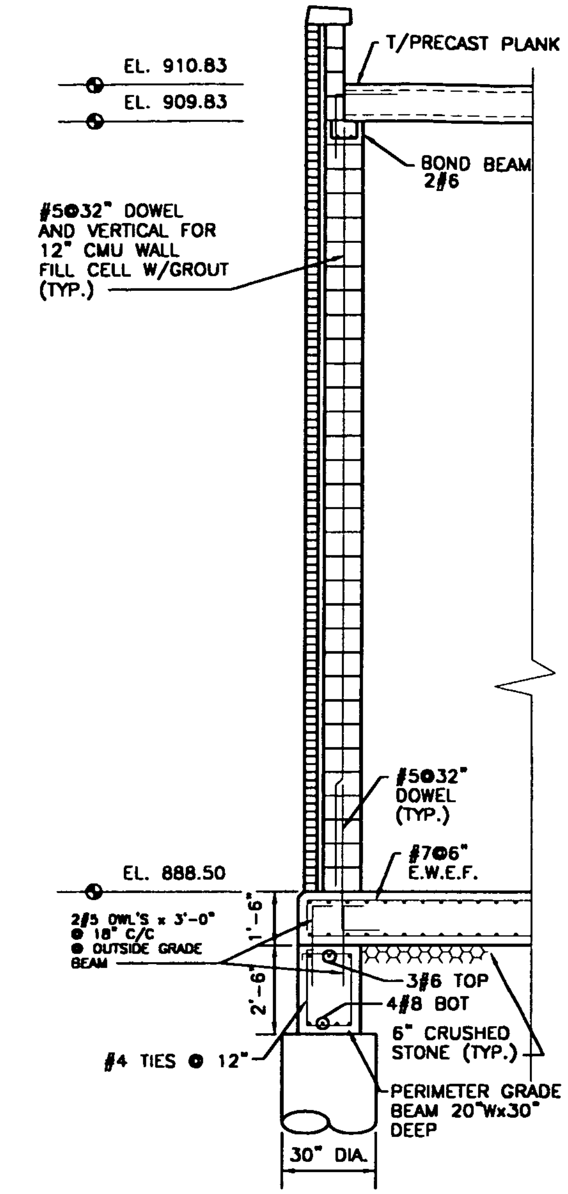


PARTIAL PLAN AT EL. 900.00

SCALE: 3/16" = 1'-0"

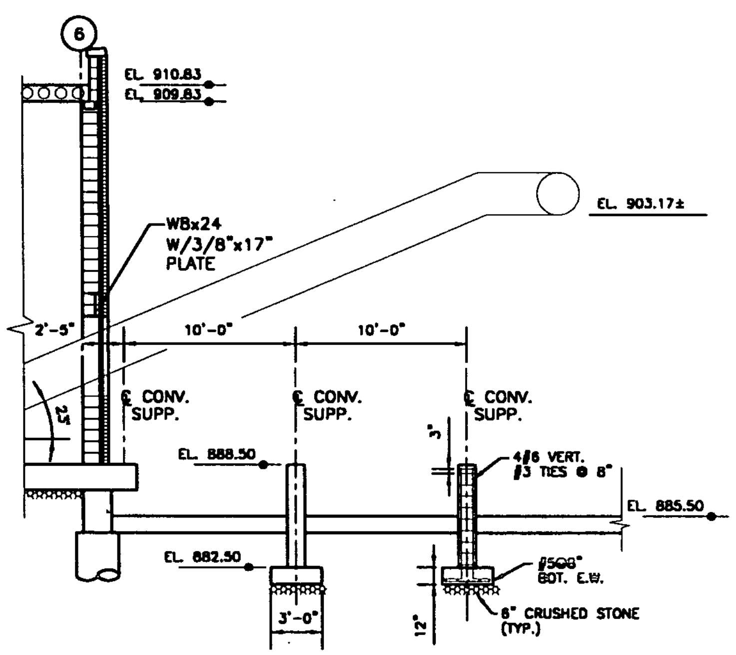
NOTES:

1. THIS AREA IS TO BE CONSTRUCTED AND APPROVED BY THE ENGINEER IN SUCH A MANNER THAT IT CAN EASILY BE DISMANTLED FOR SERVICE OF THE FILTER EQUIPMENT.
2. ALL CONNECTIONS FOR STEEL PLATFORM ARE BOLTED CONNECTIONS.
3. MINIMUM 3/8" GUSSET PLATES.
4. ALL 8" CMU WALL HAVE BOND BEAM WITH 2#5 BARS AT TOP.
   ALL 8" CMU WALL REINFORCE WITH # 4 @ 32" DOWEL AND VERT. & FILL CELL WITH GROUT.



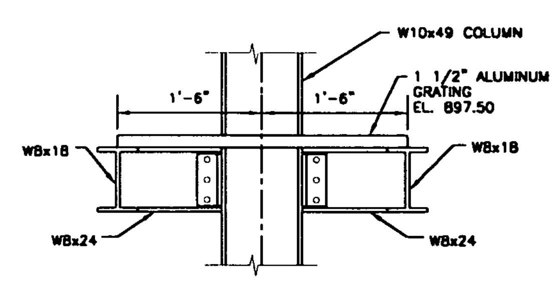
SECTION 6/14

SCALE: 3/8" = 1'-0"



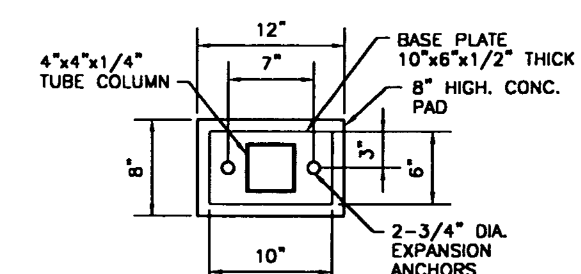
SECTION 7/14

SCALE: 3/16" = 1'-0"



SECTION 1/18

SCALE: 1" = 1'-0"



DETAIL A/18

SCALE: 1 1/2"=1'-0"

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

STRUCTURAL
DEWATERING BUILDING PLANS AND SECTIONS

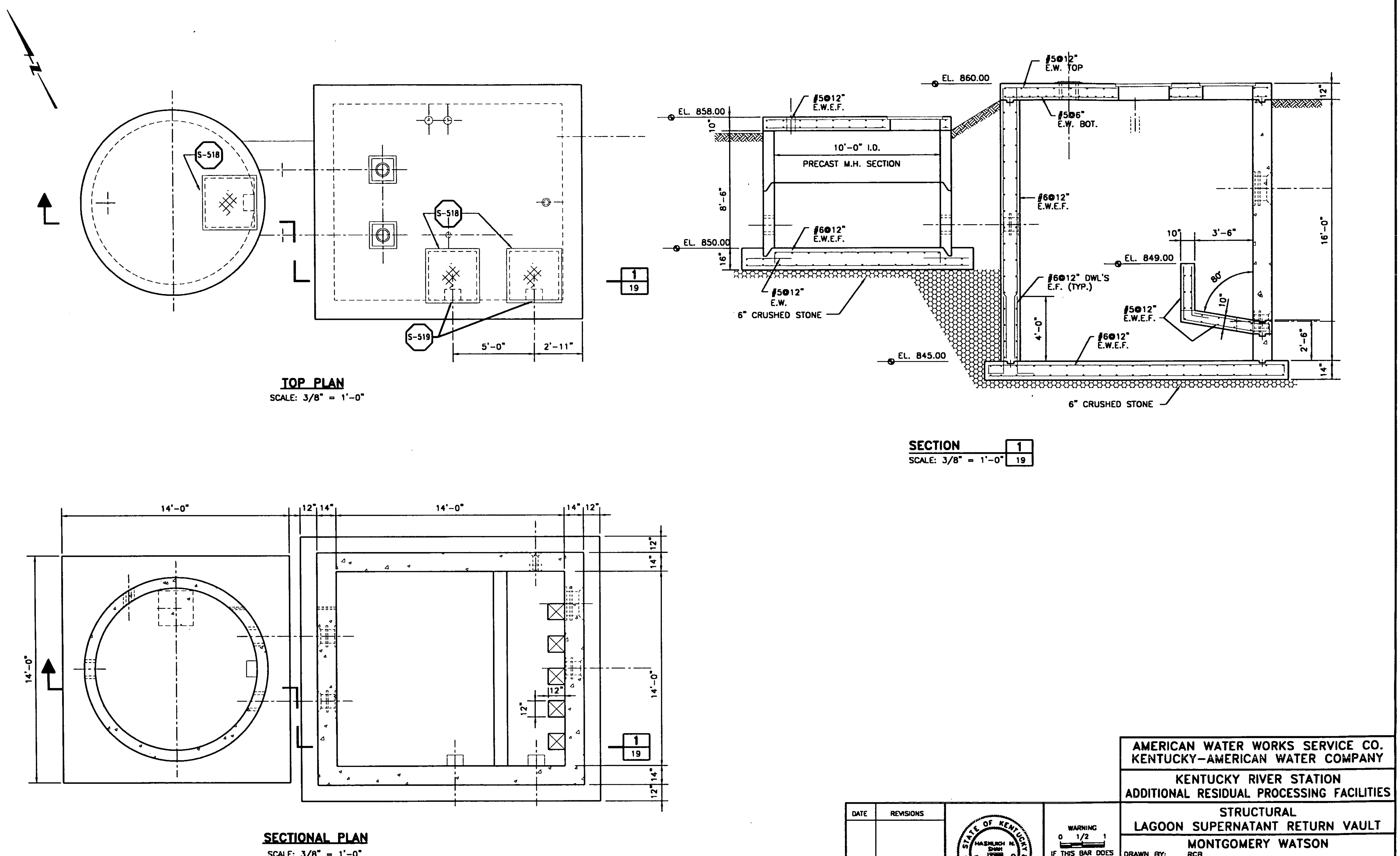
MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RGA

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-018



TOP PLAN
SCALE: 3/8" = 1'-0"

SECTION 1/19
SCALE: 3/8" = 1'-0"

SECTIONAL PLAN
SCALE: 3/8" = 1'-0"

DATE	REVISIONS

STATE OF KENTUCKY — HASMUKH N. SHAH 19988 — REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

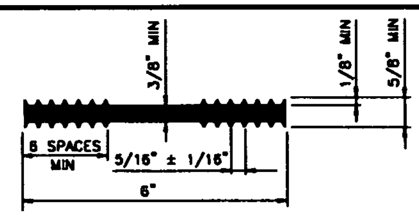
STRUCTURAL
LAGOON SUPERNATANT RETURN VAULT

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: HNS
APPROVED: RGA
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

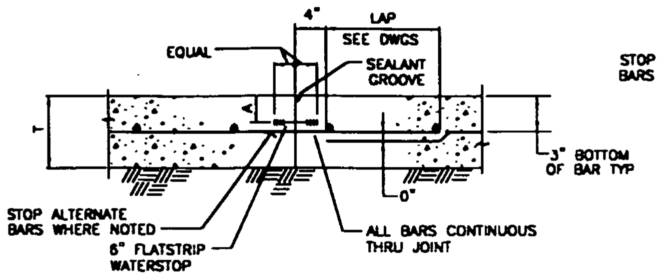
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-019



6" FLATSTRIP WATERSTOP

REV 010196 S-105



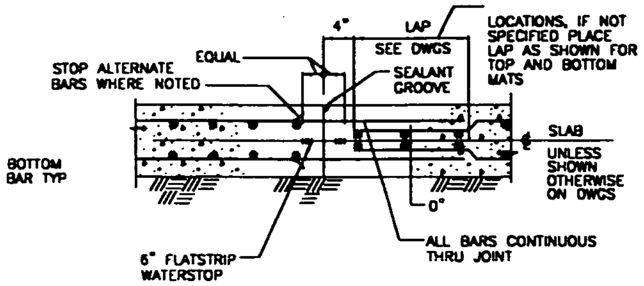
SINGLE MAT REINF – CONTINUOUS THRU JOINT

(ONLY WHEN SPECIFIED ON DRAWINGS)

WITH WATERSTOP AND SEALANT GROOVE S-112

NO WATERSTOP OR SEALANT GROOVE S-113

2. WATERSTOPS AND SEALANT GROOVES TO BE PROVIDED IN ALL WATER RETAINING SLABS, SEE DRAWINGS, FOR OTHER LOCATIONS WHERE THEY MAY BE REQUIRED
3. STAGGER SPLICES UNLESS NOTED OTHERWISE



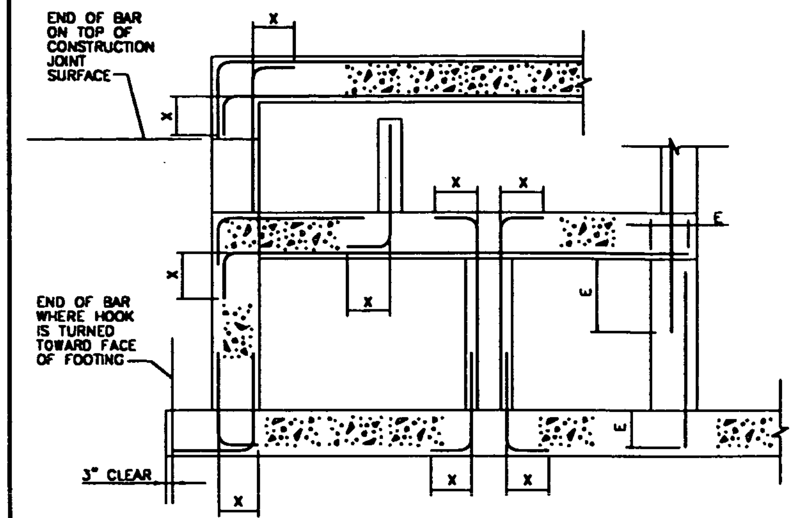
DOUBLE MAT REINF

WITH WATERSTOP AND SEALANT GROOVE S-114

NO WATERSTOP OR SEALANT GROOVE S-115

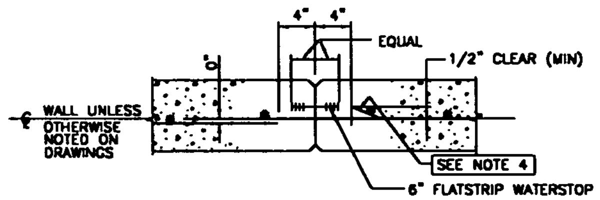
SLAB-ON-GRADE CONSTRUCTION JOINTS

REV 011696



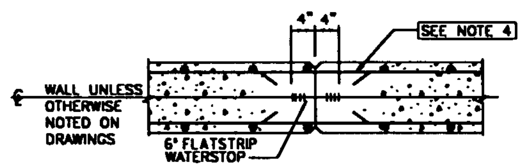
SECTION

BAR SIZE	LENGTH (INCHES) HOOK X	LAP	EMBEDMENT E
#3	6"	18"	12"
#4	8"	18"	14"
#5	10"	23"	18"
#6	12"	28"	22"
#7	14"	33"	25"
#8	16"	SEE TABLE BELOW	SEE TABLE BELOW
#9	19"		
#10	22"		
#11	24"		



SINGLE CURTAIN REINF

WITH WATERSTOP S-121 NO WATERSTOP S-122



DOUBLE CURTAIN REINF

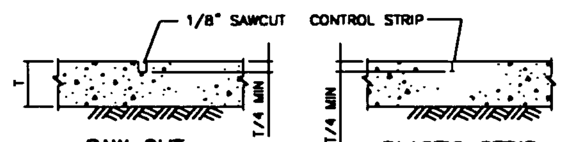
WITH WATERSTOP S-123 NO WATERSTOP S-124

NOTES:

1. IN ALL WALL CONSTRUCTION JOINTS WITH WATERSTOPS APPLY 2 COATS OF BOND BREAKER TO FACE OF JOINT AVOID COATING WATERSTOP
2. WHERE WATERSTOP IS REQUIRED IN SINGLE CURTAIN WALL REINFORCEMENT PLACE WATERSTOP ON WATER SIDE OF WALL
3. UNLESS OTHERWISE NOTED 3/4" CHAMFERS SHALL BE OMITTED IN SURFACES TO RECEIVE ARCHITECTURAL TREATMENT
4. UNLESS SPECIFICALLY NOTED OTHERWISE #5 AND LARGER BARS SHALL BE CONTINUOUS THRU JOINT. #4 & SMALLER SHALL STOP ALTERNATE AT JOINT
5. STAGGER SPLICES UNLESS NOTED OTHERWISE

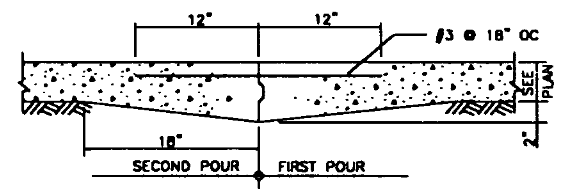
VERTICAL WALL CONSTRUCTION JOINT DETAILS

REV 010196



SAW CUT PLASTIC STRIP

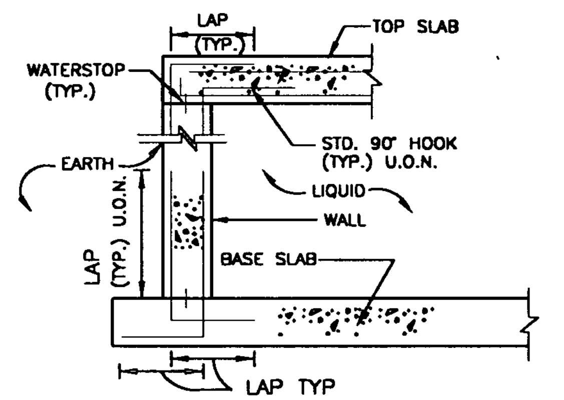
CONTROL JOINT



CONSTRUCTION JOINT

UNREINFORCED SLAB ON GRADE JOINT DETAILS

REV 010196 S-136



TYPICAL WALL SECTION
WATER PRESSURE AND EARTH PRESSURE CASES

REBAR SIZE	LENGTH (INCHES) FOR 1" TO < 2" CONCRETE COVER REBAR SPACING (CENTER TO CENTER) < 8"	≥ 8"	FOR 2" TO < 3" CONCRETE COVER REBAR SPACING (CENTER TO CENTER) < 8"	≥ 8"	FOR 3" AND LARGER CONCRETE COVER REBAR SPACING (CENTER TO CENTER) < 8"	≥ 8"
	LAP					
#8	62"	62"	37"	37"	37"	37"
#9	99"	79"	69"	55"	49"	42"
#10	125"	100"	88"	70"	63"	50"
#11	154"	123"	108"	86"	77"	62"
	EMBEDMENT E					
#8	48"	48"	29"	29"	29"	29"
#9	77"	61"	54"	43"	38"	33"
#10	97"	77"	68"	54"	49"	39"
#11	119"	95"	84"	67"	60"	48"

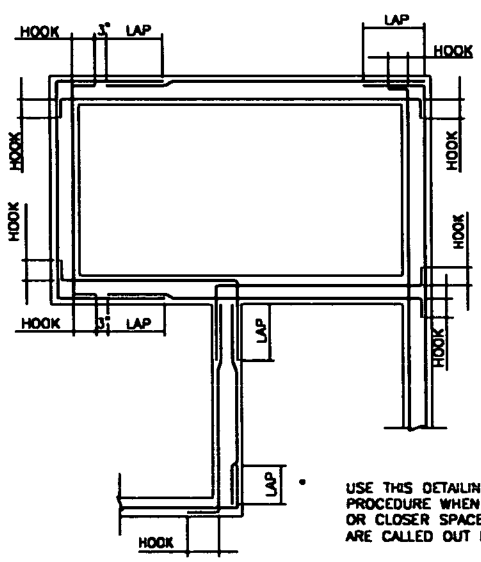
NOTES:

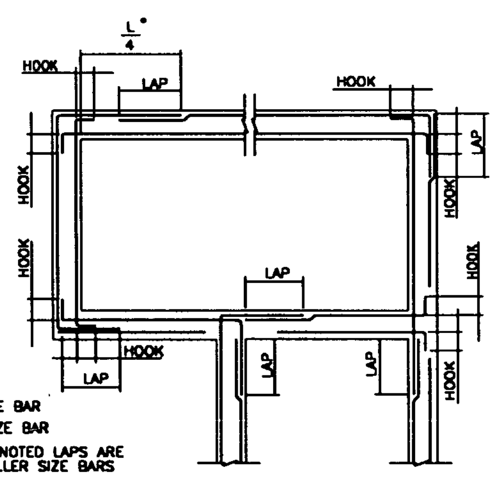
1. USE LAP LENGTHS AS DETERMINED FROM THESE TABLES UNLESS SHOWN OTHERWISE
2. THE TABLES SHOWN ARE FOR f'C=4000 PSI AND fy=60,000 PSI
3. MULTIPLY THE LAP & E SHOWN IN THESE TABLES BY 1.3 FOR WALL HORIZONTAL REBARS AND SLAB BARS WITH 12" OR MORE FRESH CONCRETE UNDERNEATH
4. WHEN BARS OF DIFFERENT SIZE ARE LAP SPLICED, LAP LENGTH SHALL BE THE LARGER OF:
   EMBEDMENT LENGTH OF LARGER BAR
   LAP LENGTH OF SMALLER BAR
5. UNLESS NOTED OTHERWISE USE REBAR COUPLERS FOR SPLICES OF #11 AND LARGER BARS
6. ALL DOWEL BARS SHALL EXTEND AN EMBEDMENT LENGTH E INTO ANOTHER MEMBER OR ACROSS A CONSTRUCTION JOINT UNLESS SHOWN TO SPLICE WITH OTHER BARS OR TO EXTEND TO THE FAR FACE OF THE MEMBER AND END WITH A STANDARD HOOK

STANDARD 90° BAR HOOKS, EMBEDMENT LENGTHS AND LAP LENGTHS

REV 010196 S-143

UNLESS OTHERWISE NOTED ON DRAWINGS





LARGER SIZE BAR
SMALLER SIZE BAR

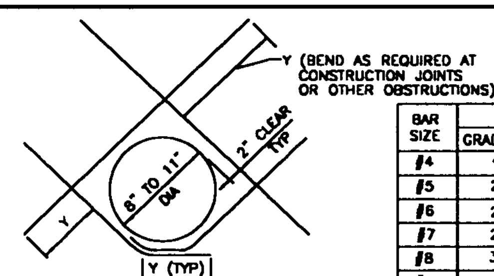
UNLESS OTHERWISE NOTED LAPS ARE BASED ON THE SMALLER SIZE BARS

L = CLEAR SPAN

USE THIS DETAILING PROCEDURE WHEN LARGER OR CLOSER SPACED BARS ARE CALLED OUT FOR CORNERS

HORIZONTAL REINFORCEMENT AT WALL INTERSECTIONS

REV 010196 S-141



BAR SIZE	Y GRADE 60
#4	15"
#5	21"
#6	24"
#7	27"
#8	36"
#9	42"

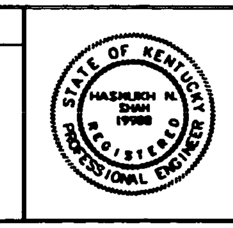
NOTES:

1. CUT NORMAL REINFORCEMENT 2" CLEAR OF OPENING
2. DIAGONAL BARS TO BE PLACED:
   A) AT CENTERLINE OF WALL OR SLAB WHERE ONE LAYER OF REINFORCEMENT IS PROVIDED
   B) AT EACH FACE OF WALL OR SLAB WHERE TWO LAYERS OF REINFORCEMENT ARE PROVIDED
3. UNLESS OTHERWISE NOTED, SIZE OF DIAGONAL BARS SHALL BE THE SIZE OF THE LARGEST NORMAL REINFORCING BAR CUT
4. THIS DETAIL TO BE USED ONLY WHEN CALLED FOR ON THE DRAWINGS OR WHEN NO OTHER DETAIL IS SPECIFIED

DIAGONAL REINFORCEMENT AT CIRCULAR OPENINGS (8" – 11" DIA)

REV 010196 S-142

DATE	REVISIONS



WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

STRUCTURAL
MISCELLANEOUS DETAILS

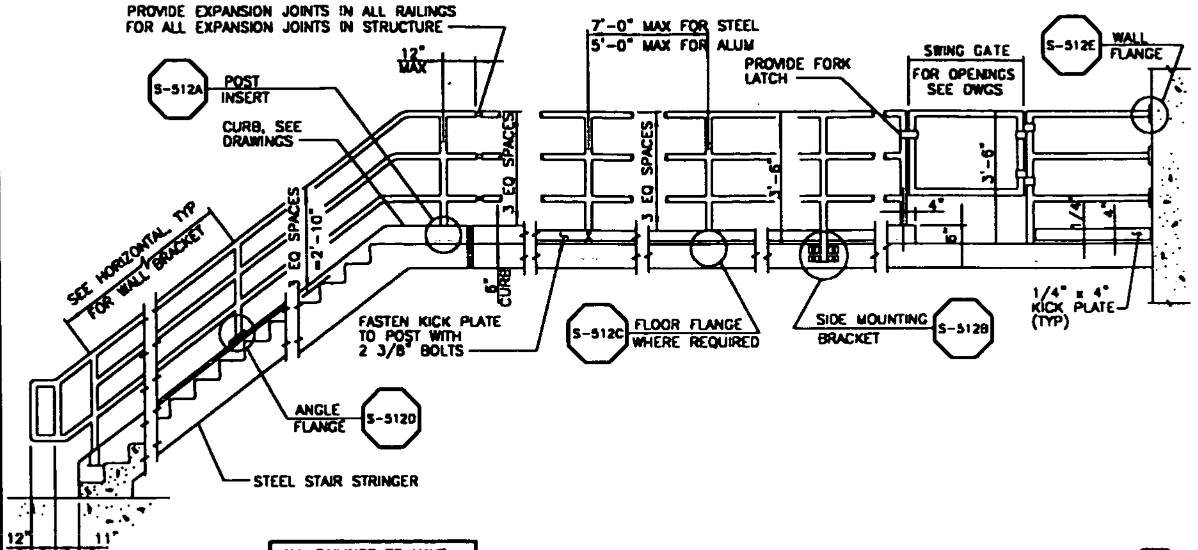
MONTGOMERY WATSON

DRAWN BY: HNS
PROJECT ENG'R: HNS
APPROVED: RGA

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-020

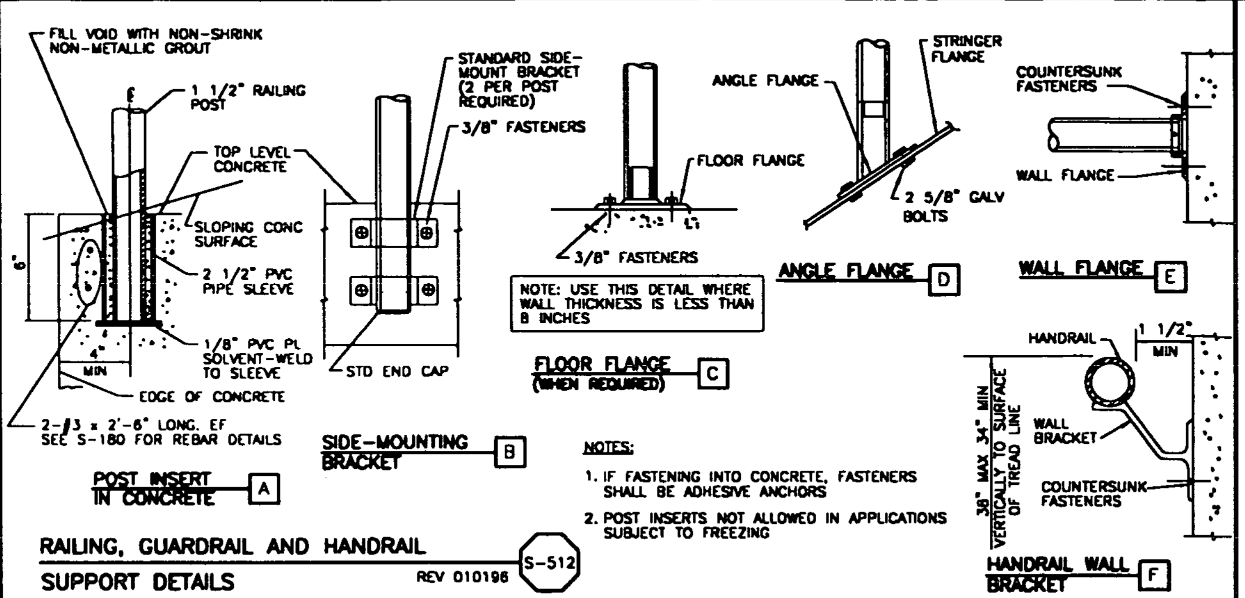


ALL RAILINGS TO HAVE A 4" KICKPLATE

ALUMINUM RAILING (S-510)

1 1/2" SCHEDULE 40 STANDARD PIPE RAILING AND POSTS WITH MECHANICAL JOINTS.

REV 022696

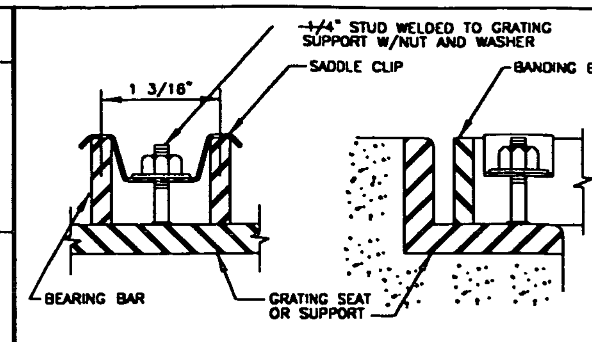


NOTES:

1. IF FASTENING INTO CONCRETE, FASTENERS SHALL BE ADHESIVE ANCHORS
2. POST INSERTS NOT ALLOWED IN APPLICATIONS SUBJECT TO FREEZING

RAILING, GUARDRAIL AND HANDRAIL SUPPORT DETAILS (S-512)

REV 010196

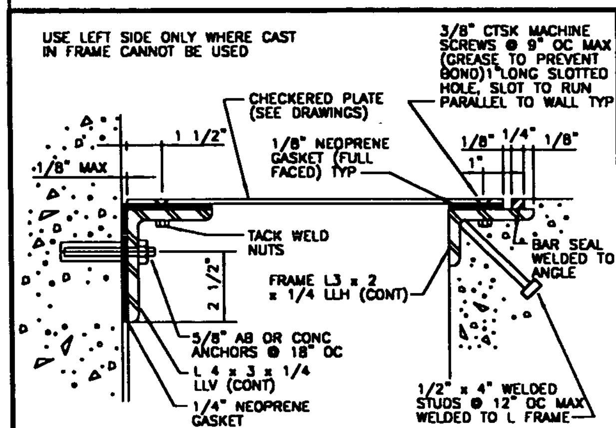


NOTES:

1. PROVIDE 4 CLIPS PER GRATING PANEL, APPROX 4" FROM PANEL CORNERS. MAXIMUM CLIP SPACING AT 38" OC
2. STUD, NUT, WASHER AND CLIP TO BE THE SAME MATERIAL AS THE GRATING EXCEPT FOR ALUMINUM USE SS
3. AT FRP GRATING USE 1/4" FRP ALL TREAD BOLTS AND ADHESIVE ANCHORS AS APPROPRIATE

GRATING ANCHOR DETAIL (S-517)

REV 010196

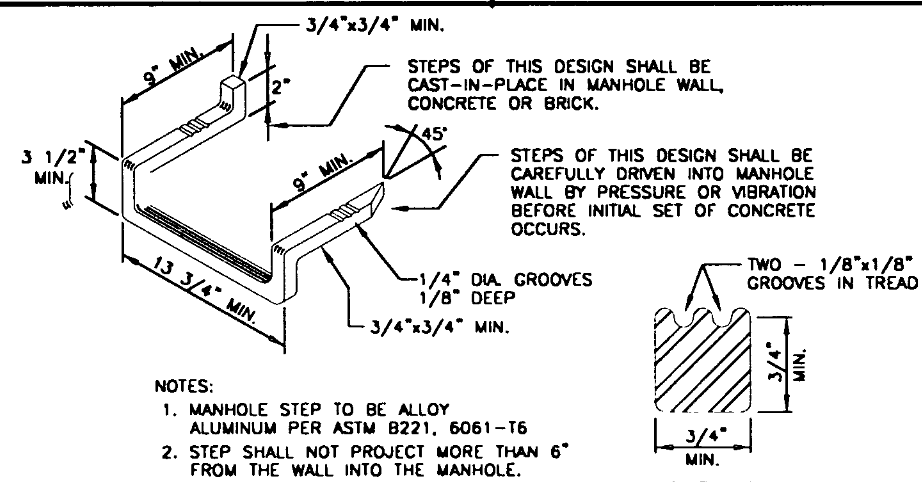


STEEL CHK'D PLATE – STEEL FRAME AND ANCHORS (GALV AFTER FABRICATION)
ALUM CHK'D PLATE – ALUM FRAME AND STUDS, AND SS ANCHORS
SS CHK'D PLATE – SS FRAME AND ANCHORS

TYPICAL PLATE COVERED OPENING (S-518)

REV 010196

MAX WEIGHT OF PLATES = 80 LBS

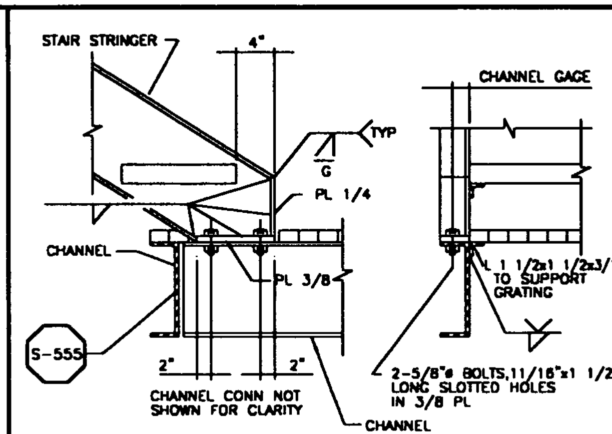


NOTES:

1. MANHOLE STEP TO BE ALLOY ALUMINUM PER ASTM B221, 6061-T6
2. STEP SHALL NOT PROJECT MORE THAN 6" FROM THE WALL INTO THE MANHOLE.
3. APPLY COATING TO MANHOLE STEP PER SPECIFICATIONS.

STANDARD ALUMINUM MANHOLE STEP (S-519)

NO SCALE

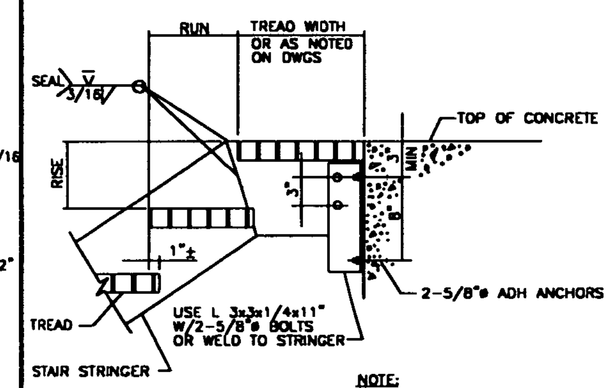


NOTES:

1. FOR CHANNEL SIZES SEE PLAN
2. HANDRAIL NOT SHOWN
3. USE PLATES OF SAME METAL AS STRINGER

STAIR BOTTOM TO CHANNEL CONNECTION (S-529)

REV 010196



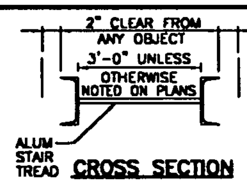
NOTE:
HANDRAIL NOT SHOWN

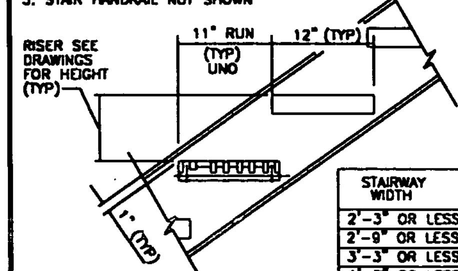
STAIR TOP CONNECTION TO CONCRETE (S-525)

REV 010196

NOTES:

1. SEE PLANS AND/OR SPECS. FOR MATERIALS USED FOR STAIRWAY USE C10X5.28 STRINGERS UNLESS NOTED OTHERWISE
2. STAIR TREADS SHALL BE MADE OF SERRATED ALUM GRATING
3. TREAD MANUFACTURER TO VERIFY HOLE LOCATION FOR BOLTED CONN
4. ALL BOLTS AND CONCRETE ANCHORS SHALL BE STAINLESS STEEL
5. STAIR HANDRAIL NOT SHOWN

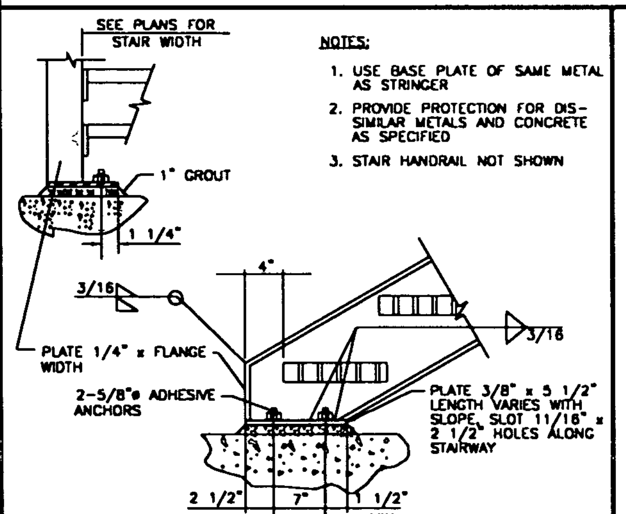




STAIRWAY WIDTH	BEARING BARS ALUMINUM TREAD
2'-3" OR LESS	1 1/4" x 3/16"
2'-9" OR LESS	1 1/2" x 3/16"
3'-3" OR LESS	1 3/4" x 3/16"
4'-7" OR LESS	2" x 3/16"

STAIR DETAIL (S-526)

REV 010196

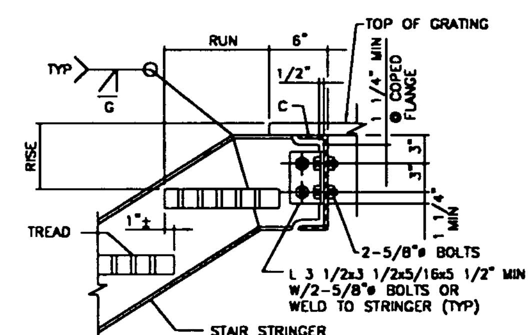


NOTES:

1. USE BASE PLATE OF SAME METAL AS STRINGER
2. PROVIDE PROTECTION FOR DISSIMILAR METALS AND CONCRETE AS SPECIFIED
3. STAIR HANDRAIL NOT SHOWN

STAIR BOTTOM CONNECTION (S-527)

REV 010196



NOTES:

1. FOR CHANNEL SIZES SEE PLAN
2. HANDRAIL NOT SHOWN
3. COPE STRINGER MIN AS REQ'D

STAIR TOP TO CHANNEL CONNECTION (S-528)

REV 010196

DATE	REVISIONS

STATE OF KENTUCKY — MASHUKOH N. SHAH — 19560 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

STRUCTURAL
MISCELLANEOUS DETAILS

MONTGOMERY WATSON

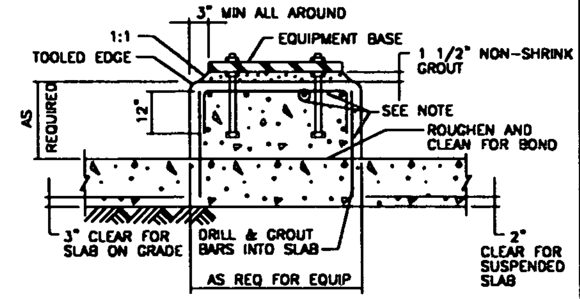
DRAWN BY: HNS
PROJECT ENG'R: HNS
APPROVED: RGA

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

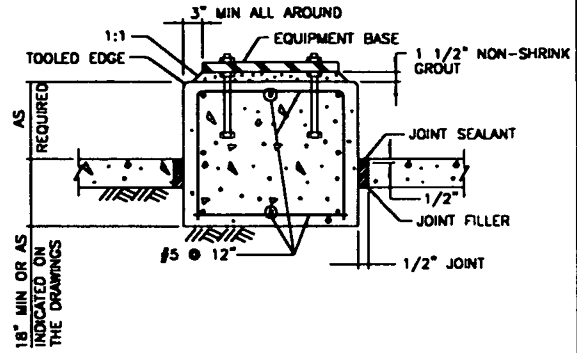
380-575-021

NOTE:
#5 @ 12" OR AS REQUIRED TO DEVELOP ANCHOR BOLTS



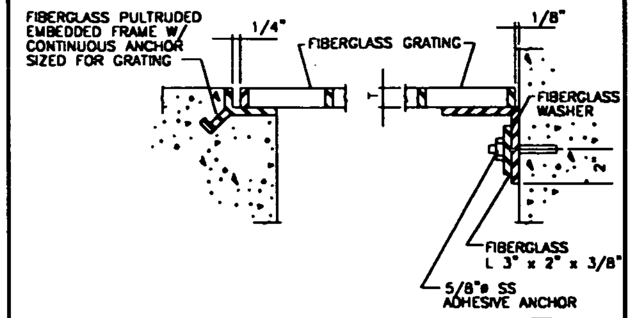
EQUIPMENT BASE
REV 010196 S-192

NOTE:
WHERE NO DIMENSION IS INDICATED ON THE DRAWINGS, BASE DEPTH SHALL BE SET SO THAT THE BASE WEIGHS AT LEAST TWICE THE WEIGHT OF THE EQUIPMENT SUPPORTED

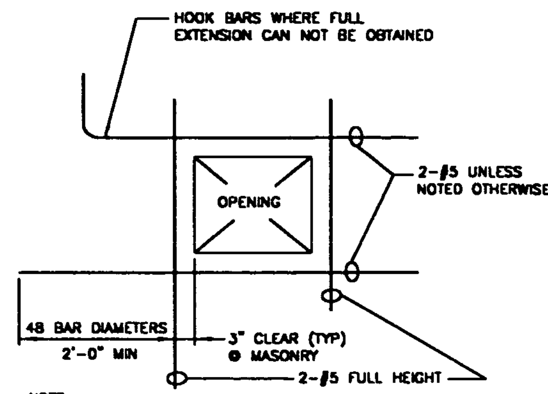


EQUIPMENT BASE ON GRADE WITH SEPARATING JOINT
REV 010196 S-193

NOTES:
1. ALL CUT EDGES SHALL BE SEALED WITH RESIN
2. ALL GRATING SHALL BE SECURED IN PLACE WITH REMOVABLE FASTENERS, SIMILAR TO DETAIL S-517
3. BONDING: USE EPOXY ADHESIVE BONDING AGENT
4. WEIGHT OF EACH SECTION OF GRATING SHALL NOT EXCEED 80 POUNDS
5. ALL FRAME COMPONENTS SHALL BE FIBERGLASS
6. T TO BE DETERMINED BY GRATING MFR & APPROVED BY ENGINEER

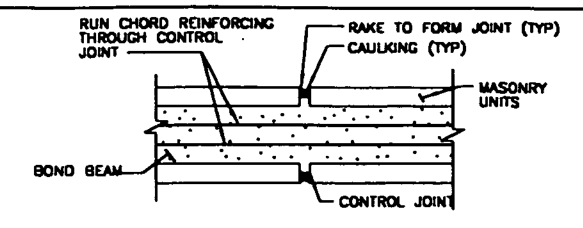


FIBERGLASS GRATING DETAILS
REV 010196 S-320

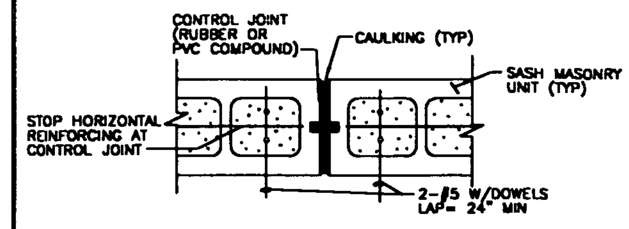


NOTE:
REINFORCING SHOWN IS IN ADDITION TO NORMAL REINFORCING AND SHALL BE PLACED WITH EACH LAYER OF BARS PROVIDED

TYPICAL REINFORCEMENT AT MASONRY WALL OPENING
REV 010196 S-410

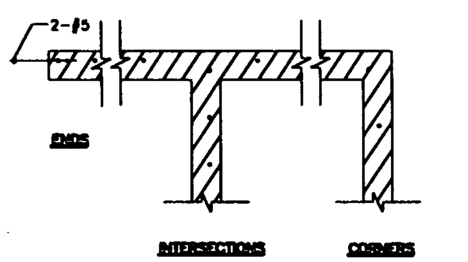


CONTROL JOINT AT BOND BEAM



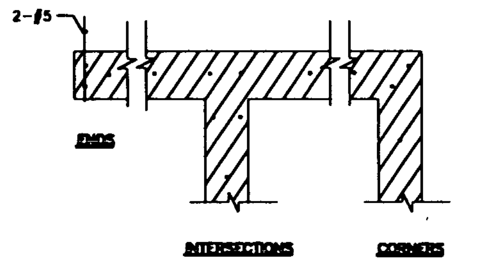
CONTROL JOINT AT WALL

CONTROL JOINTS
REV 010196 S-430



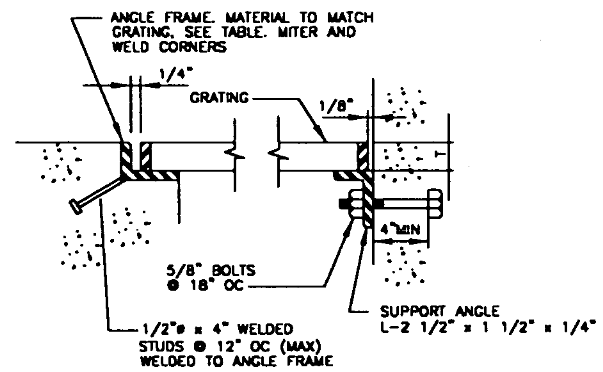
NOTE : REFER TO THE ARCH. SECTIONS FOR THE HORIZONTAL REINF

TYPICAL 8" & 10" BLOCK WALL SECTIONS
REV 010196 S-401



NOTE : REFER TO THE ARCH. SECTIONS FOR THE HORIZONTAL REINF

TYPICAL 12" BLOCK WALL SECTIONS
REV 010196 S-402



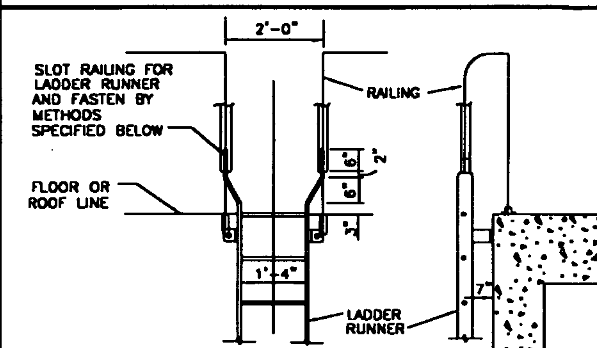
GRATING FRAME TABLE

GRATING DEPTH T	FRAME ANGLE	GRATING DEPTH T	FRAME ANGLE
1"	1 3/4 x 1 1/4 x 1/4	2"	*2 1/2 x 2 1/2 x 1/2
1 1/4"	2 x 1 1/2 x 1/4	2 1/4"	2 1/2 x 2 1/2 x 1/4
1 1/2"	1 3/4 x 1 3/4 x 1/4	2 1/2"	3 x 2 1/2 x 1/2
1 3/4"	2 x 2 x 1/4		

* OR USE 2 1/2 x 2 1/2 x 1/4 WITH 1/4" SHIM PLATE WELDED TO BOTTOM

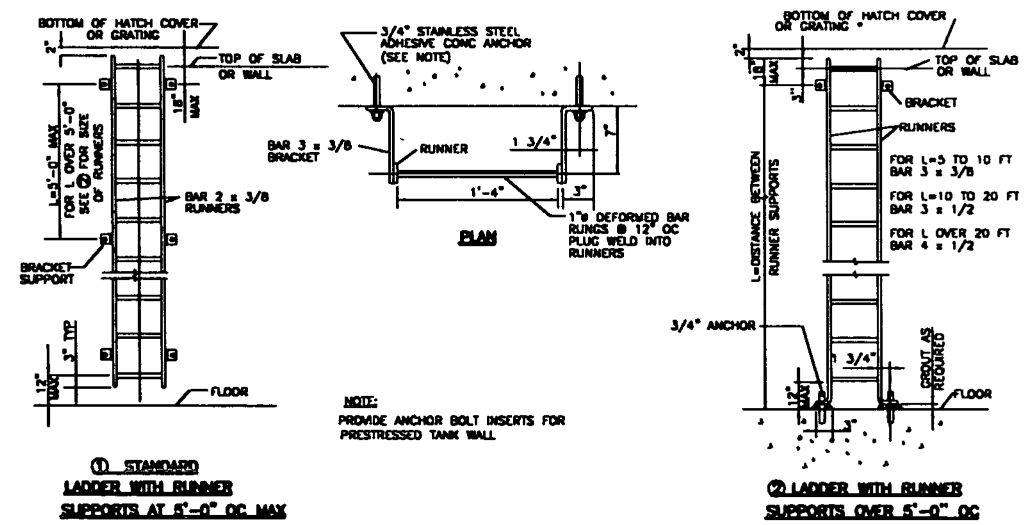
NOTES:
1. GRATING DEPTH TO BE DETERMINED BY MANUFACTURER AND APPROVED BY ENGINEER (UNO)
2. ALL ENDS AND OPENINGS SHALL BE BANDED
3. ALL GRATING SHALL BE SECURED IN PLACE WITH REMOVABLE FASTENERS. SEE DETAIL S-517
4. WEIGHT OF GRATING SECTION SHALL NOT EXCEED 80 LBS
5. BEARING BARS SHALL BE DEPTH T x 3/16" @ 1 3/16" OC CROSS BARS SHALL BE @ 4" OC

ALUMINUM GRATING
USE ALUMINUM ANGLE SUPPORTS AND STAINLESS STEEL BOLTS
S-501



CONNECTIONS:
STEEL TO STEEL OR ALUMINUM TO ALUMINUM:
WELDED CONNECTION, GRIND SMOOTH.
STEEL TO ALUMINUM:
DRILL HOLE THRU LADDER RUNNER AND RAILING FOR 1/2" PIN. INSERT PIN AND WELD BOTH ENDS AND GRIND SMOOTH. PIN SHALL BE THE SAME MATERIAL AS RAILING.

LADDER TO RAILING CONNECTIONS
REV 010196 S-507



ALUMINUM LADDER
S-504

- ALL LADDERS SHALL MEET THE GENERAL REQUIREMENTS OF OSHA AND ANSI
- PROVIDE TELESCOPIC EXTENSION BARS AT ALL HATCH LOCATIONS TYP

DATE	REVISIONS

STATE OF KENTUCKY HASMUKH N. SHAH 19503 REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

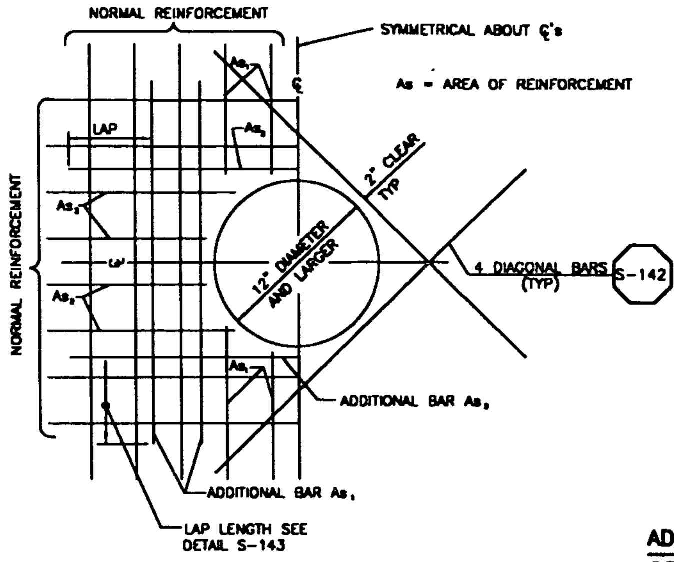
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

STRUCTURAL
MISCELLANEOUS DETAILS

MONTGOMERY WATSON

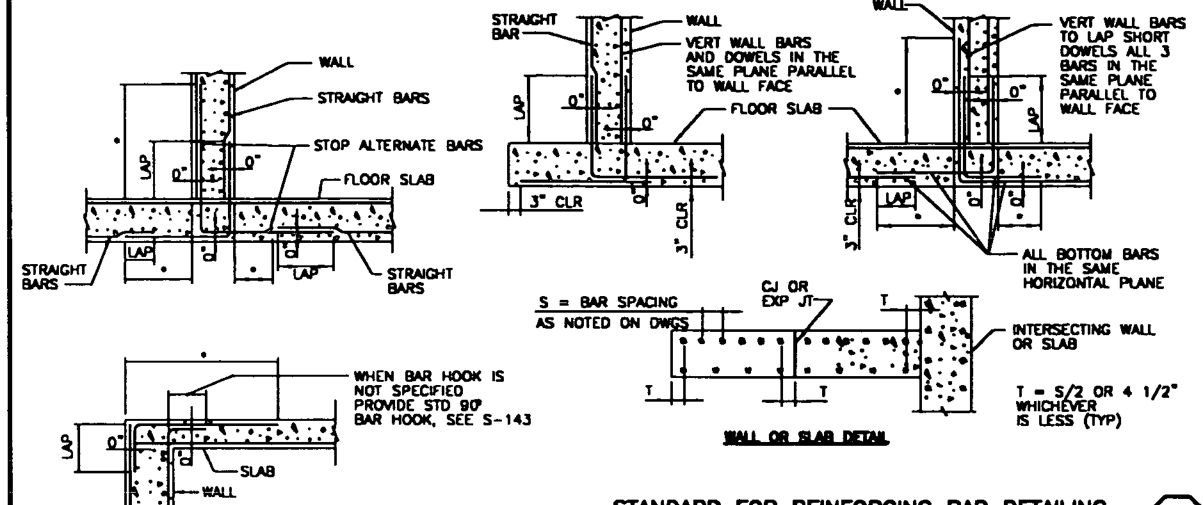
DRAWN BY: HNS
PROJECT ENG'R: HNS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES
380-575-022



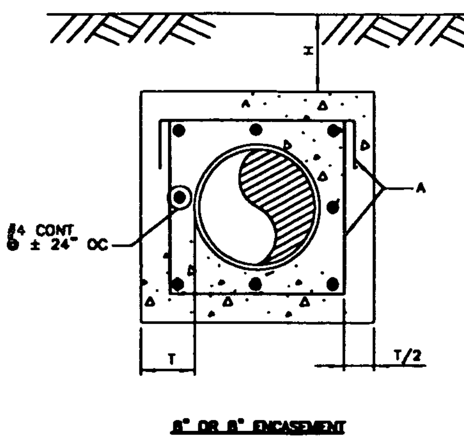
NOTES:
1. CUT NORMAL REINFORCEMENT AT OPENINGS:
As, AND As, = 1/2 AREA OF CUT BARS TO BE ADDED ON EACH SIDE OF OPENING
2. ADDITIONAL BARS As, AND As, TO BE PLACED:
A) AT CENTERLINE OF WALLS OR SLABS WHERE ONE LAYER OF REINFORCEMENT IS PROVIDED
B) AT EACH FACE OF WALLS OR SLABS WHERE TWO LAYERS OF REINFORCEMENT ARE PROVIDED
3. INCREASE SIZE OF ADDITIONAL BARS AS NEEDED TO FIT WITHIN A DISTANCE OF 2 X WALL/SLAB THICKNESS FROM OPENING, PROVIDE 2" MIN CLEAR BETWEEN BARS
4. THIS DETAIL TO BE USED ONLY WHEN NO OTHER DETAIL IS INDICATED ON THE DRAWINGS
5. WHERE A SLAB OR INTERSECTING WALL CONNECTS WITHIN ONE WALL THICKNESS OF THE OPENING, ADDITIONAL BARS ON THAT SIDE MAY BE OMITTED

ADDITIONAL REINFORCEMENT AT CIRCULAR OPENINGS (12" DIA OR LARGER) REV 010196 S-144

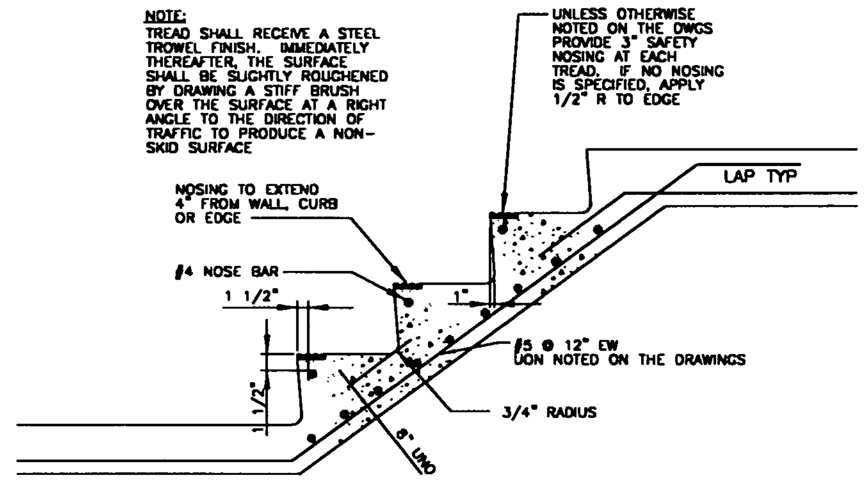


* SEE DRAWINGS

STANDARD FOR REINFORCING BAR DETAILING REV 010196 S-149



NOTE:
TREAD SHALL RECEIVE A STEEL TROWEL FINISH. IMMEDIATELY THEREAFTER, THE SURFACE SHALL BE SLIGHTLY ROUGHENED BY DRAWING A STIFF BRUSH OVER THE SURFACE AT A RIGHT ANGLE TO THE DIRECTION OF TRAFFIC TO PRODUCE A NON-SKID SURFACE

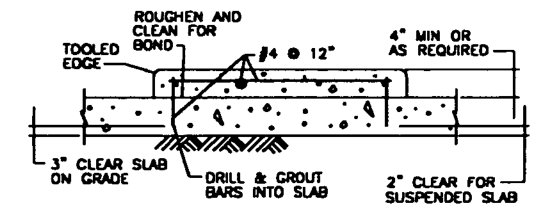


CONCRETE STAIR DETAIL REV 010196 S-153

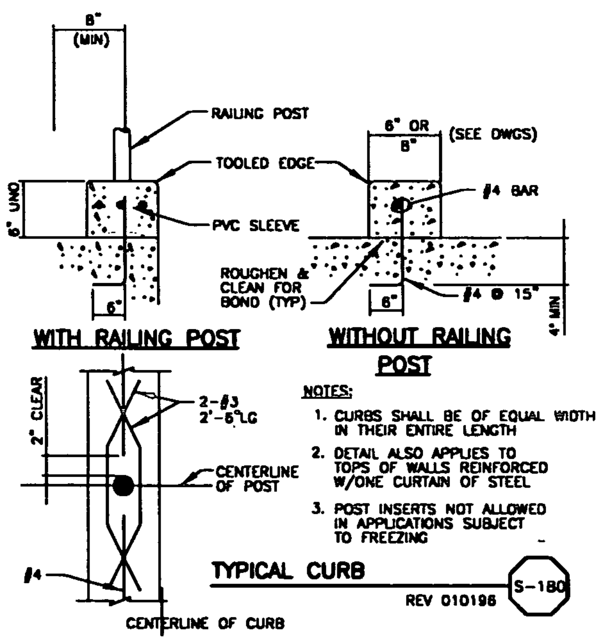
DIAMETER (inches)	MINIMUM EMBEDMENT TOP OF COLUMNS	OTHER APPLICATIONS
1/4	5	3
3/8	5	3
1/2	6	4
5/8	6	4
3/4	7	5
7/8	8	6
1	9	7
1 1/8	10	8
1 1/4	11	9

NOTES
1. USE ONLY HEADED ANCHORS, J-BOLTS ARE NOT ALLOWED
2. THIS DETAIL APPLIES TO BOTH CONCRETE AND MASONRY
3. IN MASONRY PROVIDE A 1" ANNULAR SPACE IN BLOCK SHELL AROUND ANCHOR. GROUT TO SURFACE

TYPICAL ANCHOR BOLT EMBEDMENT REV 010196 S-175



HOUSEKEEPING PAD S-191 6

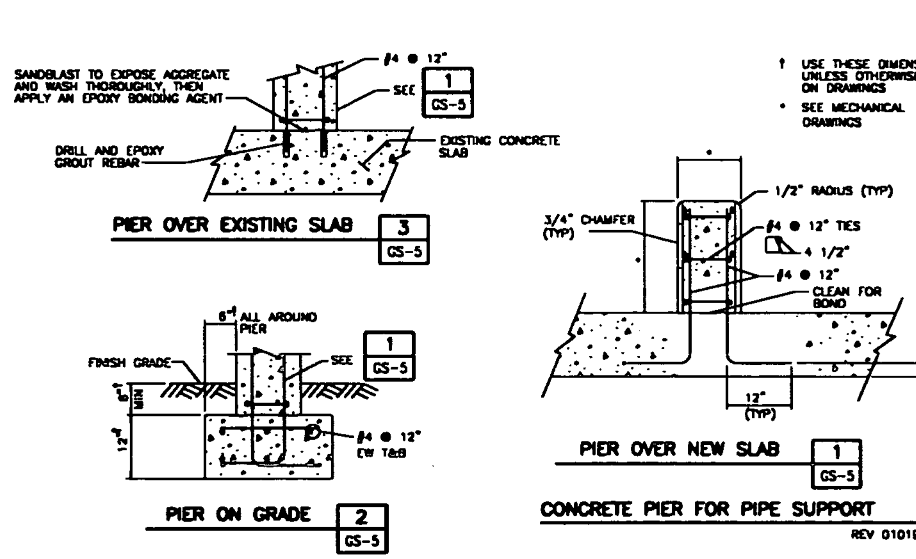


WITH RAILING POST

WITHOUT RAILING POST

NOTES:
1. CURBS SHALL BE OF EQUAL WIDTH IN THEIR ENTIRE LENGTH
2. DETAIL ALSO APPLIES TO TOPS OF WALLS REINFORCED W/ONE CURTAIN OF STEEL
3. POST INSERTS NOT ALLOWED IN APPLICATIONS SUBJECT TO FREEZING

TYPICAL CURB REV 010196 S-180

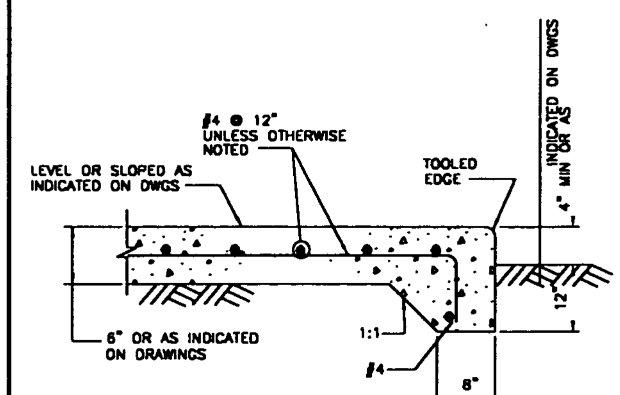


PIER OVER EXISTING SLAB 3 GS-5

PIER ON GRADE 2 GS-5

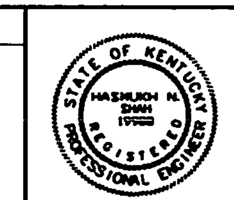
PIER OVER NEW SLAB 1 GS-5

CONCRETE PIER FOR PIPE SUPPORT REV 010196 S-181



SLAB ON GRADE REV 010196 S-190

DATE	REVISIONS



WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

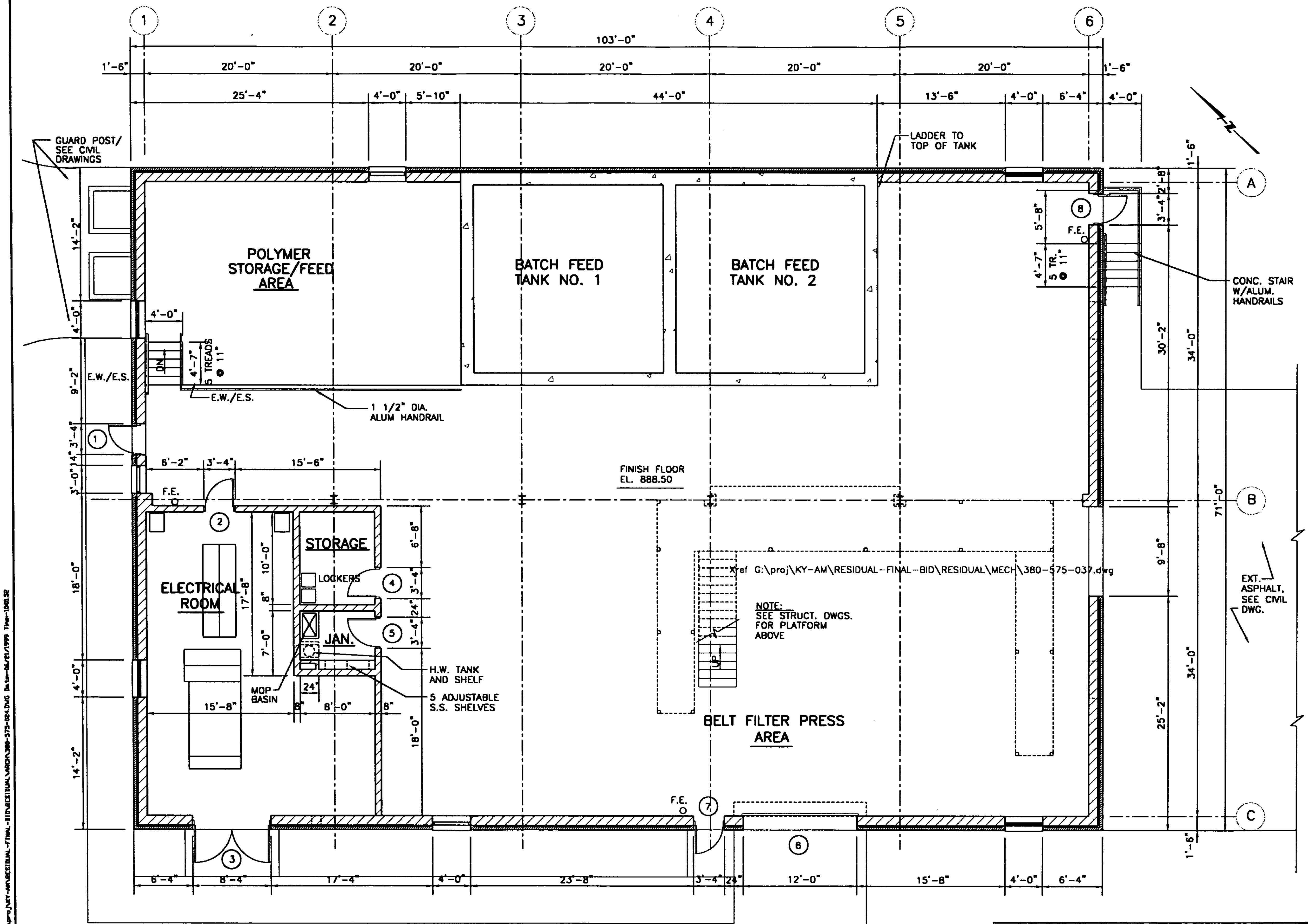
STRUCTURAL
MISCELLANEOUS DETAILS

MONTGOMERY WATSON

DRAWN BY: HNS
PROJECT ENG'R: HNS
APPROVED: RGA
REV 010196
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-023



FLOOR PLAN

3/16"=1'-0"

CODE INFORMATION

GOVERNING CODE: KENTUCKY BUILDING CODE

OCCUPANCY GROUP: F-2

CONSTRUCTION CLASSIFICATION: TYPE 2C

FLOOR AREA: 5,846 SQ. FT.

ALLOWABLE AREA: 14,400 SQ. FT.

FIRE SPRINKLER SYSTEM: NOT REQUIRED

MIN. NUMBER OF EXITS: 2

MAX. DISTANCE TO AN EXIT: 300 FT.

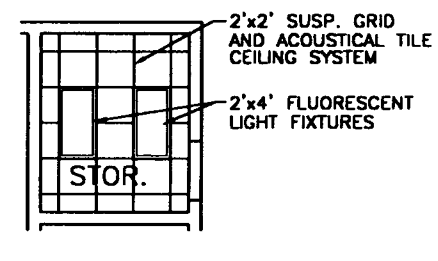
OCCUPANT LOAD: ACTUAL = 0
PER KBC TABLE
1008.1.2 = 1 PER 100 SF.

LEGEND

C.M.U.

FACE BRICK

POURED-IN-PLACE CONCRETE



REFLECTED CEILING PLAN

3/16"=1'-0"

DATE	REVISIONS

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ARCHITECTURAL
DEWATERING BUILDING FLOOR PLAN

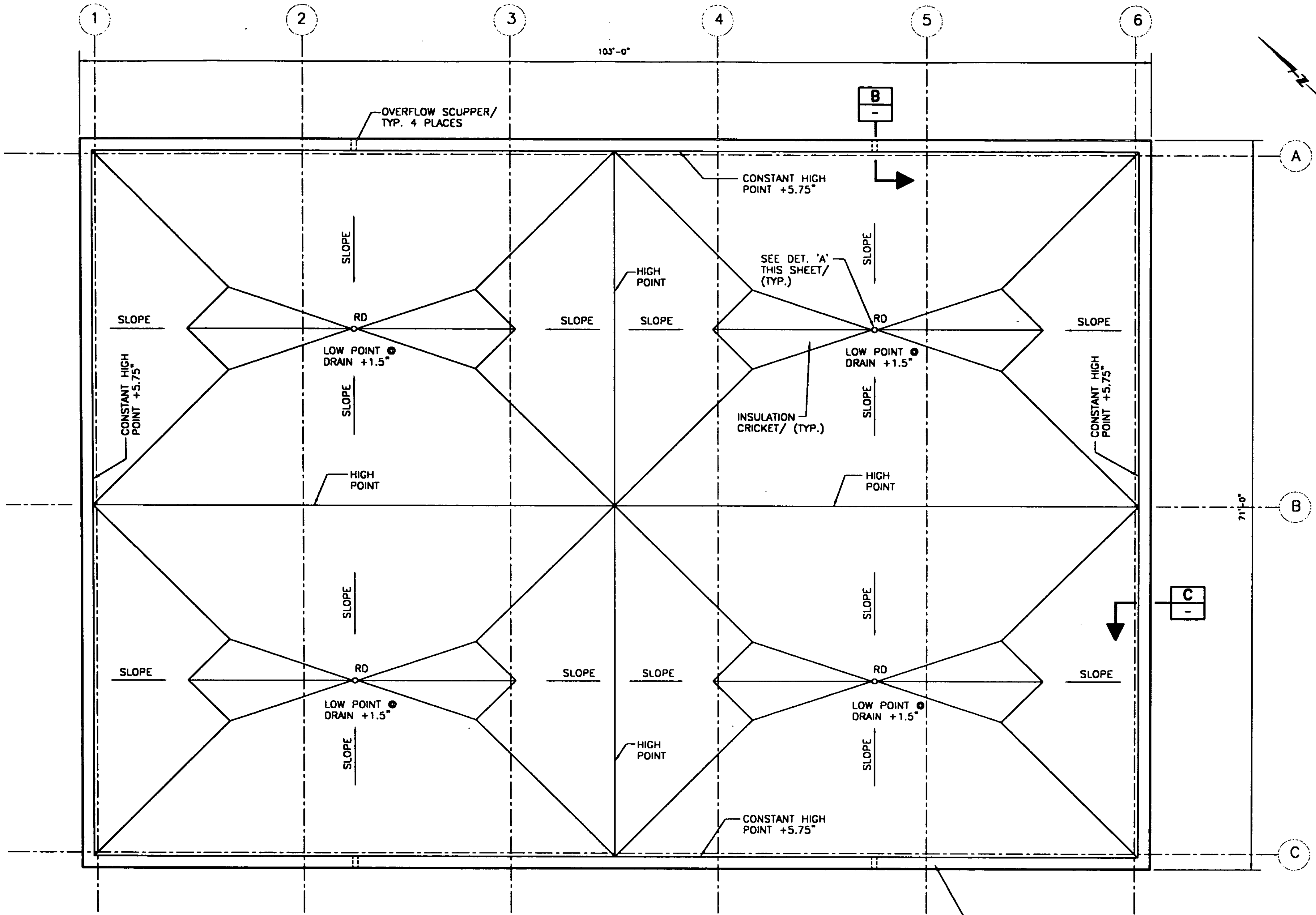
MONTGOMERY WATSON

DRAWN BY: TCG
PROJECT ENG'R: TCG
APPROVED: EWM

DATE: JUNE 1999 USE DIMENSIONS ONLY SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-024



ROOF CONSTRUCTION

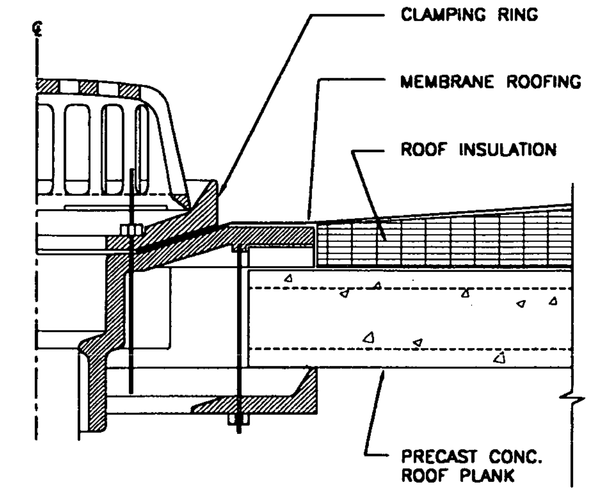
FULLY-ADHERED SINGLE-PLY MEMBRANE ROOFING ON TAPERED INSULATION ON 12" THICK PRECAST CONCRETE PLANKS

ROOF PLAN

SCALE: 3/16 = 1'-0"

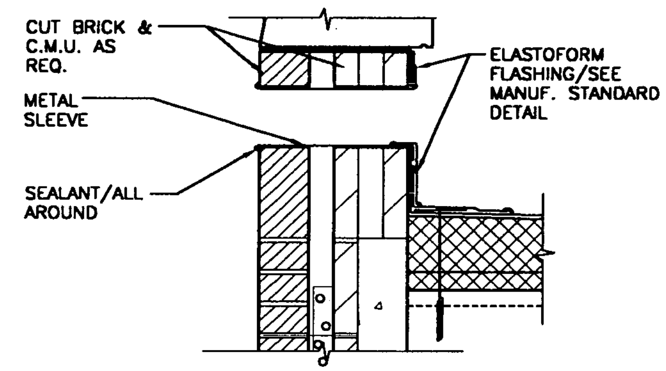
GENERAL NOTES

1. +1.5" AND +5.75" ARE THICKNESSES OF INSULATION ON TOP OF PRECAST CONCRETE PLANKS/MIN. SLOPE 1/4" PER FOOT.



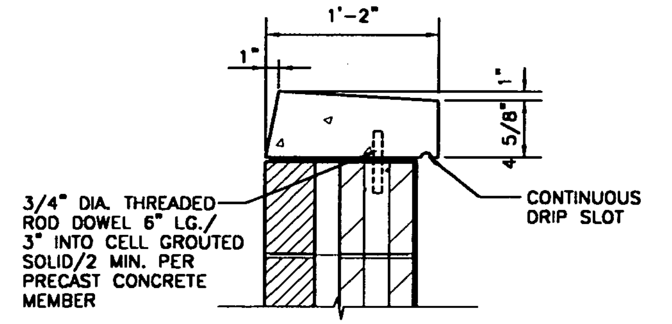
ROOF DRAIN DETAIL A/-

SCALE: NONE



SCUPPER DETAIL B/-

SCALE: NONE



PRECAST COPING C/-

SCALE: NONE

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

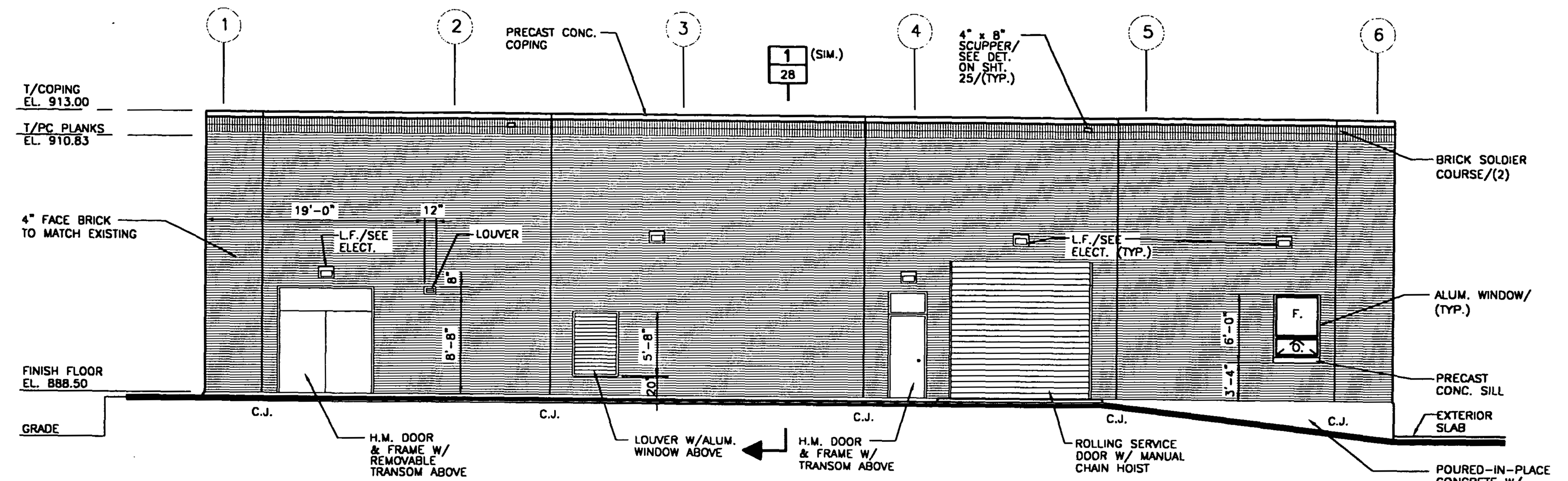
ARCHITECTURAL
DEWATERING BUILDING ROOF PLAN

MONTGOMERY WATSON

DRAWN BY: TCG
PROJECT ENG'R: TCG
APPROVED: EWM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

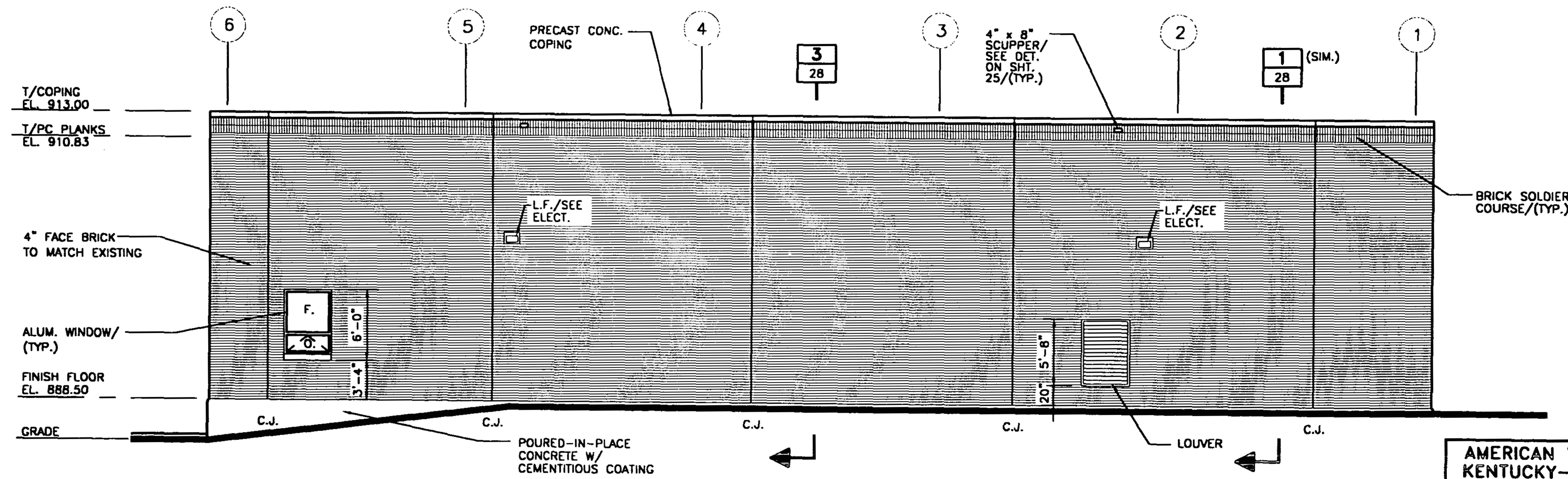
380-575-025



SOUTH ELEVATION

SCALE: 3/16" = 1'-0"

F. = FIXED
O. = OPERABLE
C.J. = CONTROL JOINT



NORTH ELEVATION

SCALE: 3/16" = 1'-0"

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

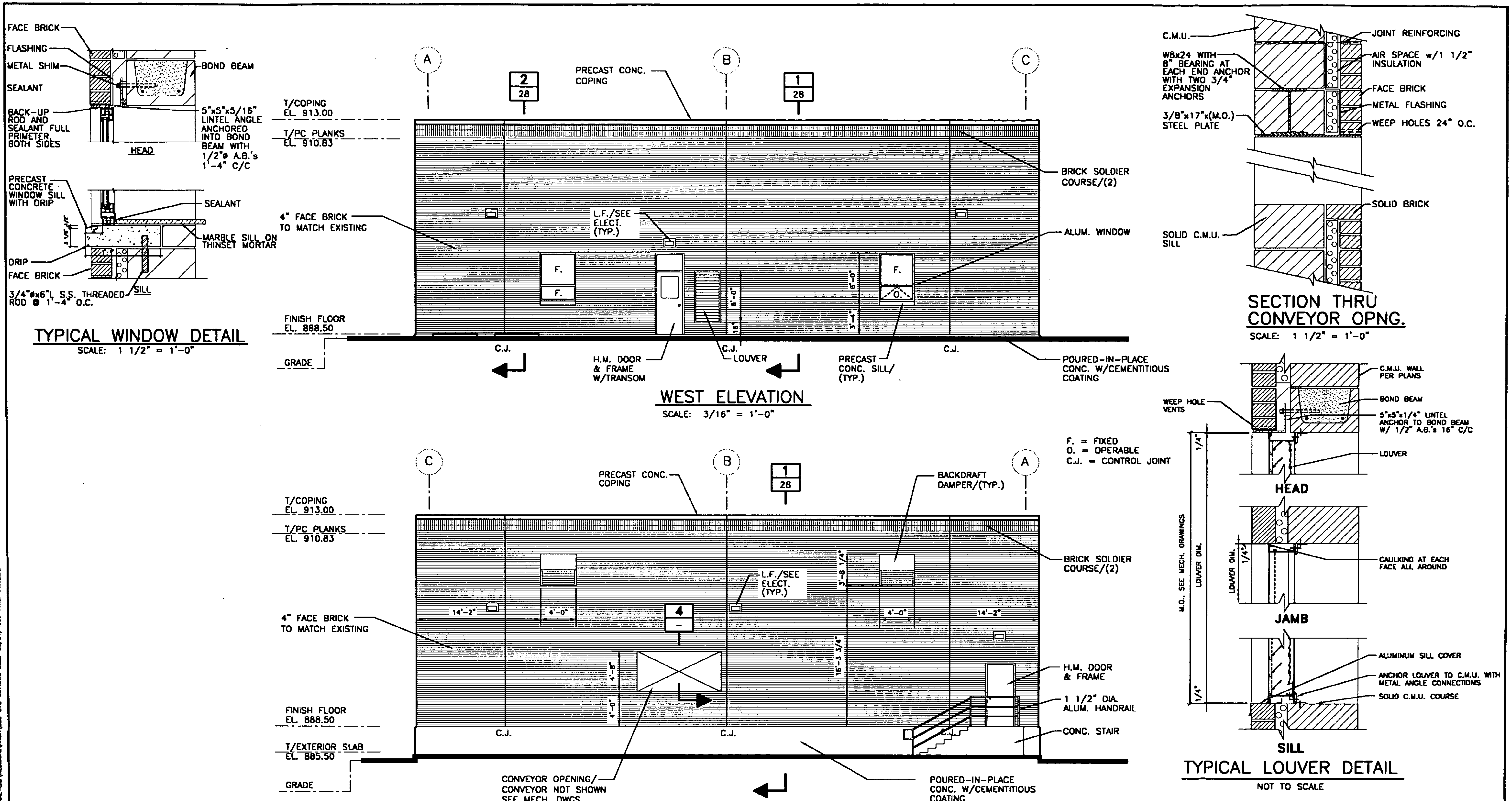
ARCHITECTURAL
DEWATERING BUILDING ELEVATIONS

MONTGOMERY WATSON

DRAWN BY: TCG
PROJECT ENG'R: TCG
APPROVED: EWM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-026



DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

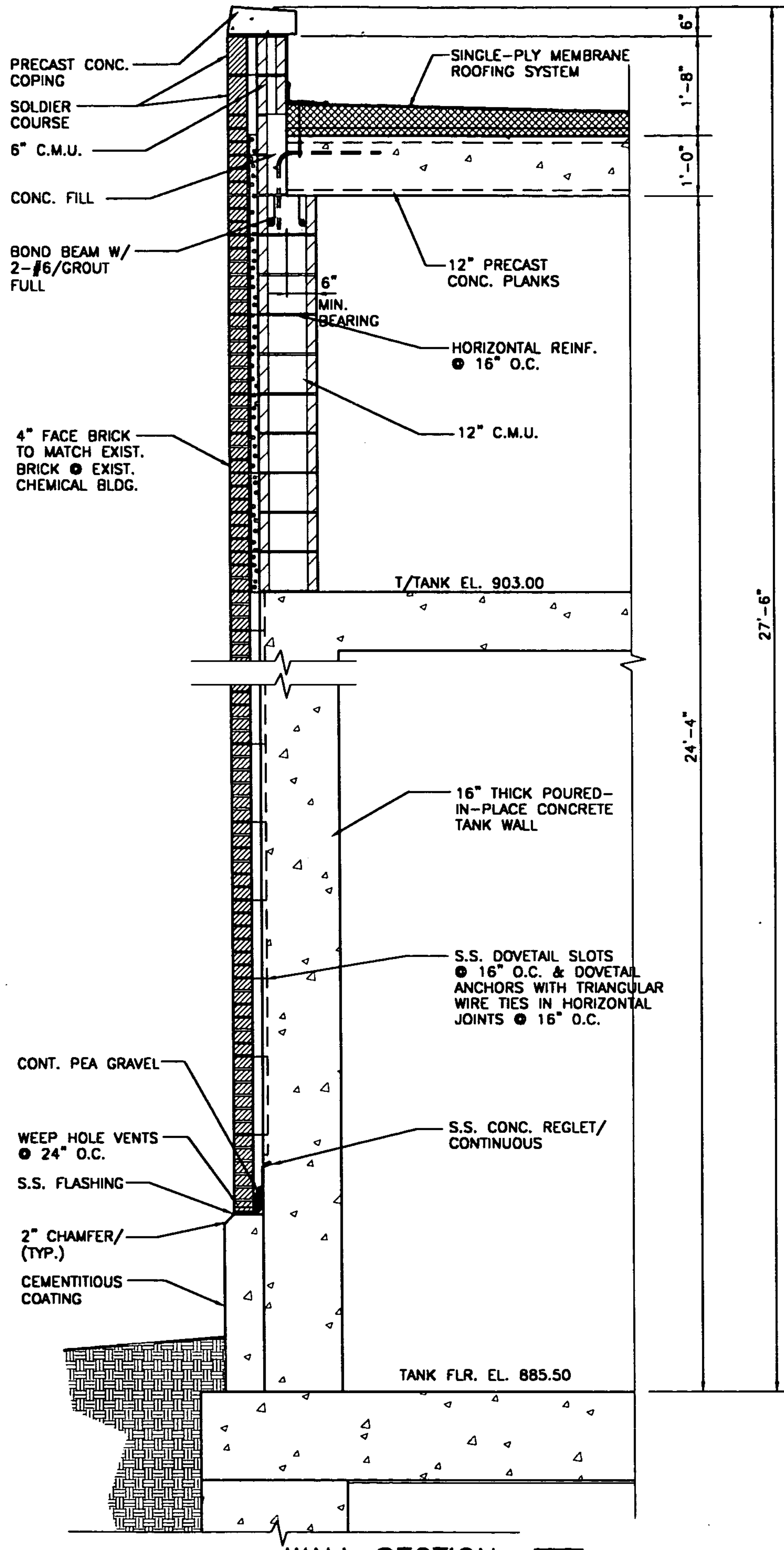
ARCHITECTURAL
DEWATERING BUILDING ELEVATIONS

MONTGOMERY WATSON

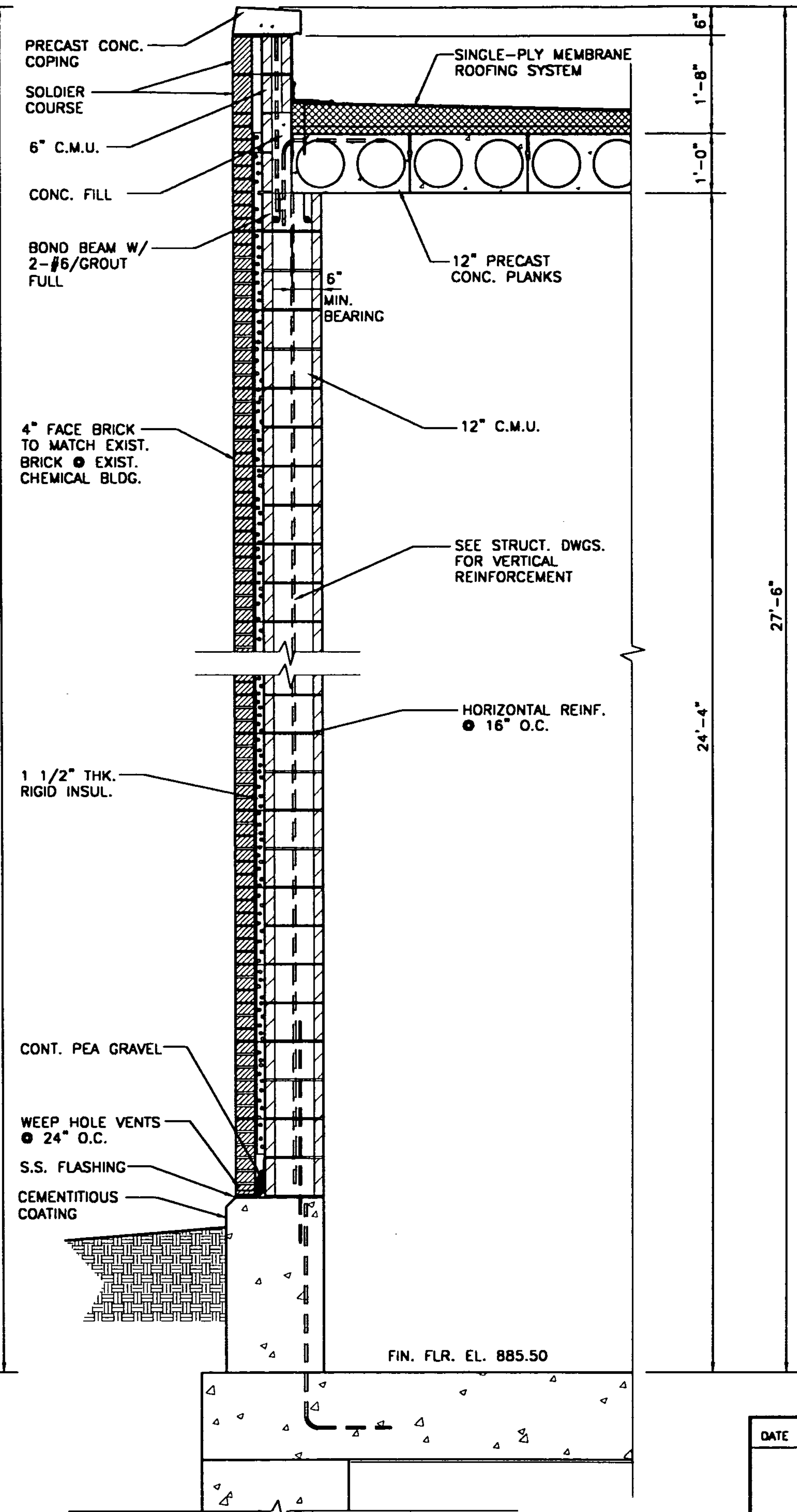
DRAWN BY: TCG
PROJECT ENG'R: TCG
APPROVED: EWM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

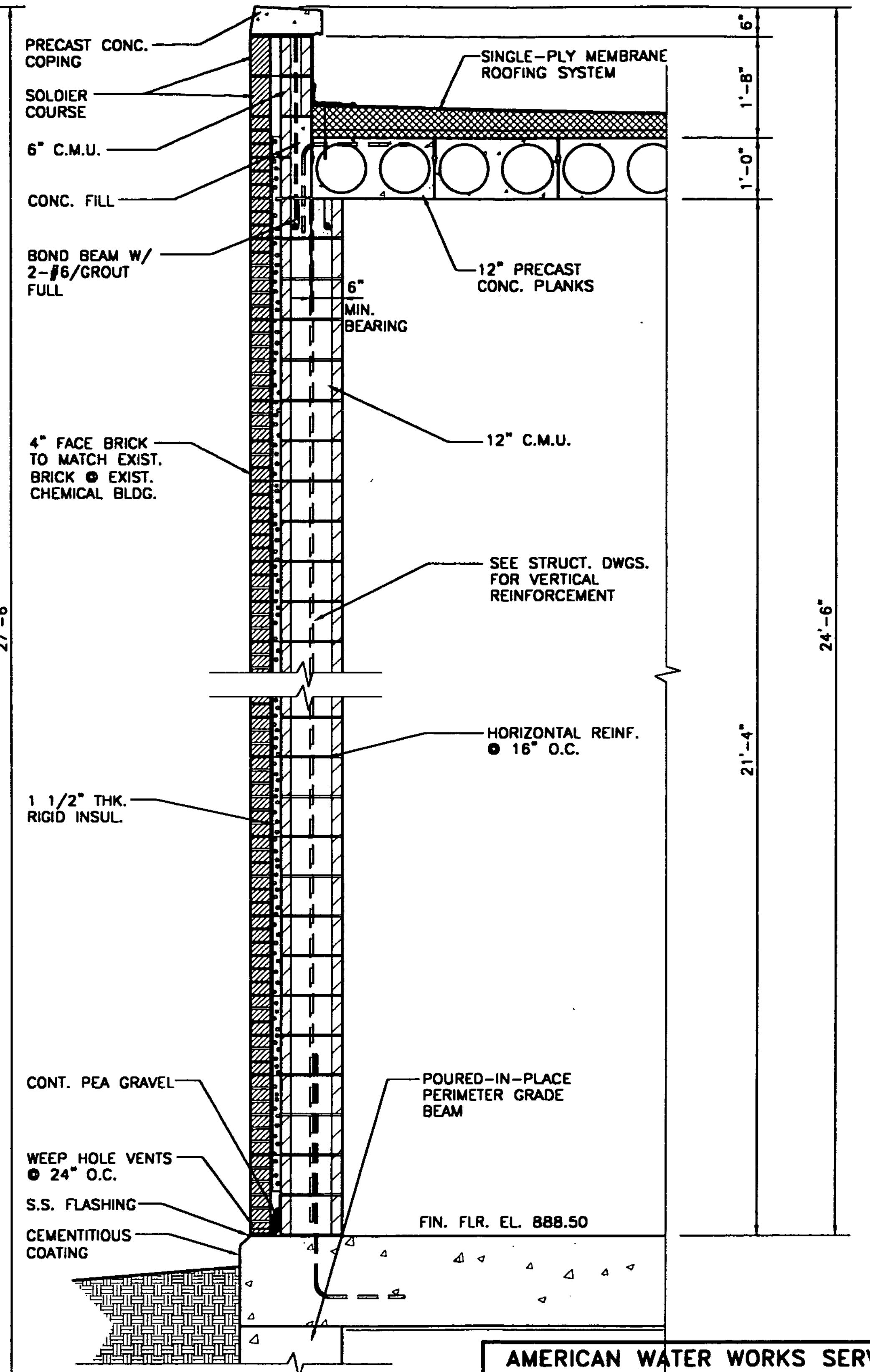
380-575-027



WALL SECTION 3 -



WALL SECTION 2 -



WALL SECTION 1 -
SCALE: 3/4" = 1'-0"

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ARCHITECTURAL
DEWATERING BLDG. SECTIONS & DETAILS

MONTGOMERY WATSON

DRAWN BY: TCG
PROJECT ENG'R: TCG
APPROVED: EWM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

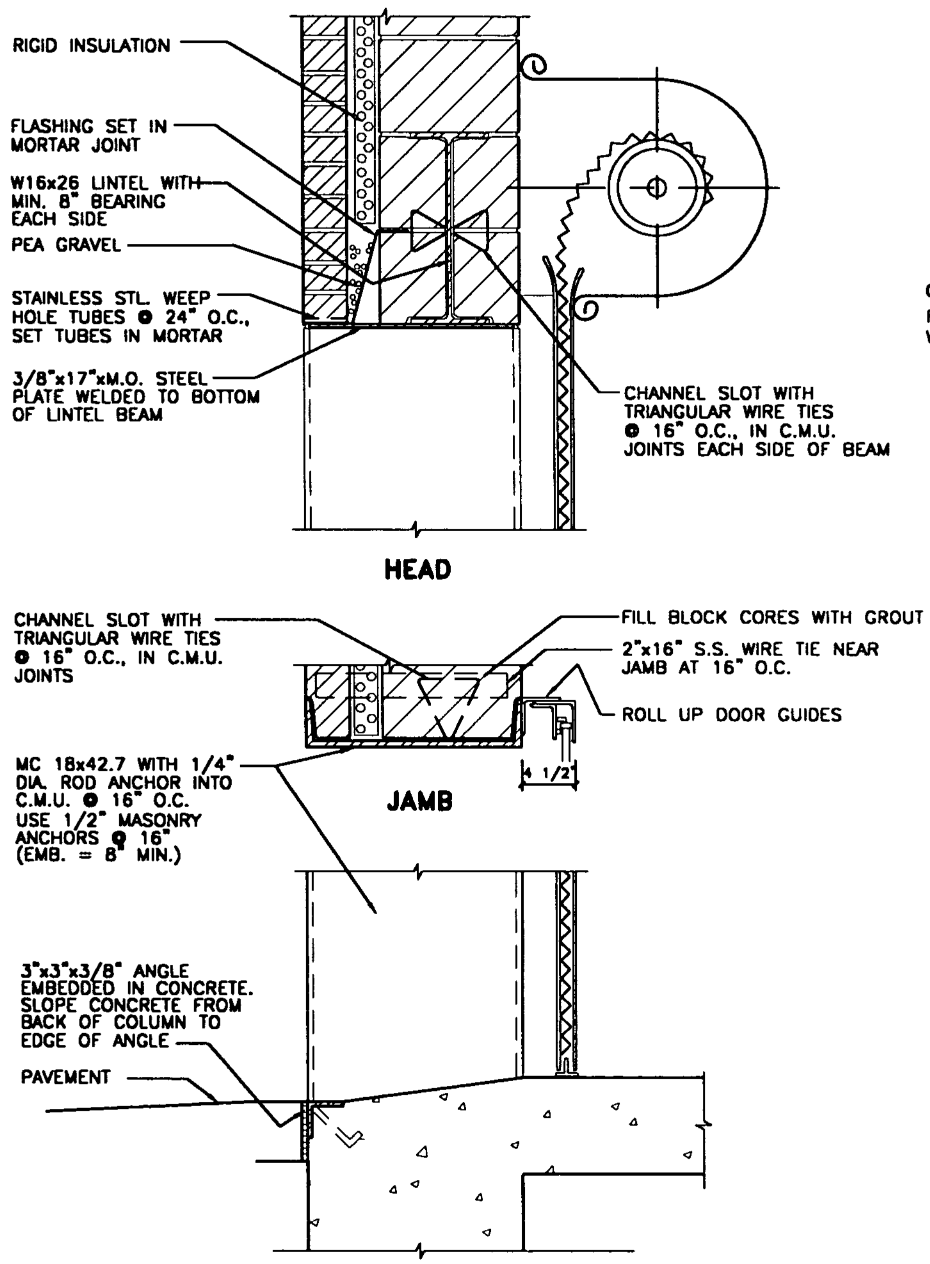
380-575-028

ROOM FINISH SCHEDULE

Building	Mark	Room Name	Floor Elevation	Floor: Concrete Sealer	Floor: Slab Finish (See Specs)	Floor: Terrazzo	Floor: Ceramic Tile	Floor: Quarry Tile	Floor: Vinyl Tile	Floor: Carpet	Floor: Removable Access Flr.	Floor: Aluminum Grating	Floor: Slate	Floor: Painted	Base: Concrete	Base: Ceramic Tile	Base: Vinyl Cove	Base: Vinyl Flat	Base: Glazed Cove	Base: Painted	Base: None	Walls: Concrete	Walls: Glazed Tile	Walls: Ceramic Tile	Walls: Drywall	Walls: Vinyl Covering	Walls: Concrete Block	Walls: Metal Siding	Walls: Painted	Ceiling: Concrete	Ceiling: Suspended Acoustical	Ceiling: Applied Acoustical	Ceiling: Metal Deck	Ceiling: Exposed Structural	Ceiling: Drywall	Ceiling: Painted	Remarks	Mark
SLUDGE DEWATERING BUILDING	1	BFP AREA	888.50	•	•																•	•					•		•					•		•		1
	2	ELECTRICAL ROOM	888.50	•	•																•						•		•					•		•		2
	3	OFFICE	888.50	•	•																•						•		•		•							3
	4	JANITOR'S CLOSET	888.50	•	•																•						•		•					•		•		4
	5	POLYMER AREA	885.50	•	•																•	•					•		•					•		•		5

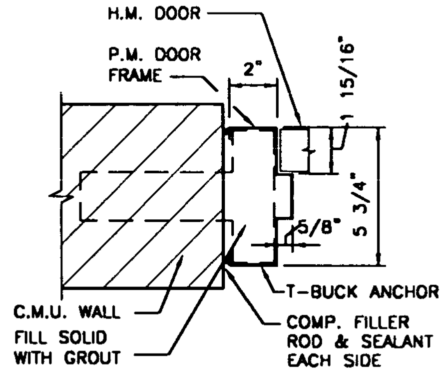
DOOR SCHEDULE & HARDWARE

Building	Mark	Size and Thickness	Floor Elevation	Door: Material	Door: Type	Door: Label	Frame: Material	Frame: Detail No.	Frame: Sheet No.	Hardware: Butt Hinges (Pairs)	Lock Set	Lock	Latch Set	Closer	Door Stay	Dead Bolt	Flushbolt	Astragal	Push-Pull	Stop	Threshold	Weather Stripping	Panic Exit Device	Removable Mullion	Kick Plate	Door Bottom Seal	Coordinator	Remarks	Mark
SLUDGE DEWATERING BUILDING	1	3/0x7/2x1 3/4"	888.50	H.M.	C	–	P.M.	[illegible]	29	1 1/2	•			•	•						•	•				•			1
	2	3/0x7/2x1 3/4"	888.50	H.M.	B	–	P.M.	[illegible]	29	1 1/2	•										•					•			2
	3	(2) 4/0x7/2x1 3/4"	888.50	H.M.	D	–	P.M.	[illegible]	29	3	•			•	•		•	•			•	•				•	•	2'-2" TRANSOM PANEL	3
	4	3/0x7/2x1 3/4"	888.50	H.M.	B	–	P.M.	[illegible]	29	1 1/2	○									W	○					○			4
	5	3/0x7/2x1 3/4"	888.50	H.M.	A	–	P.M.	[illegible]	29	1 1/2	•									W									5
	6	12/0x12/0	888.50	H.M.	E	–	P.M.	[illegible]	29	–	•																	ROLLING SERVICE DOOR	6
	7	3/0x7/2x1 3/4"	888.50	H.M.	A	–	P.M.	[illegible]	29	1 1/2	•			•	•						•	•				•			7
	8	3/0x7/2x1 3/4"	888.50	H.M.	A	–	P.M.	[illegible]	29	1 1/2	•			•	•						•	•				•			8



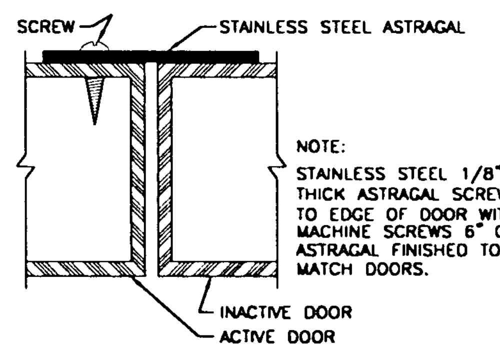
ROLLING SERVICE DOOR SECTION H-3 / – J-3 / –

1 1/2" = 1'-0"



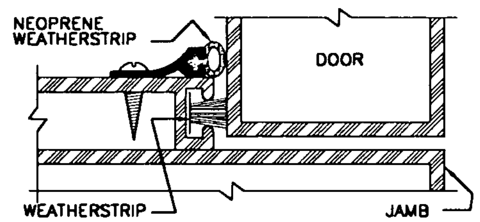
DOOR JAMB DETAIL J-1 / –

3" = 1'-0"



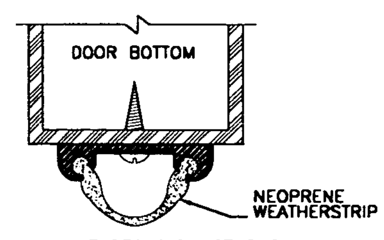
ASTRAGAL DETAIL

NO SCALE



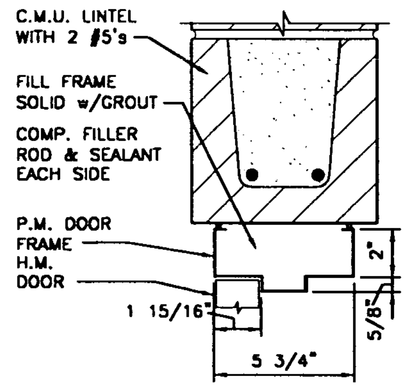
WEATHERSTRIP DETAIL

NO SCALE



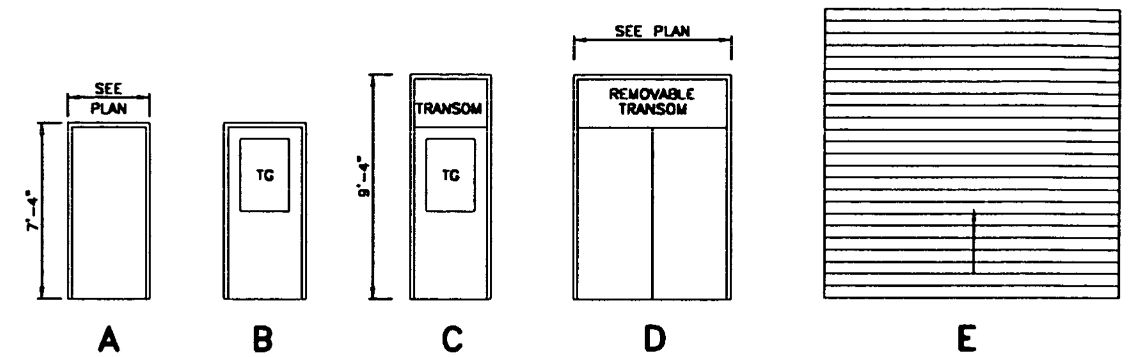
DOOR SEAL DETAIL

NO SCALE



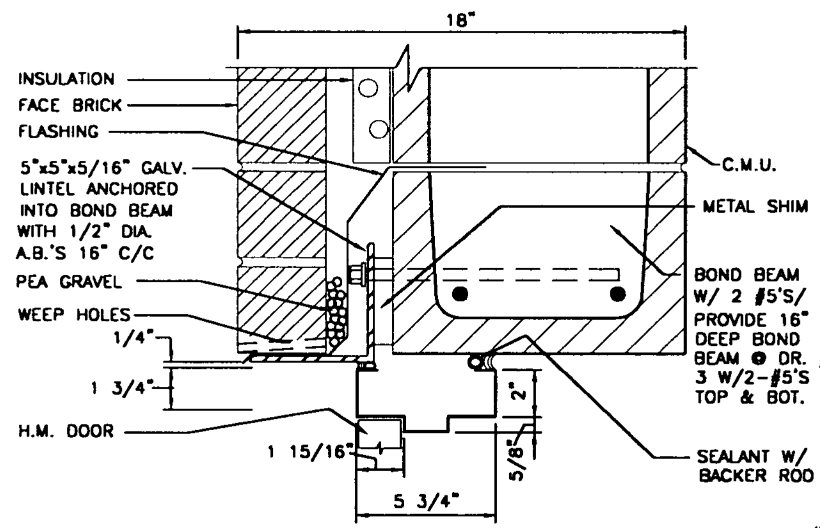
DOOR HEAD DETAIL H-1 / –

3" = 1'-0"



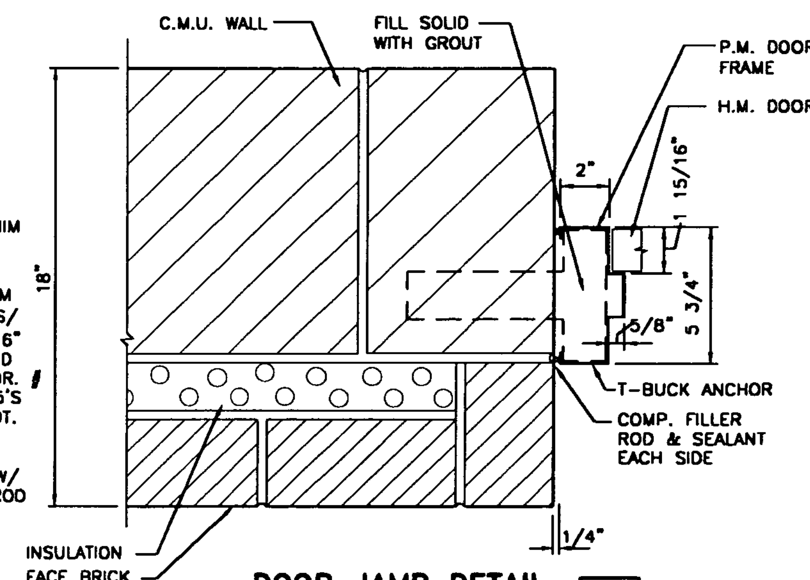
DOOR TYPE ELEVATIONS

SCALE: NONE



DOOR HEAD DETAIL H-2 / –

3" = 1'-0"



DOOR JAMB DETAIL J-2 / –

3" = 1'-0"

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ARCHITECTURAL
SCHEDULES AND DETAILS

MONTGOMERY WATSON

DRAWN BY: TCG
PROJECT ENG'R: TCG
APPROVED: EWM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-029

EQUIPMENT DESIGNATION	DESCRIPTION	SERVICE/TYPE	QUANTITY	CAPACITY/SIZE/HP
AIR-COMP-00.01, -00.02	AIR COMPRESSOR FOR BELT FILTER PRESS ALIGNMENT	AIR	2	15.0 CFM, 145 PSI, 5 HP
BPOL-MX-00.01	MIXER FOR DAY TANK	POLYMER FOR BFP	1	½ HP
BPOL-P-00.01, -00.02	TRANSFER PUMPS	POLYMER FOR BELT FILTER PRESS	2	50 GPM, 15 FT. TDH, 1 HP
BPOL-PBS-10.01, -20.01	POLYMER BLENDING SYSTEM FOR BELT FILTER PRESSES	POLYMER	2	0.125 - 2.5 GPH POLYMER 60-600 GPM DILUTION WATER
BPOL-T-00.01	BULK STORAGE TANK	POLYMER FOR BFP	1	2500 GAL
BPOL-T-00.02	DAY TANK	POLYMER FOR BFP	1	100 GAL
BPOL-WSC-00.01	WEIGH SCALE FOR DAY TANK	POLYMER FOR BELT FILTER PRESS	1	0-2000 LB.
DRN-P-00.01	LAGOON SUPERNATANT RETURN VAULT SUMP PUMP	DRAIN THE VALVE VAULT	1	½ HP
GPOL-MX-00.01	MIXER FOR DAY TANK	POLYMER FOR GRAVITY THICKENER AND WASH WATER WASTE	1	½ HP
GPOL-P-00.01, -00.02	TRANSFER PUMPS	POLYMER FOR GRAVITY THICKENER	2	50 GPM, 15 FT. TDH, 1 HP
GPOL-PBS-00.01, -00.02	POLYMER BLENDING SYSTEM FOR GRAVITY THICKENERS	POLYMER	2	0.08 - 1 GPH POLYMER, 3-300 GPH DILUTION WATER
GPOL-T-00.01	BULK STORAGE TANK	POLYMER FOR GRAVITY THICKENER AND WASH WATER WASTE	1	5000 GAL
GPOL-T-00.02	DAY TANK	POLYMER FOR GRAVITY THICKENER AND WASH WATER WASTE	1	100 GAL
GPOL-WSC-00.01	WEIGH SCALE FOR DAY TANK	POLYMER FOR GRAVITY THICKENER	1	0-2000 LB.
LSR-P-00.01, -00.02	RELOCATED AND MODIFIED SUPERNATANT PUMPS FROM THE WASH WATER WASTE HOLDING TANK NO. 1. PUMPS RELOCATED TO LAGOON SUPERNATANT RETURN VAULT NO. 2	LAGOON SUPERNATANT RETURN	2	1000 GPM, 80 FT. TDH, 40 HP
PW-P-00.01, -00.02	BOOSTER PUMPS FOR BELT FILTER PRESS WASH	PLANT WATER	2	30-300 GPM, 25HP
SC-CON-10.01	BELT CONVEYOR FOR BELT FILTER PRESS DISCHARGE	SLUDGE CAKE FROM BFP	1	20 HP
SC-CON-20.01	BELT CONVEYOR FOR BELT FILTER PRESS DISCHARGE	SLUDGE CAKE FROM BFP	1	15 HP
SS-P-00.01, -00.02	SETTLED SOLIDS PUMPS LOCATED IN THE SLUDGE WELL. CONTROLLED BY NEW ULTRASONIC LEVEL SENSORS.	SETTLED SOLIDS	2	700 GPM, 30 FT. TDH, 10 HP
TS-BFP-10.01, -20.01	BELT FILTER PRESS	THICKENED SOLIDS	2	2.8 METER, 4000 LB/D, 10 HP
TS-FM-10.01, -20.01	SOLIDS FLOW METER	THICKENED SOLIDS	2	0-500 GPM, 6-INCH
TS-MX-10.01, 20.01	BATCH FEED TANK VERTICAL SHAFT MIXERS	THICKENED SOLIDS	2	3 HP
TS-P-00.01, -00.02, -00.03, -00.04	EXISTING THICKENED SOLIDS PUMPS LOCATED AT THE GRAVITY THICKENERS, DISCHARGE COLUMN MODIFIED	THICKENED SOLIDS	4 TOTAL, 2 PER G.T.	350 GPM, 30 FT. TDH, 15 HP
TS-P-10.01, -20.01	BELT FILTER PRESS FEED PUMPS	THICKENED SOLIDS	2	70-350 GPM WITH 190 GPM AVE., 20 HP VFD
TS-SC-00.01, -00.02	SLUDGE COLLECTOR IN GRAVITY THICKENERS	THICKENED SOLIDS	2 TOTAL, 1 PER G.T.	SPUR GEAR, RAKE ARM TIP SPEED OF 7 TO 10 FT/MIN,
WPOL-PBS-00.01, -00.02	POLYMER BLENDING SYSTEM FOR WASH WATER WASTE FLOW STREAM	POLYMER	2	0.125 - 2.5 GPH POLYMER 60-600 GPH DILUTION WATER
DRN-EV-00.0X X=1-10	PURIFICATION UNIT DRAIN VALVES	BUTTERFLY	10	12-INCH
LS-EV-00.0X X=1, 2, 3, 4	LAGOON SUPERNATANT LINE	TELESCOPING	4	6-INCH

EQUIPMENT DESIGNATION	DESCRIPTION	SERVICE/TYPE	QUANTITY	CAPACITY/SIZE/HP
LS-HV-00.01	INLET LINE TO LAGOON SUPERNATANT RETURN VAULT NO. 2	BUTTERFLY	1	12-INCH
LSR-CV-00.0X X=1,2	DISCHARGE OF LAGOON SUPERNATANT RETURN PUMPS NO. 1 AND 2	CHECK	2	10-INCH
LSR-HV-00.0X X=1,2	DISCHARGE OF LAGOON SUPERNATANT RETURN PUMPS NO. 1 AND 2	BUTTERFLY	2	10-INCH
PW-SV-00.0X X=1-10	FLUSHING WATER LINES FROM PURIFICATION UNITS	SOLENOID	10	2-INCH
SS-EV-00.0X X=21, 22	INLET VALVE TO GRAVITY THICKENERS	PLUG	2	6-INCH
SS-EV-00.0X X=1,3,...19	SETTLED SOLIDS BLOWDOWN LINE FROM THE PURIFICATION UNITS	EXISTING BALL VALVE WITH ELECTRIC OPERATOR	10	3-INCH
SS-EV-00.0X X=2,4,...20	SETTLED SOLIDS LINES FROM PURIFICATION UNITS TO SLUDGE WELL	EXISTING PLUG VALVE WITH NEW OPERATOR	10	4-INCH
TS-CV-X0.01 X=1,2	FEED PUMP DISCHARGE LINE	CHECK	2	6-INCH
TS-EV-X0.01 X=1,2	BATCH TANK INLET VALVES	PLUG	2	6-INCH
TS-HV-00.01	THICKENED SOLIDS LINE BACK TO THE SLUDGE WELL	PLUG	1	6-INCH
TS-HV-00.02	FEED PUMP SUCTION PIPING INTERCONNECT LINE	PLUG	1	10-INCH
TS-HV-00.03	FEED PUMP DISCHARGE PIPING INTERCONNECT LINE	PLUG	1	6-INCH
TS-HV-X0.01 X=1,2	FEED PUMP SUCTION PIPING	PLUG	2	10-INCH
TS-HV-X0.01 X=1,2	FEED PUMP DISCHARGE LINE	PLUG	2	6-INCH
WWW-EV-00.0X X=1,2,3	INLET VALVES TO LAGOONS 1, 2 AND 3	BUTTERFLY	3	30-INCH
SS-HV-00.01	DIVERTS SETTLED SOLIDS TO GRAVITY THICKENERS	PLUG	1	6-INCH
DRN-EV-00.11 & 00.12	DRAIN FROM BATCH TANKS	PLUG	2	8-INCH

NOTE:

VALVE SCHEDULE AND DESIGNATIONS ARE ONLY USED FOR VALVES 6" AND LARGER AND ALL VALVES WITH OPERATORS OTHER THAN HAND OPERATORS.

DATE	REVISIONS

STATE OF KENTUCKY
19947
REGISTERED
PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

MECHANICAL
EQUIPMENT AND VALVE SCHEDULE

MONTGOMERY WATSON

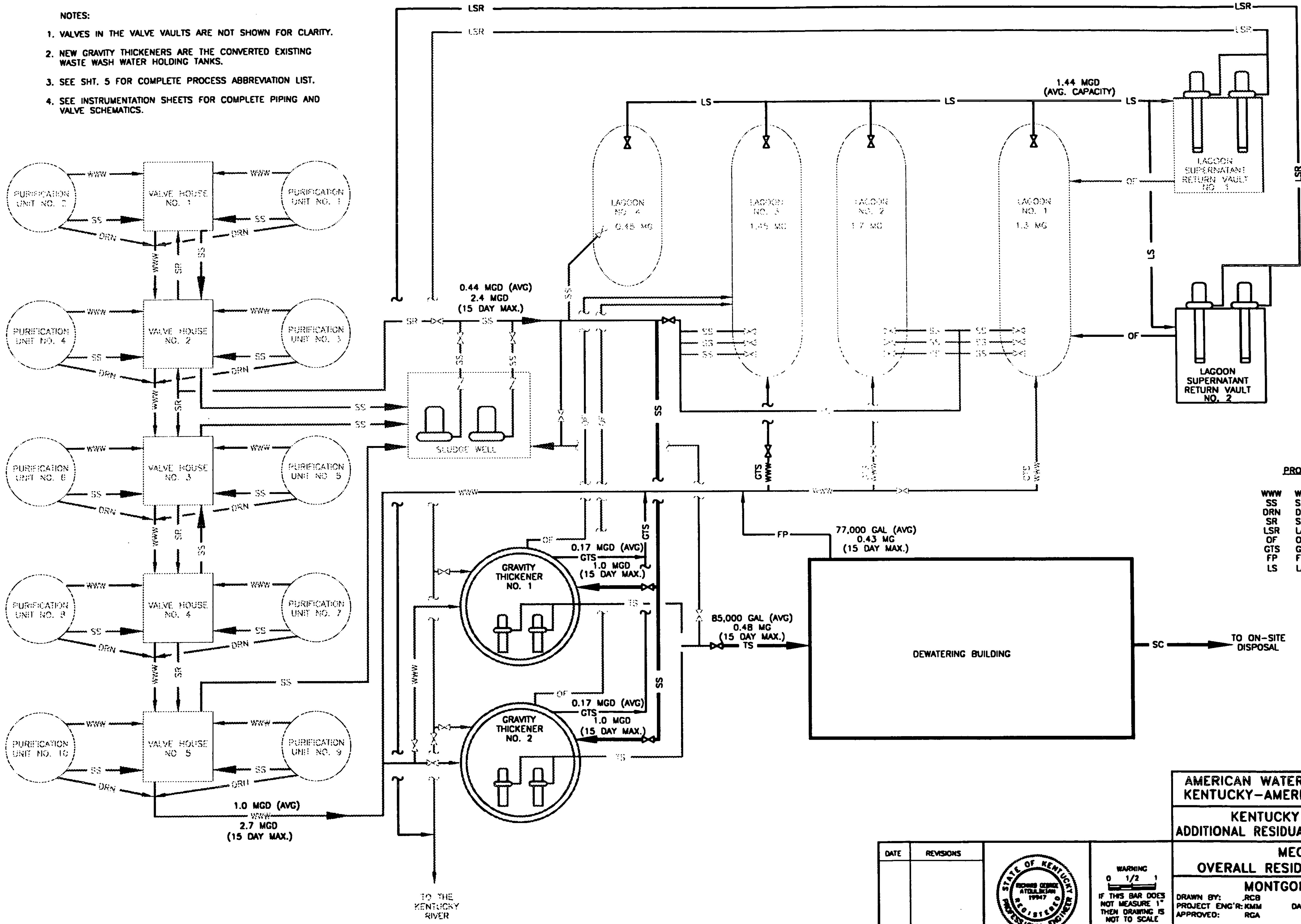
DRAWN BY: MMP
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-030

NOTES:

1. VALVES IN THE VALVE VAULTS ARE NOT SHOWN FOR CLARITY.
2. NEW GRAVITY THICKENERS ARE THE CONVERTED EXISTING WASTE WASH WATER HOLDING TANKS.
3. SEE SHT. 5 FOR COMPLETE PROCESS ABBREVIATION LIST.
4. SEE INSTRUMENTATION SHEETS FOR COMPLETE PIPING AND VALVE SCHEMATICS.



PROCESS ABBREVIATIONS

WWW	WASH WATER WASTE
SS	SETTLED SLUDGE
DRN	DRAIN
SR	SLUDGE RECIRCULATION
LSR	LAGOON SUPERNATANT RETURN
OF	OVERFLOW
GTS	GRAVITY THICKENER SUPERNATANT
FP	FILTER PRESSATE
LS	LAGOON SUPERNATANT

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

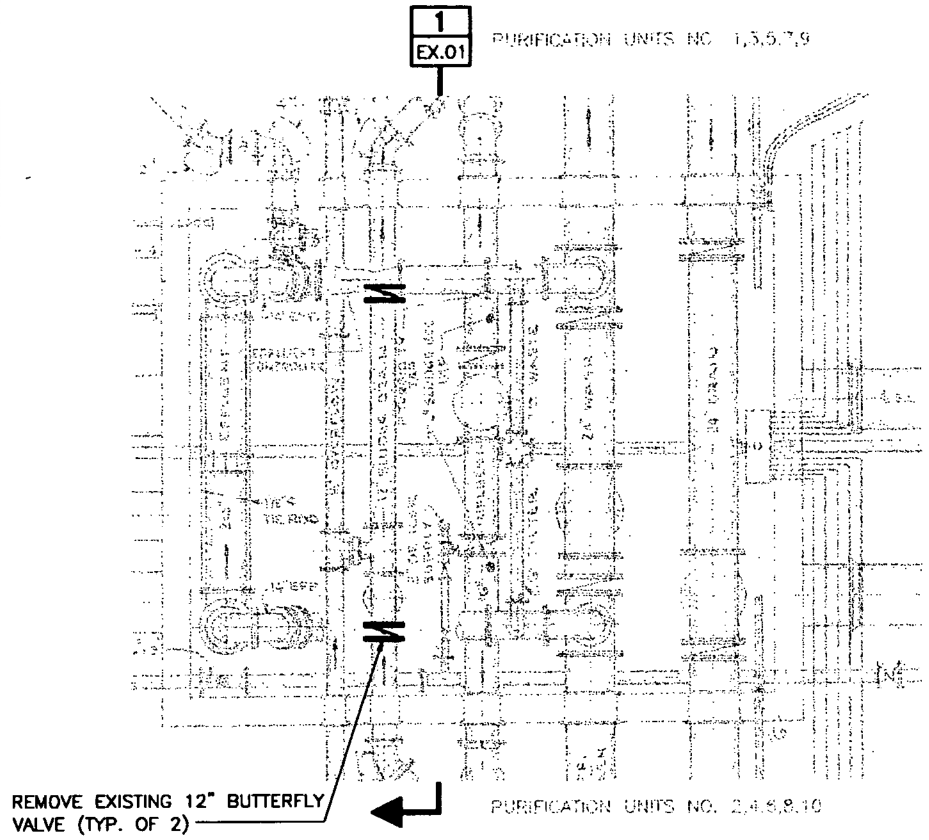
MECHANICAL
OVERALL RESIDUAL SOLIDS SYSTEM

MONTGOMERY WATSON

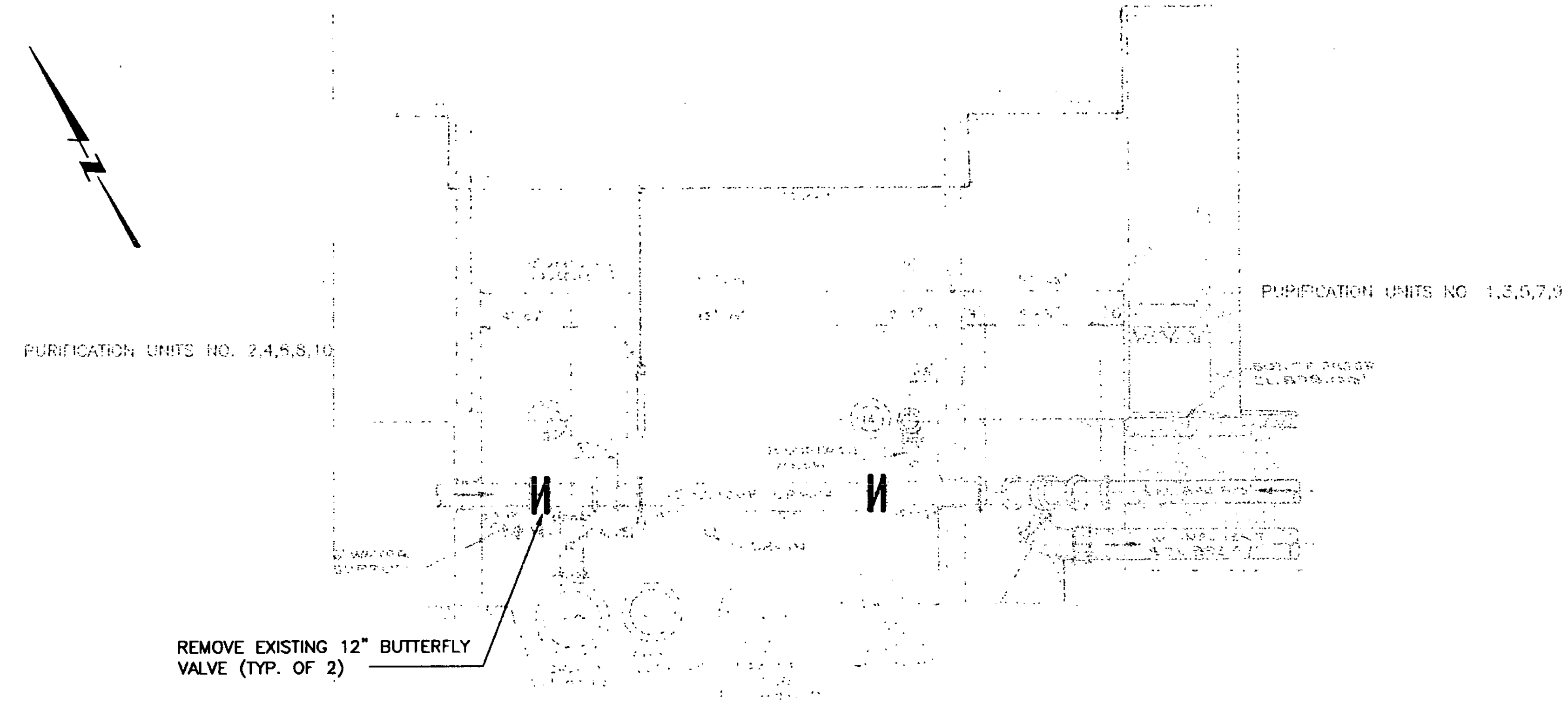
DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

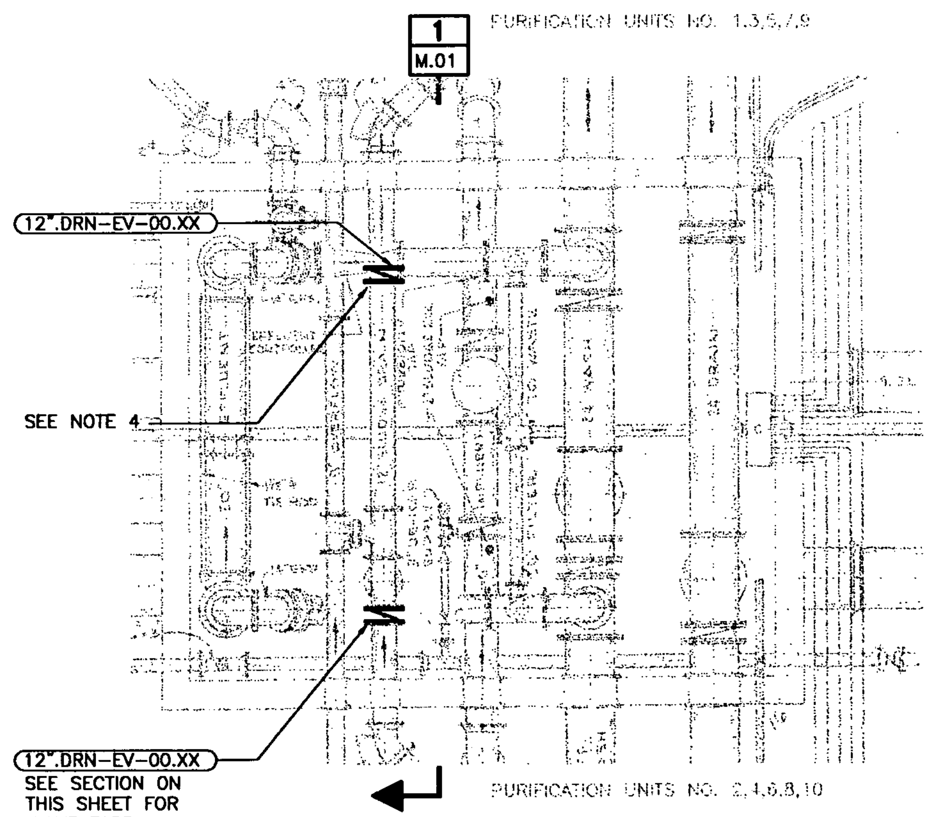
380-575-031



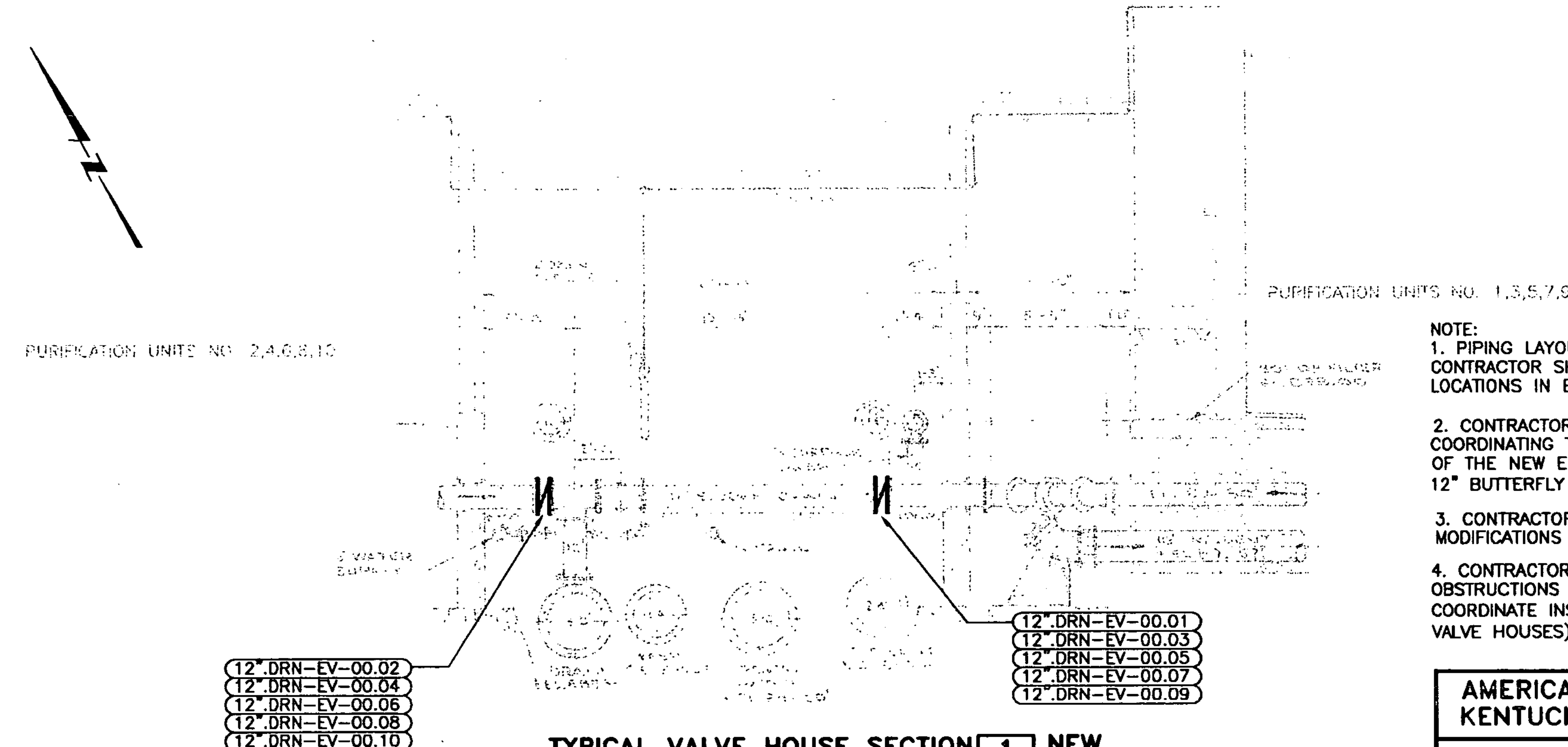
TYPICAL VALVE HOUSE LOWER PLAN – REMOVAL
(TYPICAL OF 5)
SCALE: 1/4" = 1'-0"



TYPICAL VALVE HOUSE SECTION 1/32 REMOVAL
(TYPICAL OF 5)
SCALE: 1/4" = 1'-0"



TYPICAL VALVE HOUSE LOWER PLAN – NEW
(TYPICAL OF 5)
SCALE: 1/4" = 1'-0"



NOTE:
SEE VALVE SCHEDULE FOR VALVE TYPE.

TYPICAL VALVE HOUSE SECTION 1/32 NEW
(TYPICAL OF 5)
SCALE: 1/4" = 1'-0"

NOTE:
1. PIPING LAYOUT MAY VARY SLIGHTLY AMONG VALVE HOUSES. CONTRACTOR SHALL FIELD VERIFY PIPING AND VALVE LOCATIONS IN EACH VALVE HOUSE.

2. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING THE LOCATION AND ARRANGEMENT OF THE NEW ELECTRIC ACTUATORS FOR THE 12" BUTTERFLY VALVES.

3. CONTRACTOR SHALL BE RESPONSIBLE FOR LAY LENGTH MODIFICATIONS FOR THE 12" BUTTERFLY VALVES.

4. CONTRACTOR SHALL FIELD VERIFY POTENTIAL OBSTRUCTIONS FOR ELECTRIC OPERATORS AND COORDINATE INSTALLATION ACCORDINGLY (TYP. OF ALL VALVE HOUSES)

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

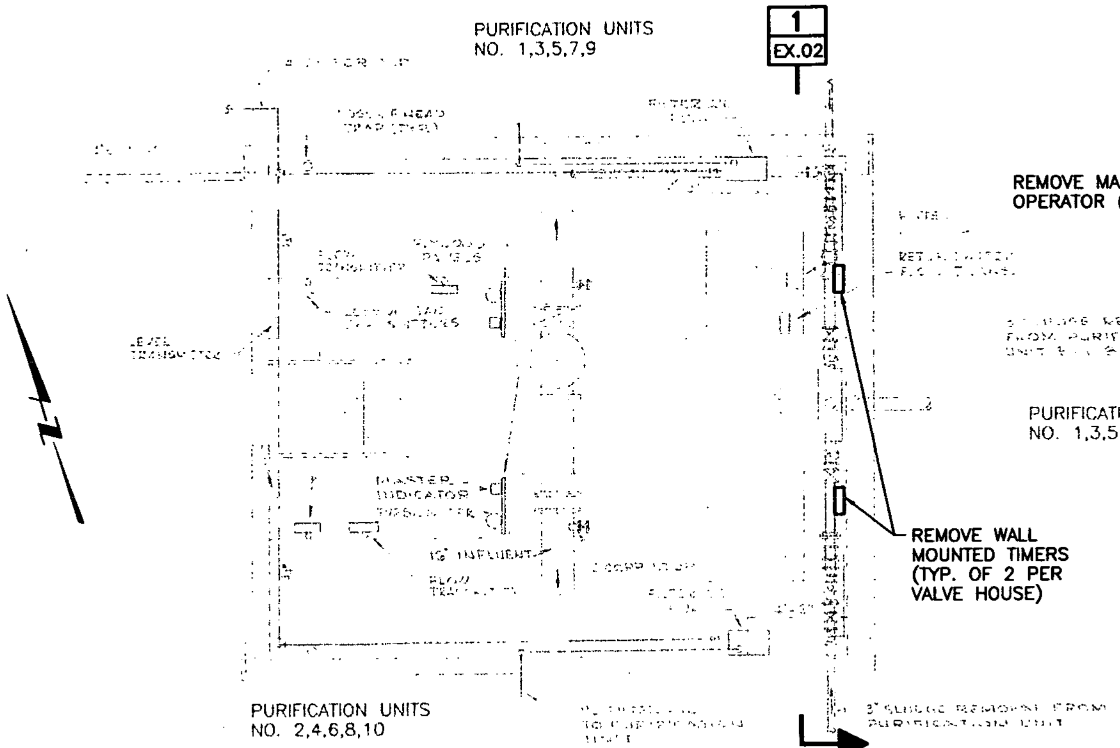
MECHANICAL – DEMOLITION/NEW
TYPICAL VALVE HOUSE DRAIN LINE

MONTGOMERY WATSON

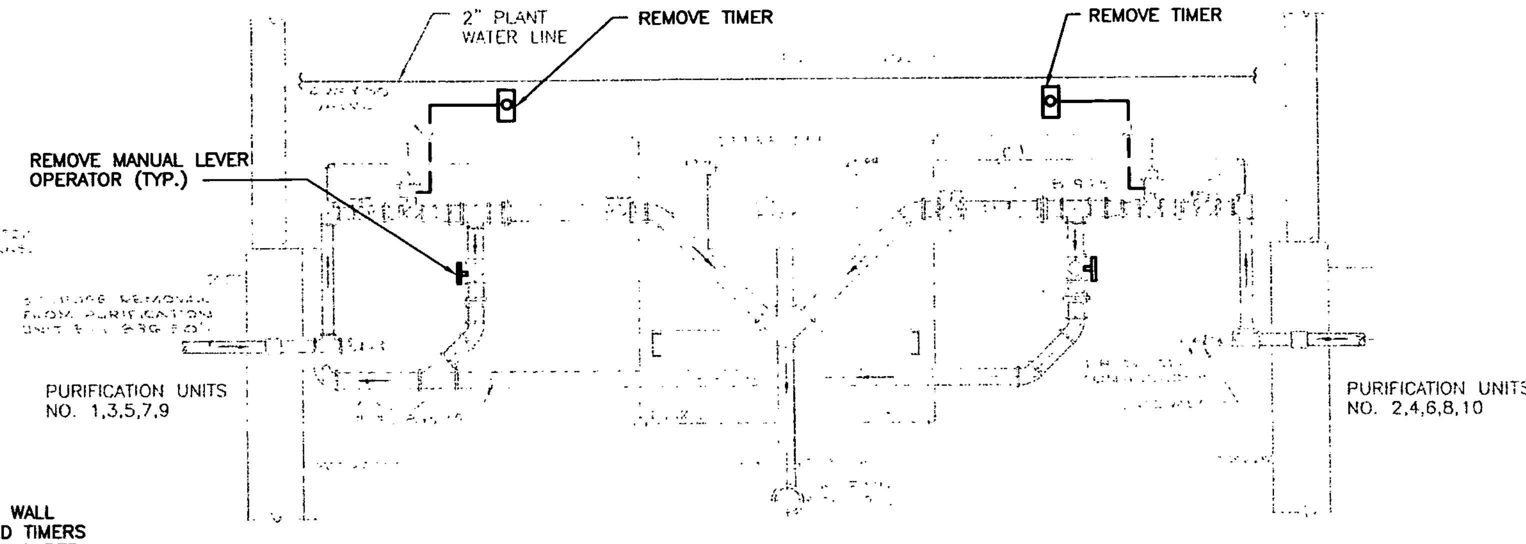
DRAWN BY: RCB
PROJECT ENG'R: KLP
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

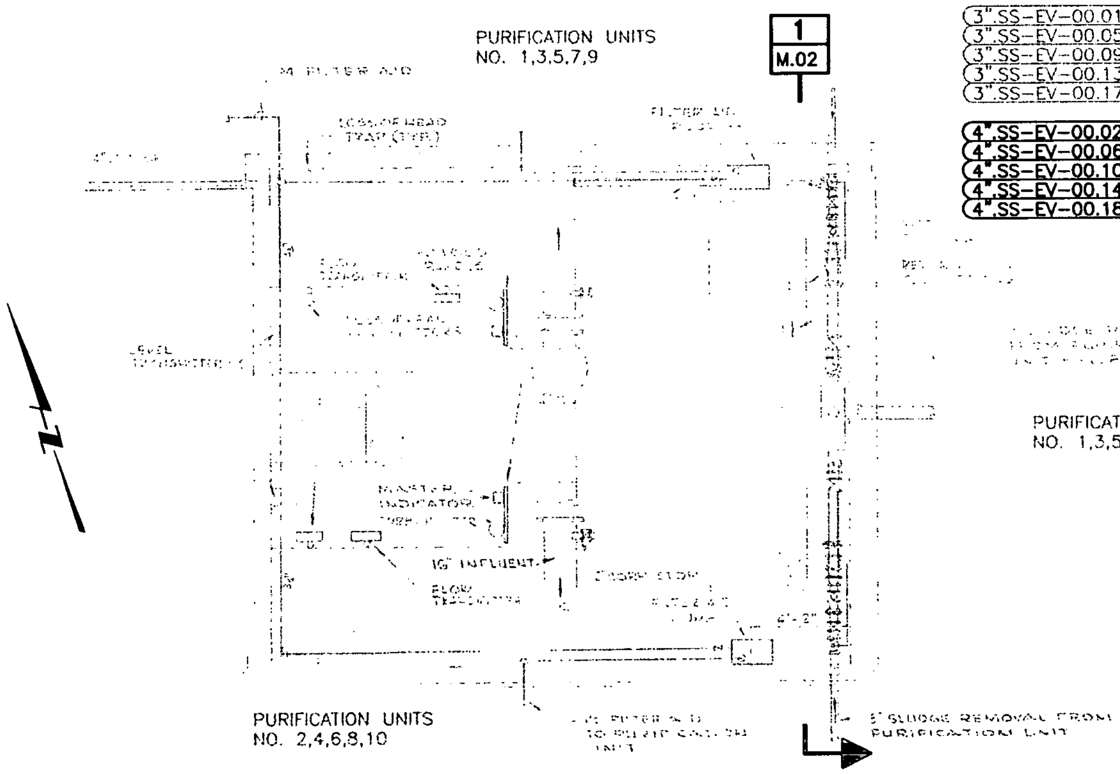
380-575-032



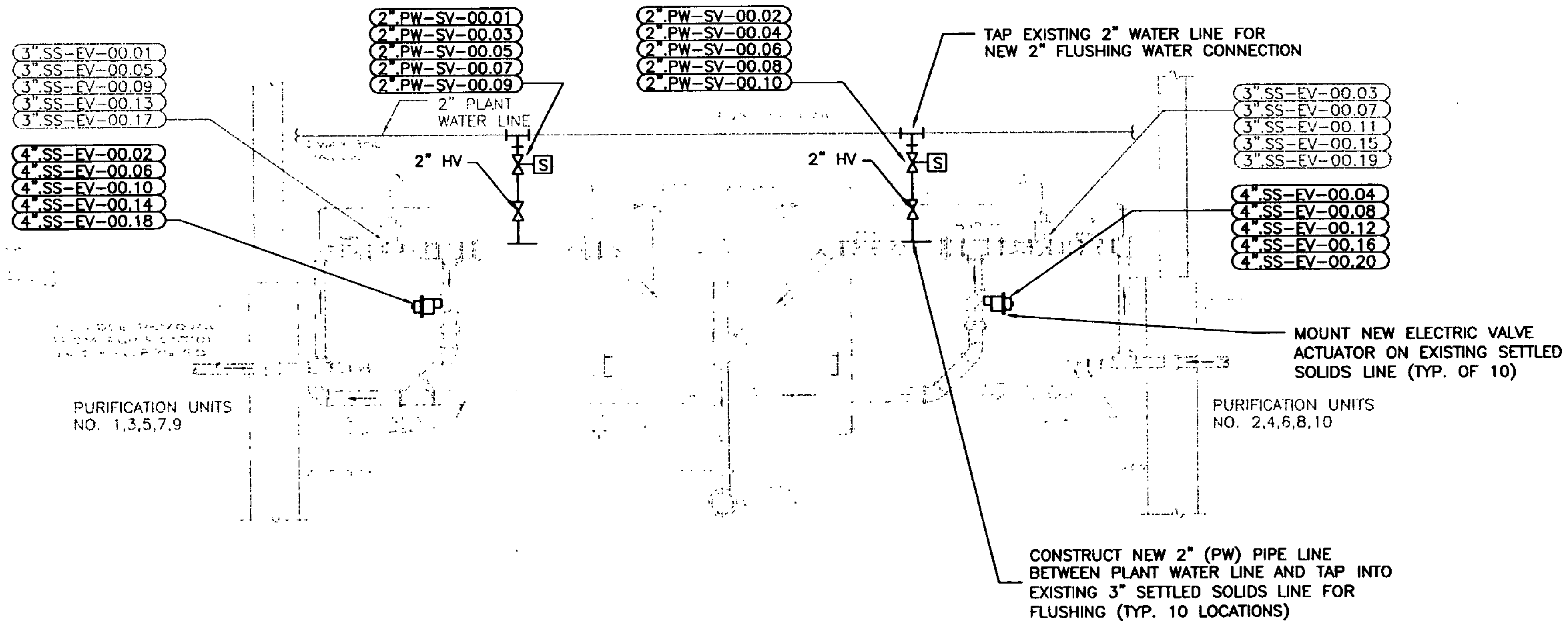
TYPICAL VALVE HOUSE UPPER PLAN – REMOVAL
(TYPICAL OF 5)
SCALE: 1/4" = 1'-0"



TYPICAL VALVE HOUSE SECTION 1/33 REMOVAL
(TYPICAL OF 5)
SCALE: 1/2" = 1'-0"



TYPICAL VALVE HOUSE UPPER PLAN – NEW
(TYPICAL OF 5)
SCALE: 1/4" = 1'-0"



TYPICAL VALVE HOUSE SECTION 1/33 NEW
(TYPICAL OF 5)
SCALE: 1/2" = 1'-0"

NOTE:

PIPING LAYOUT MAY VARY SLIGHTLY AMONG VALVE HOUSES. CONTRACTOR SHALL FIELD VERIFY PIPING AND VALVE LOCATIONS IN EACH VALVE HOUSE.

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY–AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

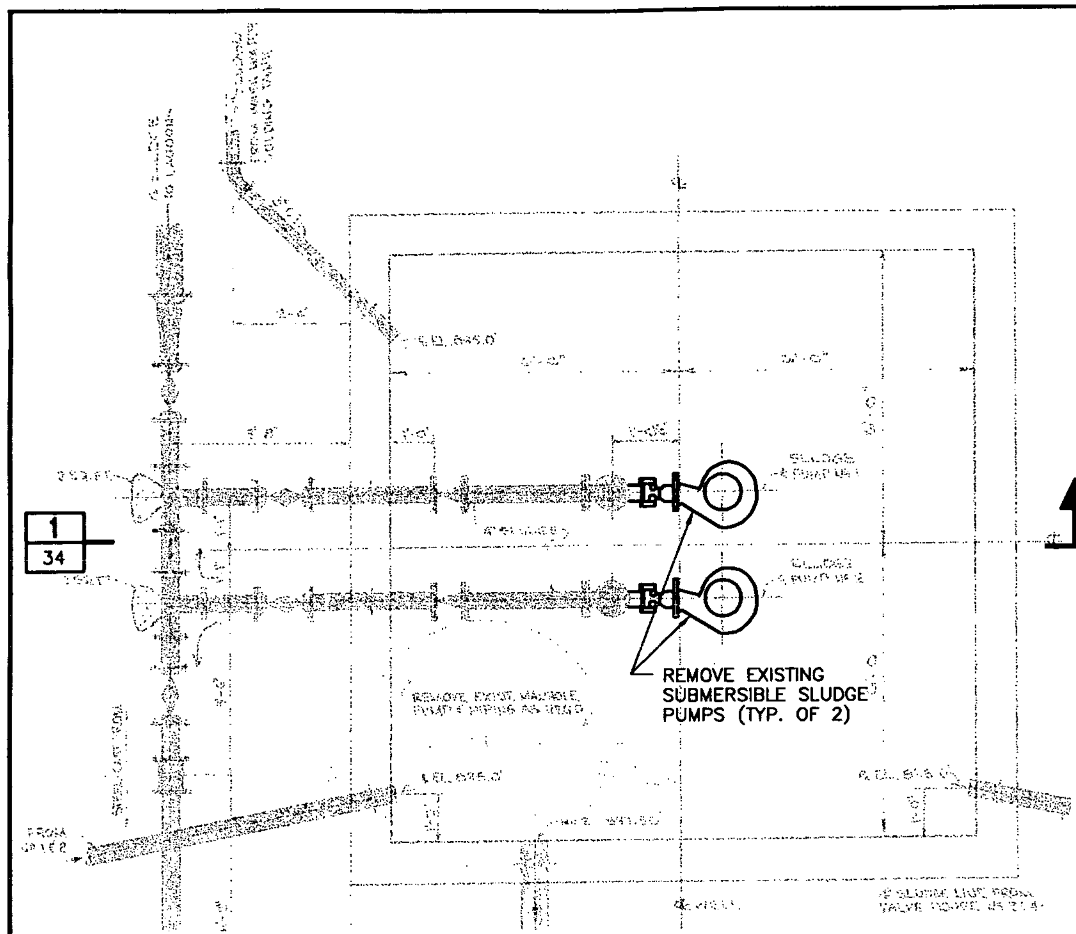
MECHANICAL
TYPICAL VALVE HOUSE FLUSHING LINE

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KLP
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

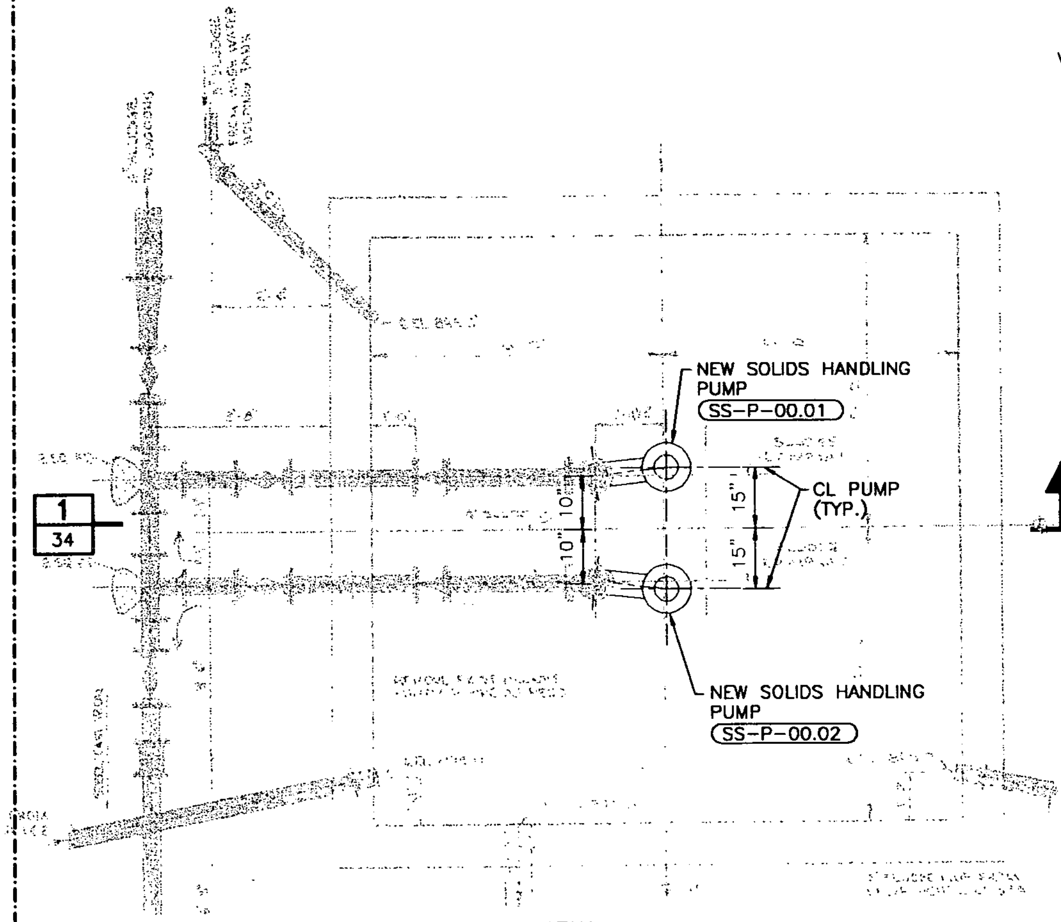
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-033



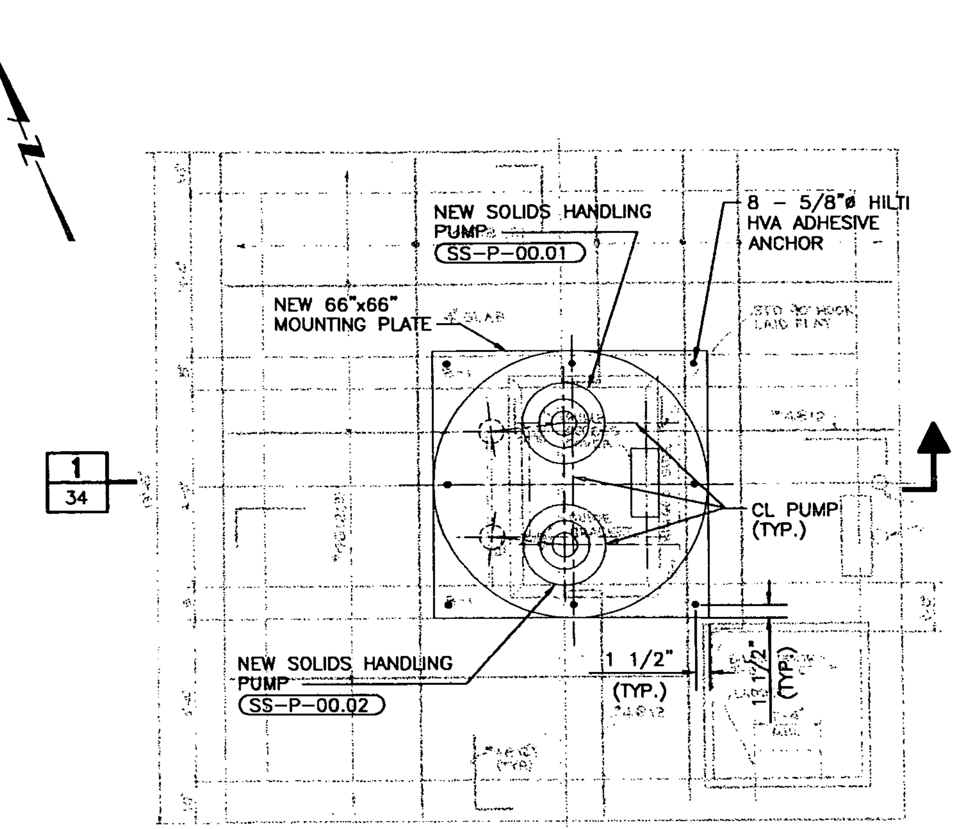
PLAN – REMOVAL

SCALE: 1/2" = 1'-0"



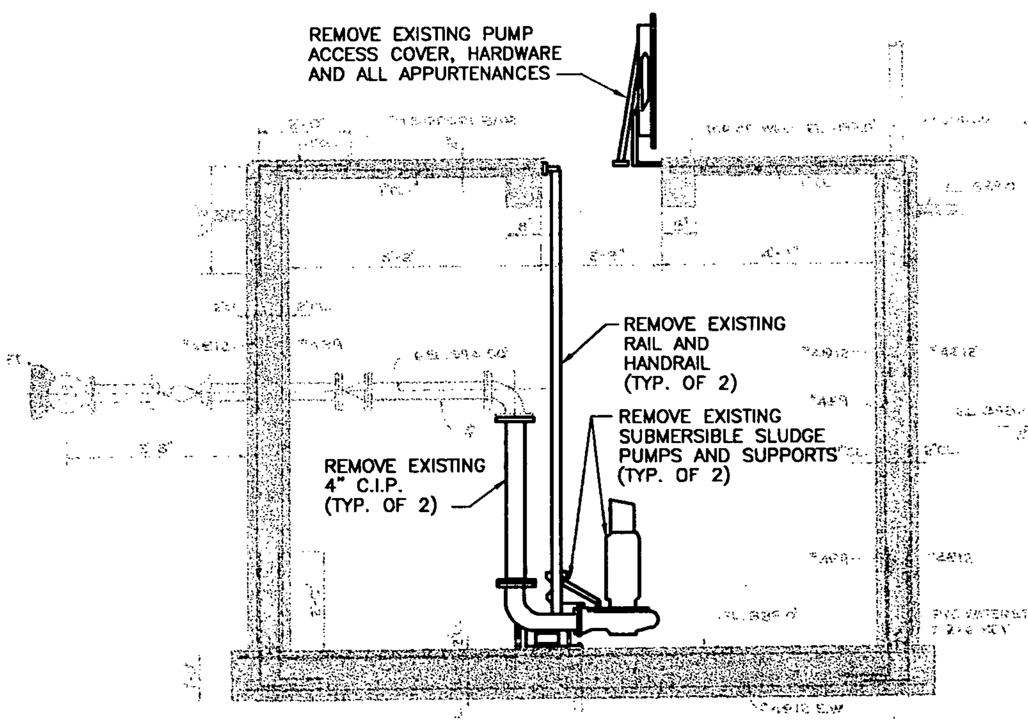
LOWER PLAN – NEW

SCALE: 1/2" = 1'-0"



TOP PLAN – NEW

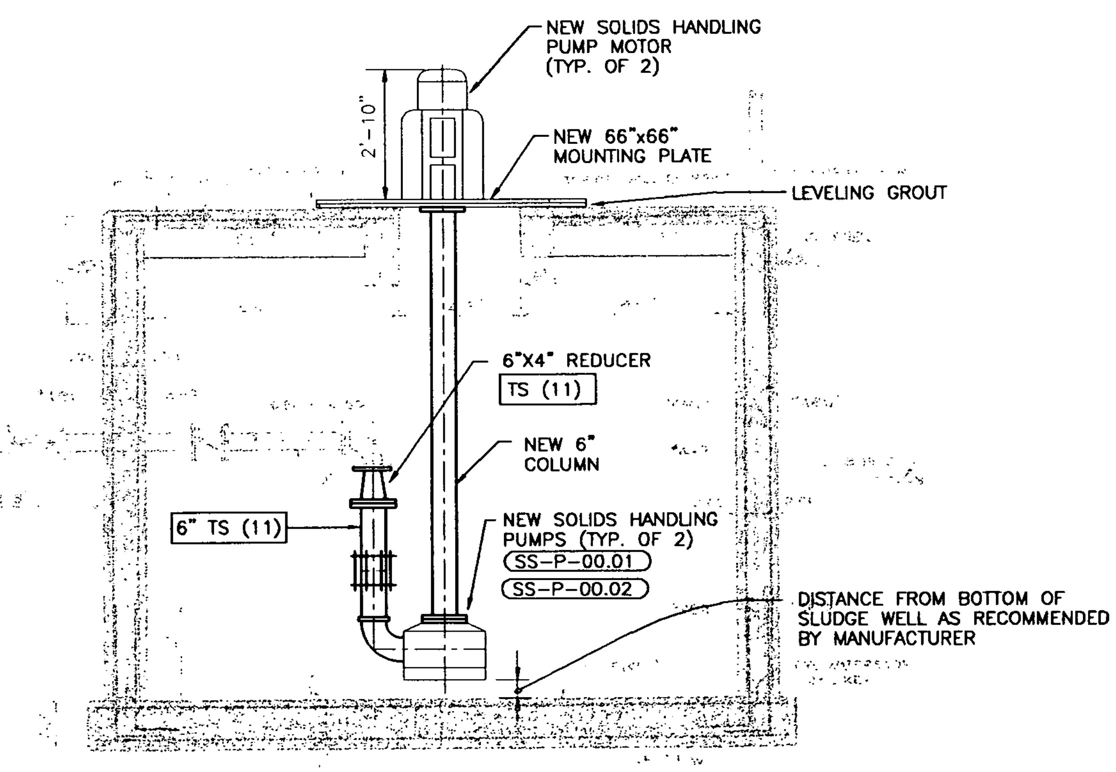
SCALE: 1/2" = 1'-0"



SECTION – REMOVAL

1/34

SCALE: 1/2" = 1'-0"



SECTION – NEW

1/34

SCALE: 1/2" = 1'-0"

NOTE:

MOUNT LEVEL SENSOR IN SLUDGE WELL AS APPROVED BY ENGINEER

DATE	REVISIONS

STATE OF KENTUCKY – RICHARD GEORGE ATOULIKIAN – 19947 – REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

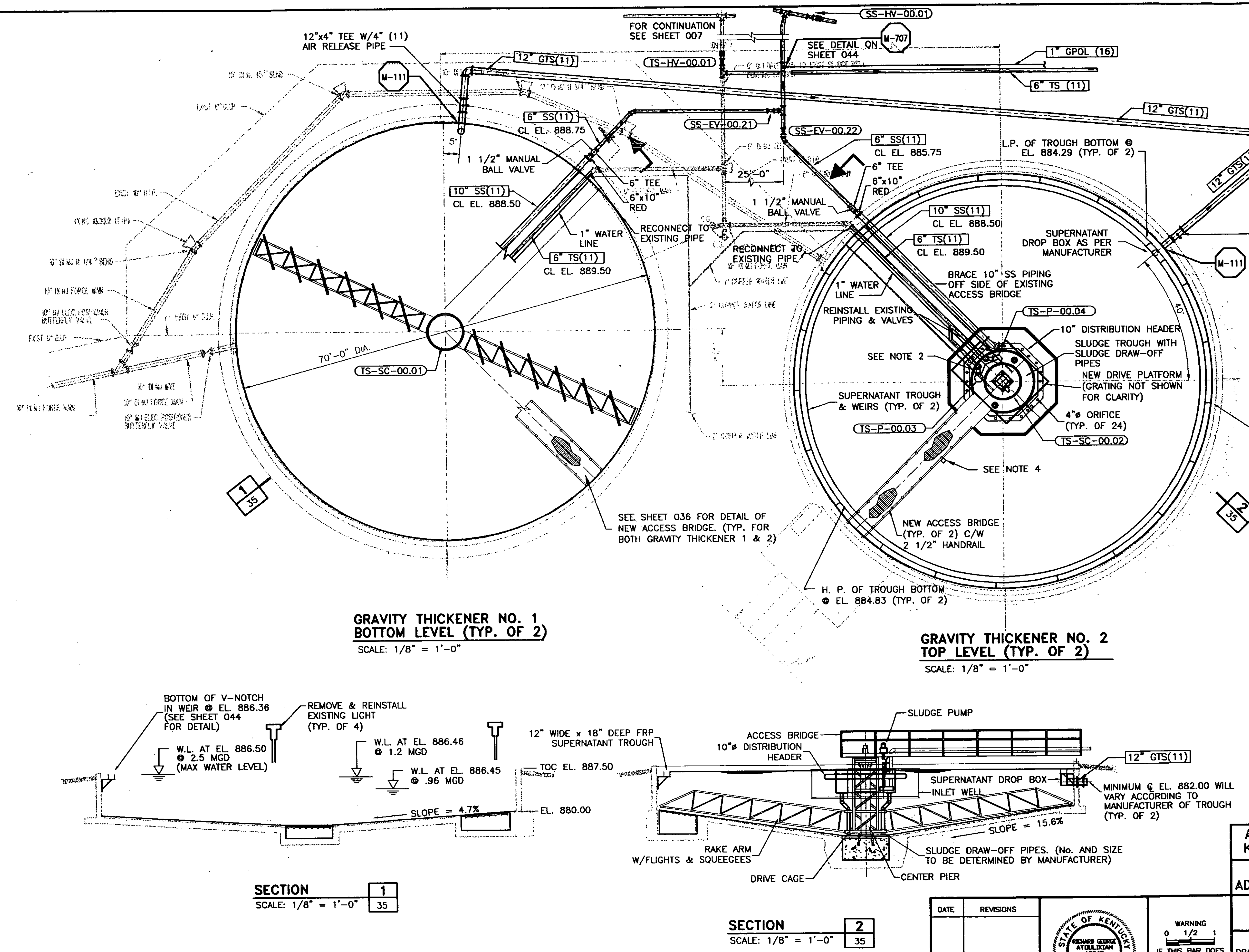
MECHANICAL – DEMOLITION/NEW
SLUDGE WELL PLAN AND SECTION

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KLP
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE 1/2" = 1'-0"

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-034



NOTES:

1. CONTRACTOR SHALL FIELD VERIFY ALL PIPING LOCATIONS, AND ELEVATIONS BEFORE SUBMITTING SHOP DRAWINGS. THERE SHALL BE NO INTERFERENCE BETWEEN NEW AND EXISTING PIPING.

2. EXISTING BRIDGE TO BE SUPPORTED FROM NEW CENTER PIER. CONTRACTOR TO PROVIDE DETAILED DRAWING SHOWING ATTACHMENT METHOD INCLUDING CALCULATIONS SIGNED AND STAMPED BY A REGISTERED PROFESSIONAL ENGINEER AND APPROVAL OF ATTACHMENT MEANS FROM THE MANUFACTURER OF THE NEW CENTER PIER.

3. CONTRACTOR SHALL REPAIR AND REFINISH ANY SECTIONS OF THE GRAVITY THICKENER WALL ALTERED DURING THE DEMOLITION PHASE OF CONSTRUCTION.

4. SLUDGE BLANKET LEVEL DETECTOR TO BE INSTALLED ACCORDING TO EQUIPMENT SUPPLIER (TYP. OF 2). CONTRACTOR SHALL COORDINATE INSTALLATION WITH RAKE ARM MANUFACTURER.

5. CONNECT NEW ACCESS GUARD RAILING TO EXISTING GUARD RAILING SURROUNDING GRAVITY THICKENER.

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULOKIAN
19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

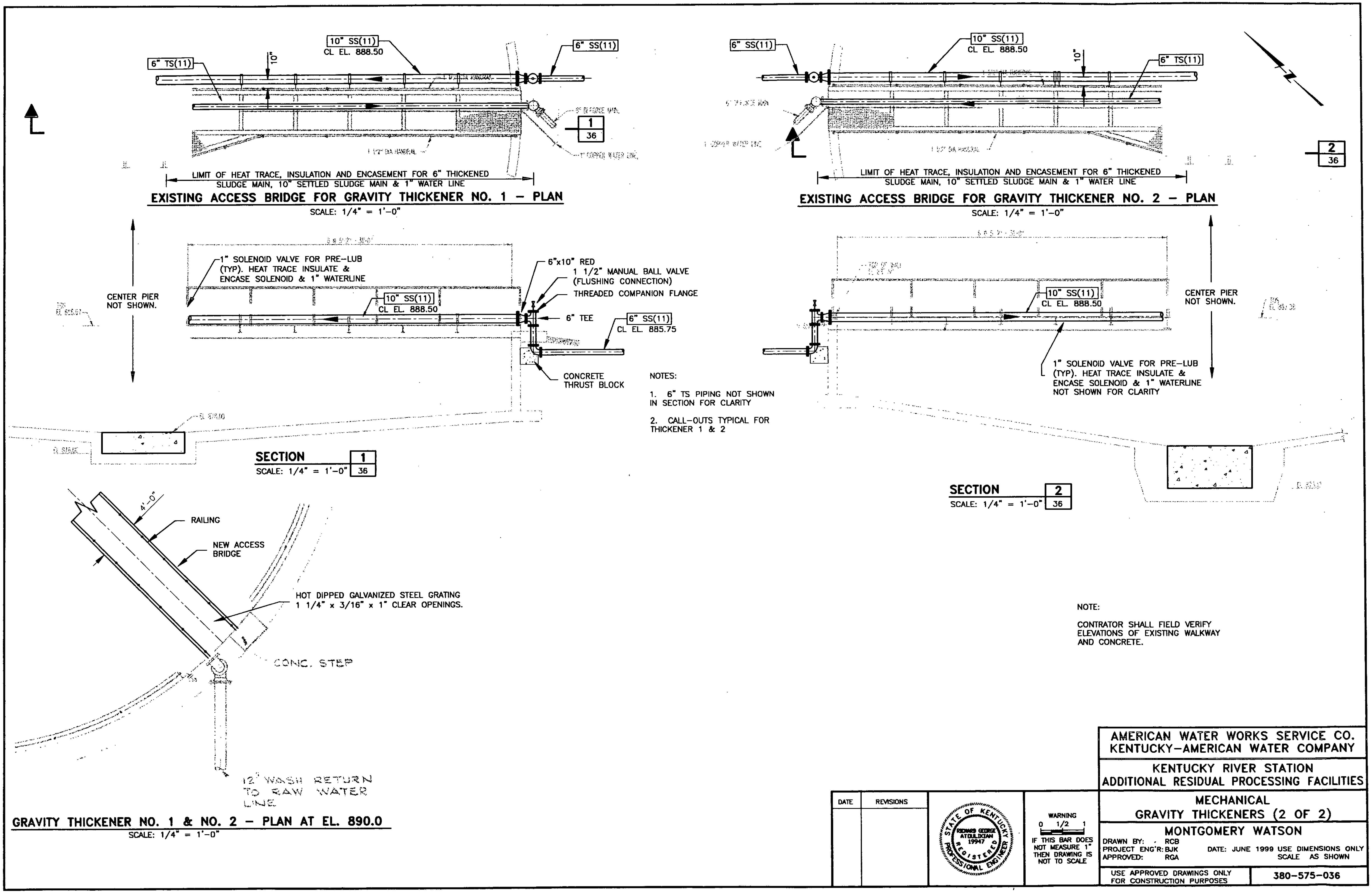
MECHANICAL
GRAVITY THICKENERS (1 OF 2)

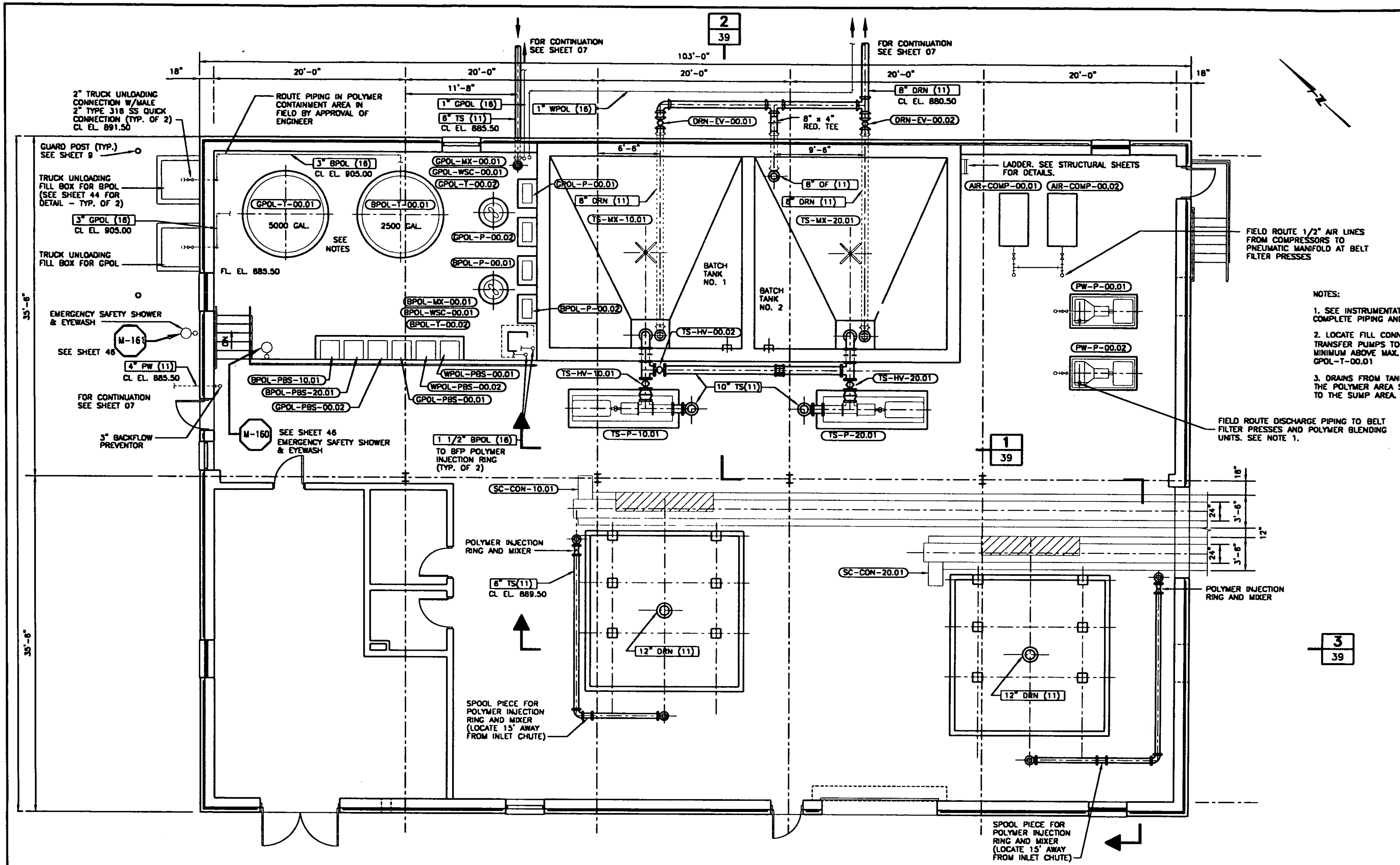
MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: BJK
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-035


10" SS(11)
CL EL. 888.50
6" TS(11)
10"
6" SS(11)
1
36
LIMIT OF HEAT TRACE, INSULATION AND ENCASEMENT FOR 6" THICKENED SLUDGE MAIN, 10" SETTLED SLUDGE MAIN & 1" WATER LINE
EXISTING ACCESS BRIDGE FOR GRAVITY THICKENER NO. 1 – PLAN
SCALE: 1/4" = 1'-0"
LIMIT OF HEAT TRACE, INSULATION AND ENCASEMENT FOR 6" THICKENED SLUDGE MAIN, 10" SETTLED SLUDGE MAIN & 1" WATER LINE
EXISTING ACCESS BRIDGE FOR GRAVITY THICKENER NO. 2 – PLAN
SCALE: 1/4" = 1'-0"
2
36
CENTER PIER NOT SHOWN.
1" SOLENOID VALVE FOR PRE-LUB (TYP). HEAT TRACE INSULATE & ENCASE SOLENOID & 1" WATERLINE
10" SS(11)
CL EL. 888.50
6"x10" RED
1 1/2" MANUAL BALL VALVE (FLUSHING CONNECTION)
THREADED COMPANION FLANGE
6" TEE
6" SS(11)
CL EL. 885.75
CONCRETE THRUST BLOCK
NOTES:
1. 6" TS PIPING NOT SHOWN IN SECTION FOR CLARITY
2. CALL-OUTS TYPICAL FOR THICKENER 1 & 2
CENTER PIER NOT SHOWN.
10" SS(11)
CL EL. 888.50
1" SOLENOID VALVE FOR PRE-LUB (TYP). HEAT TRACE INSULATE & ENCASE SOLENOID & 1" WATERLINE NOT SHOWN FOR CLARITY
SECTION
SCALE: 1/4" = 1'-0"
1
36
SECTION
SCALE: 1/4" = 1'-0"
2
36
4'-0"
RAILING
NEW ACCESS BRIDGE
HOT DIPPED GALVANIZED STEEL GRATING 1 1/4" x 3/16" x 1" CLEAR OPENINGS.
CONC. STEP
12" WASH RETURN TO RAW WATER LINE
GRAVITY THICKENER NO. 1 & NO. 2 – PLAN AT EL. 890.0
SCALE: 1/4" = 1'-0"
NOTE:
CONTRATOR SHALL FIELD VERIFY ELEVATIONS OF EXISTING WALKWAY AND CONCRETE.
DATE
REVISIONS
STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN
19947
REGISTERED PROFESSIONAL ENGINEER
WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE
AMERICAN WATER WORKS SERVICE CO.
KENTUCKY–AMERICAN WATER COMPANY
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES
MECHANICAL
GRAVITY THICKENERS (2 OF 2)
MONTGOMERY WATSON
DRAWN BY: RCB
PROJECT ENG'R: BJK
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES
380-575-036



PLAN AT EL. 888.50

SCALE: 3/16" = 1'-0"

NOTES:

1. SEE INSTRUMENTATION SHEETS FOR COMPLETE PIPING AND VALVE SCHEMATICS.
2. LOCATE FILL CONNECTIONS FROM ALL TRANSFER PUMPS TO DAY TANKS 6" MINIMUM ABOVE MAX. LEVEL IN GPOL-T-00.01
3. DRAINS FROM TANKS AND PIPING IN THE POLYMER AREA SHALL BE ROUTED TO THE SUMP AREA.

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOLIEKIAN
19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
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IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

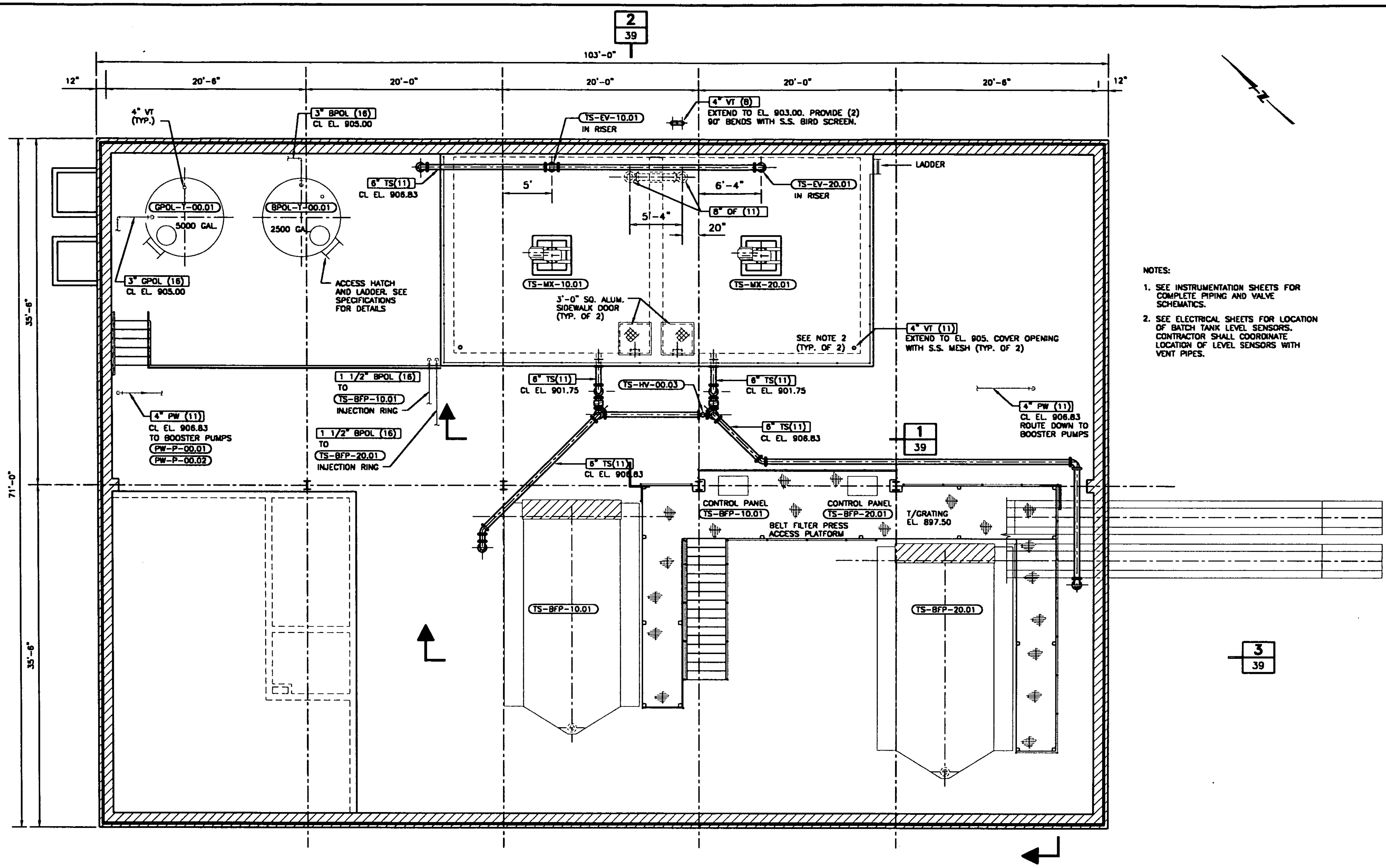
MECHANICAL
DEWATERING BUILDING PLAN AT EL. 888.50

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-037



NOTES:

1. SEE INSTRUMENTATION SHEETS FOR COMPLETE PIPING AND VALVE SCHEMATICS.
2. SEE ELECTRICAL SHEETS FOR LOCATION OF BATCH TANK LEVEL SENSORS. CONTRACTOR SHALL COORDINATE LOCATION OF LEVEL SENSORS WITH VENT PIPES.

PLAN AT EL. 907.83

SCALE: 3/16" = 1'-0"

DATE	REVISIONS

STATE OF KENTUCKY RICHARD GEORGE ATTOLLAH 19947 REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

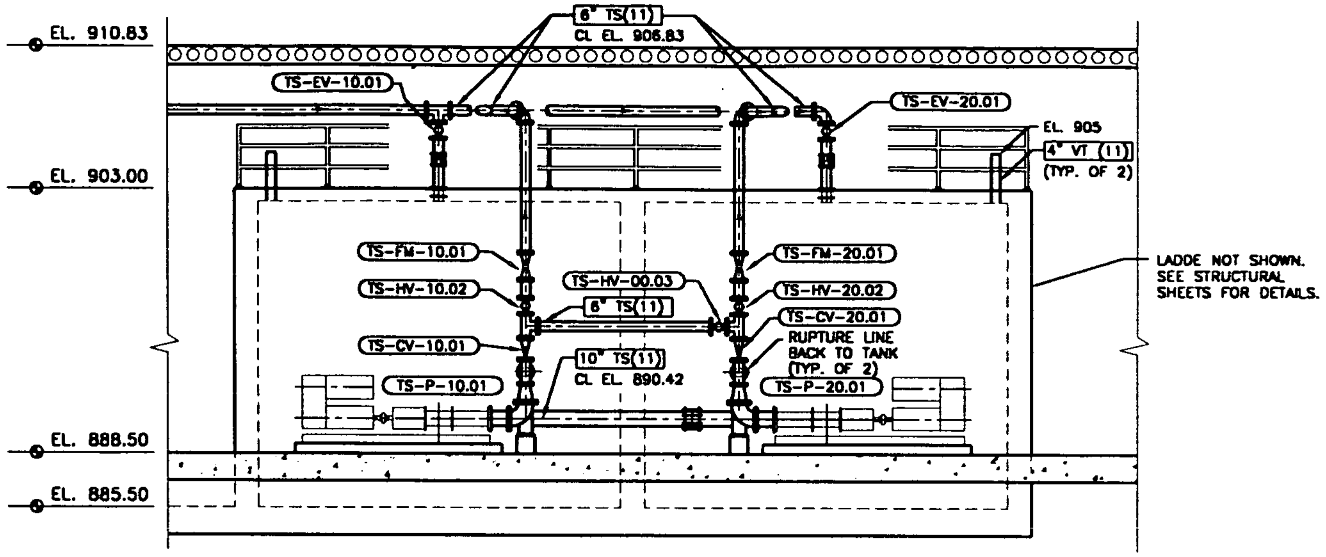
MECHANICAL
DEWATERING BUILDING PLANT AT EL. 907.83

MONTGOMERY WATSON

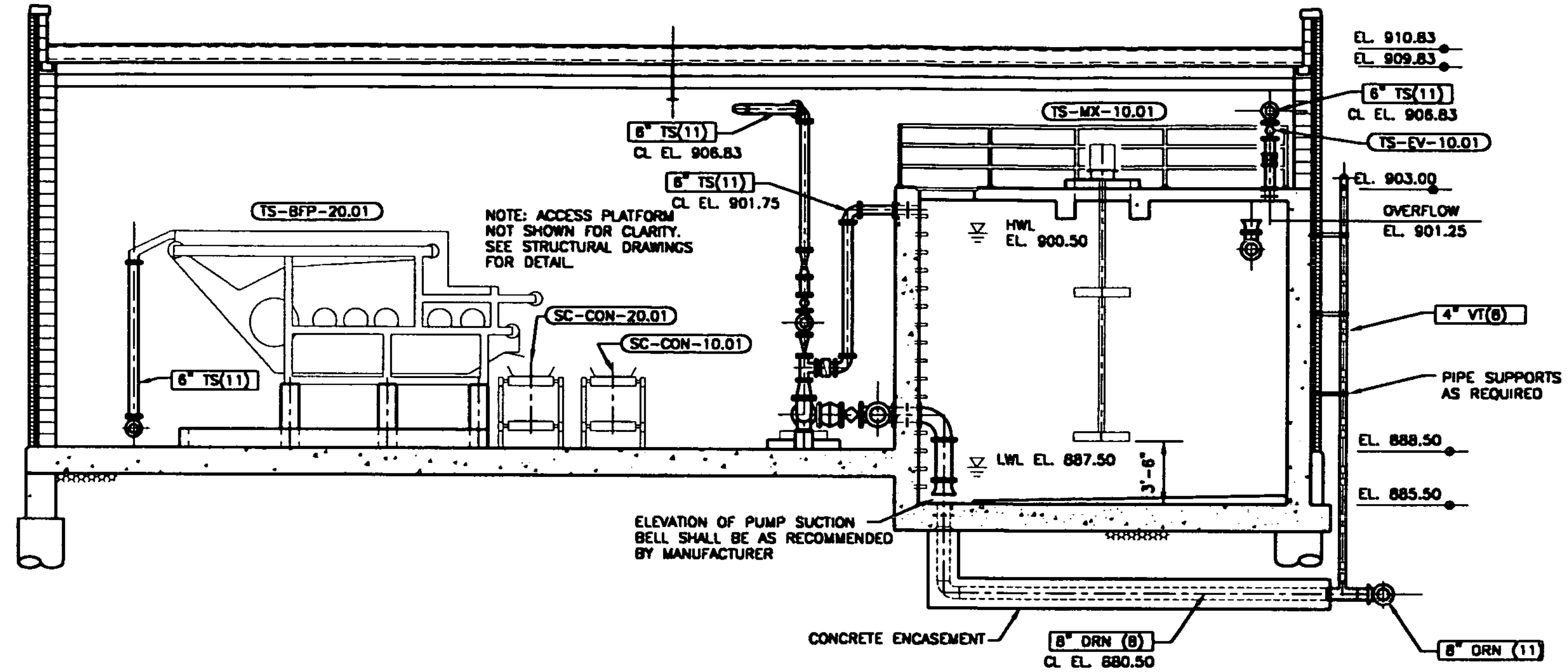
DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

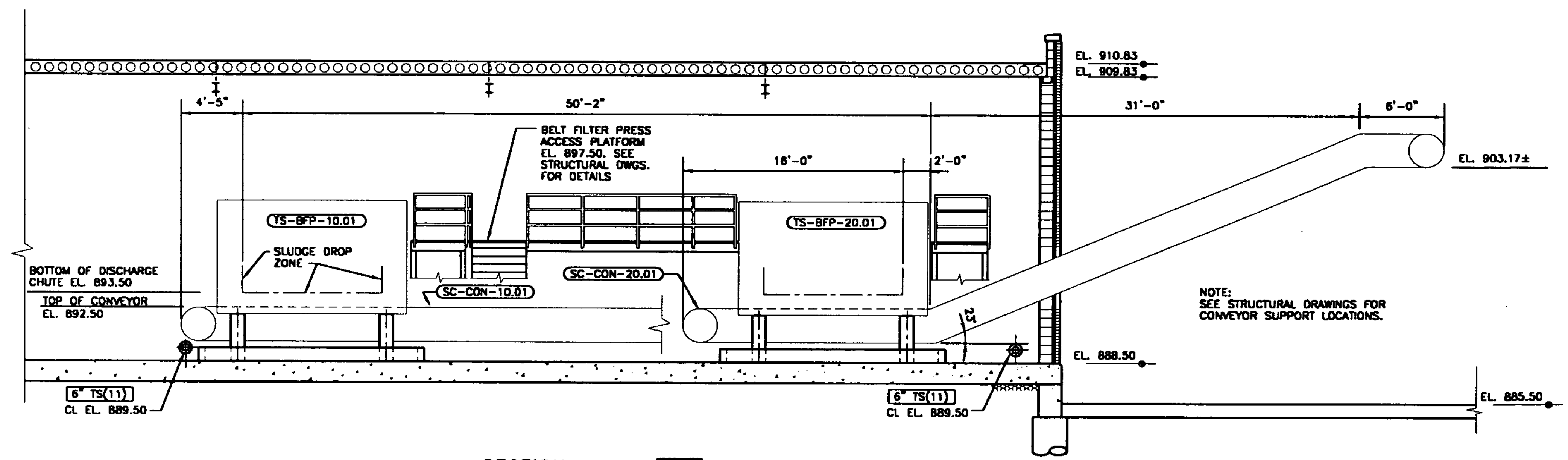
380-575-038



SECTION 1/37
SCALE: 3/16" = 1'-0"



SECTION 2/37
SCALE: 3/16" = 1'-0"



SECTION 3/37
SCALE: 3/16" = 1'-0"

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOUL
19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

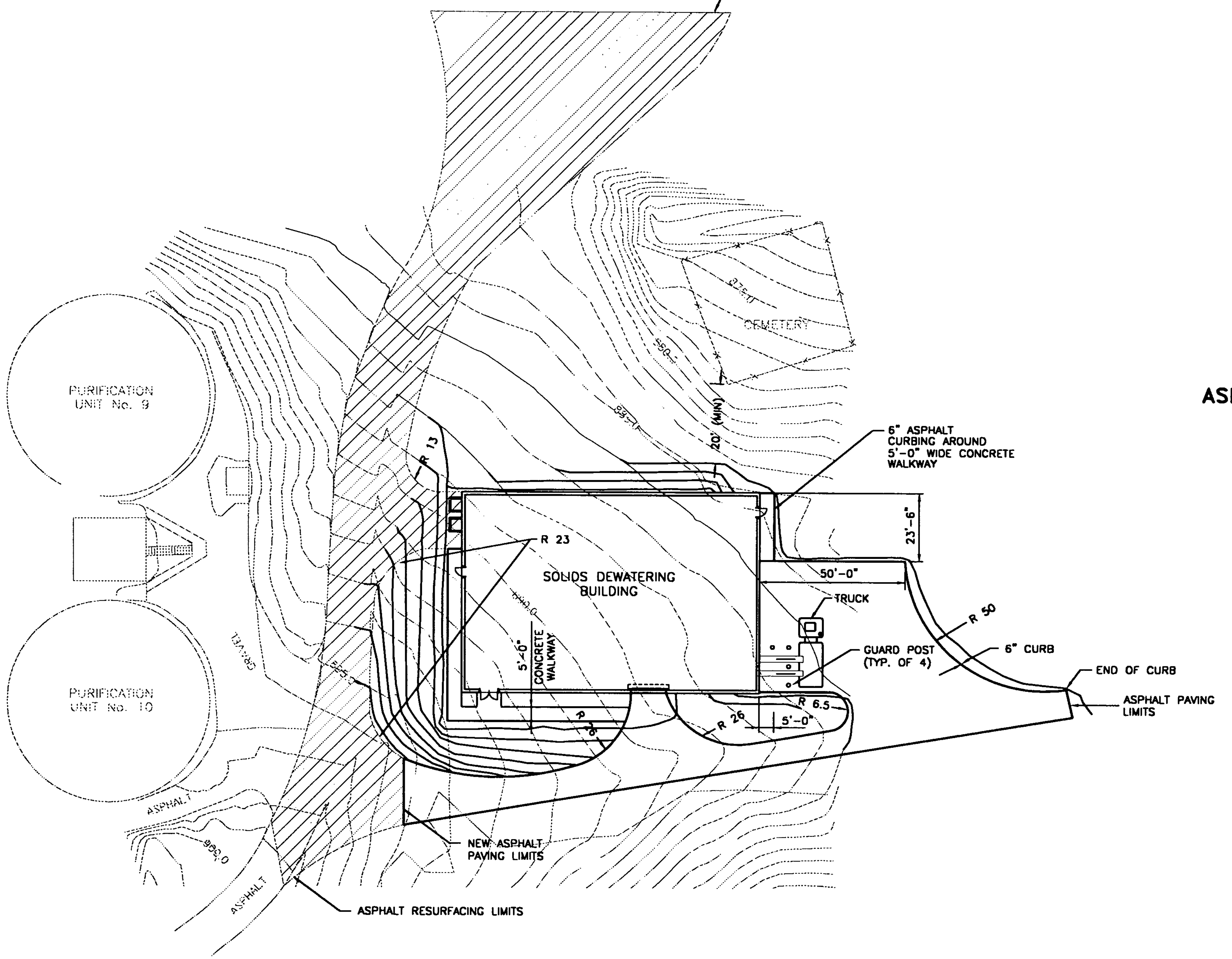
MECHANICAL
DEWATERING BUILDING SECTIONS

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

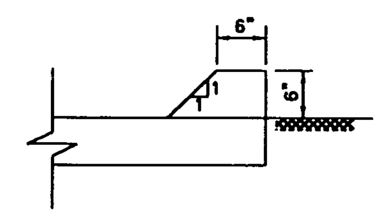
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-039



DEWATERING BUILDING DETAILS
ROAD PAVING/RESURFACING AREAS

SCALE 1" - 20'



ASPHALT CURBING DETAIL

NO SCALE

NOTES:

1. SEE SECTION 02900 FOR SEEDING OF GRASSED AREA SHOWN ON THIS SHEET.

2. EXISTING GRADE SHOWN AS SHADED LINE AND NEW GRADE SHOWN AS DARK CONTOUR LINES.

3. EXCAVATION LIMITS TO BE AT LEAST 20' FROM EDGE OF CEMETERY.

DATE	REVISIONS

STATE OF KENTUCKY
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

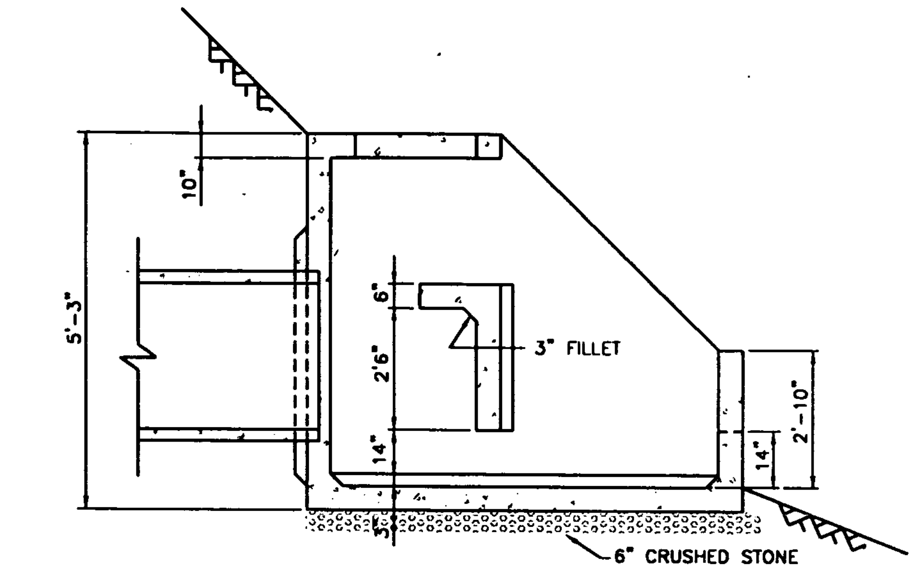
MECHANICAL
DEWATERING BUILDING DETAILS

MONTGOMERY WATSON

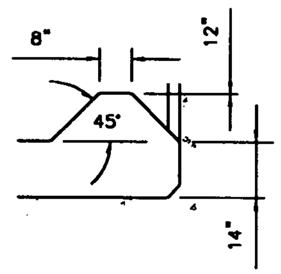
DRAWN BY: MP
PROJECT ENG'R: GS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

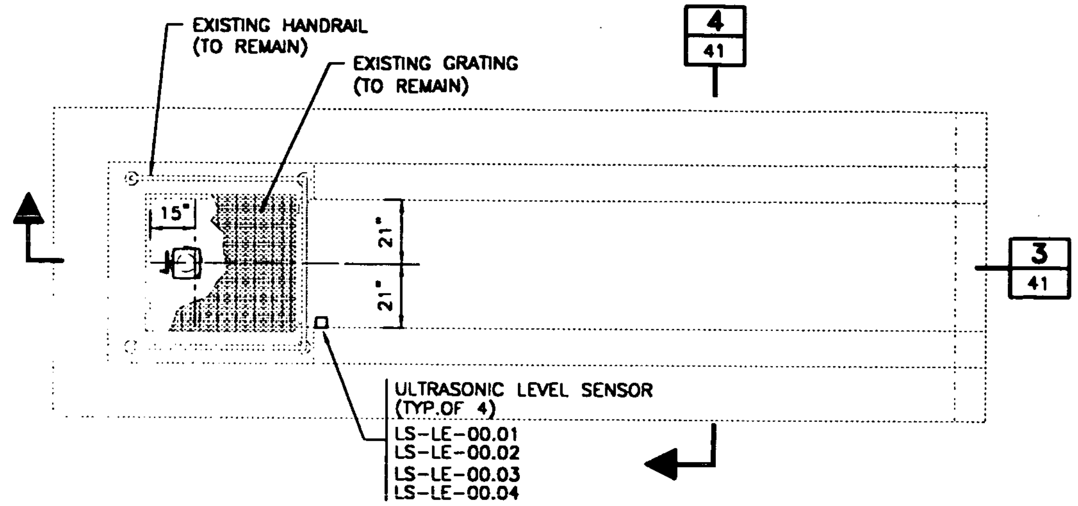
380-575-040



SECTION 1/41
SCALE: 1/2" = 1'-0"



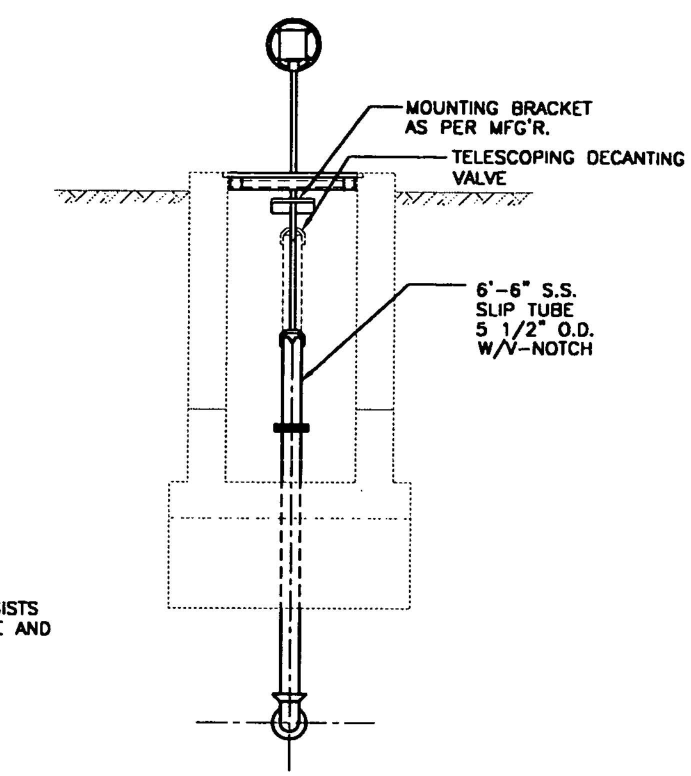
SECTION 2/41
SCALE: 1/4" = 1'-0"



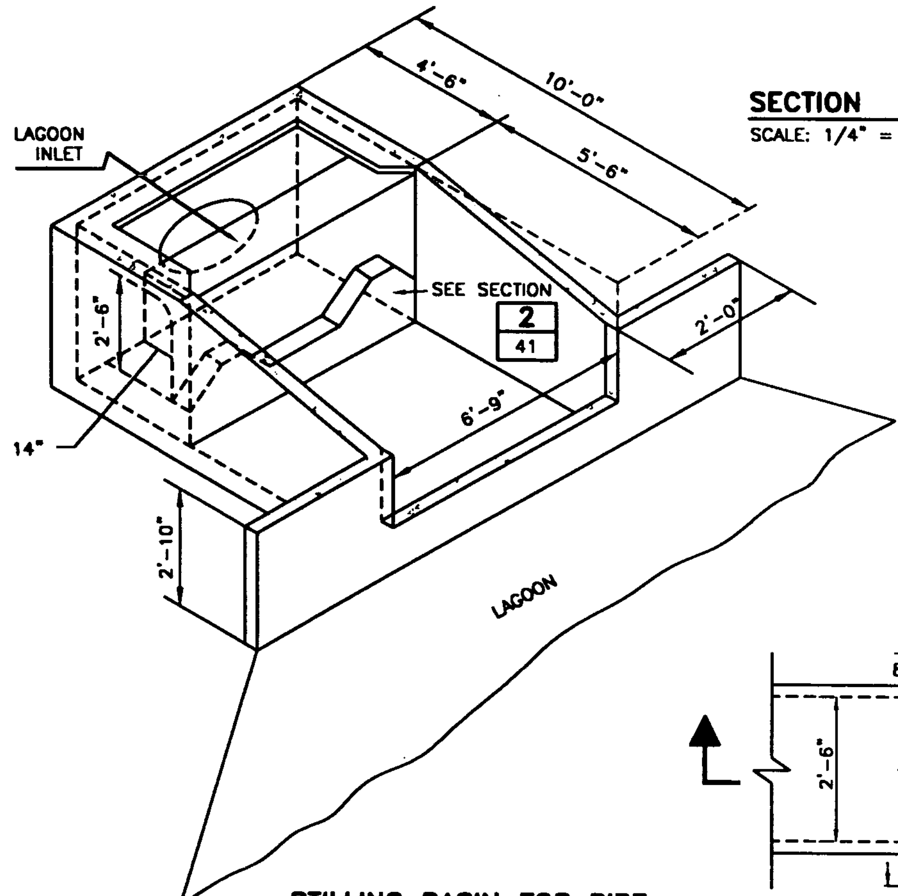
PLAN
SCALE: 3/8" = 1'-0"

NOTE:

LAGOON DECANT WORK CONSISTS ONLY OF TELESCOPING VALVE AND CONCRETE REPAIR



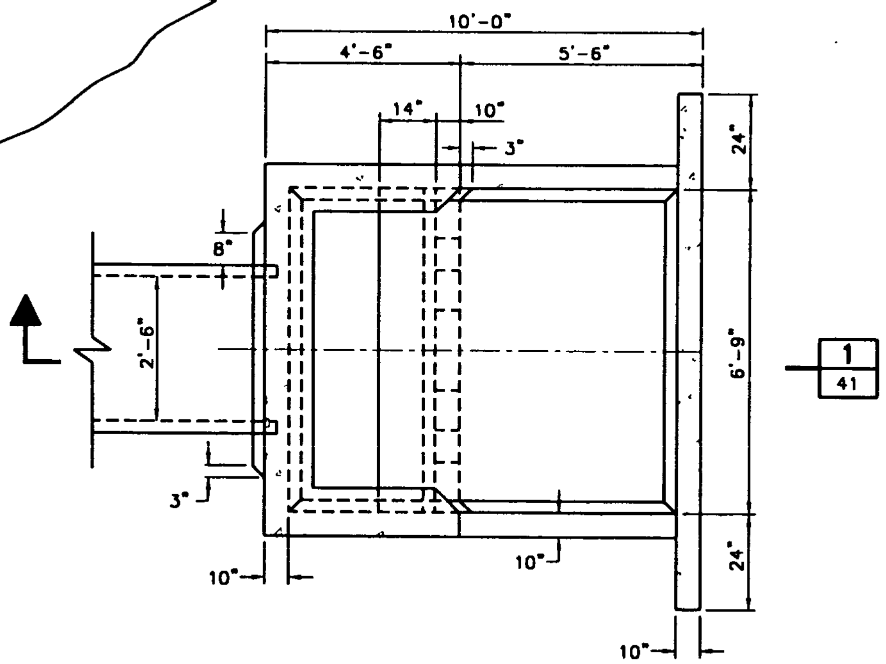
SECTION 4/41
SCALE: 3/8" = 1'-0"



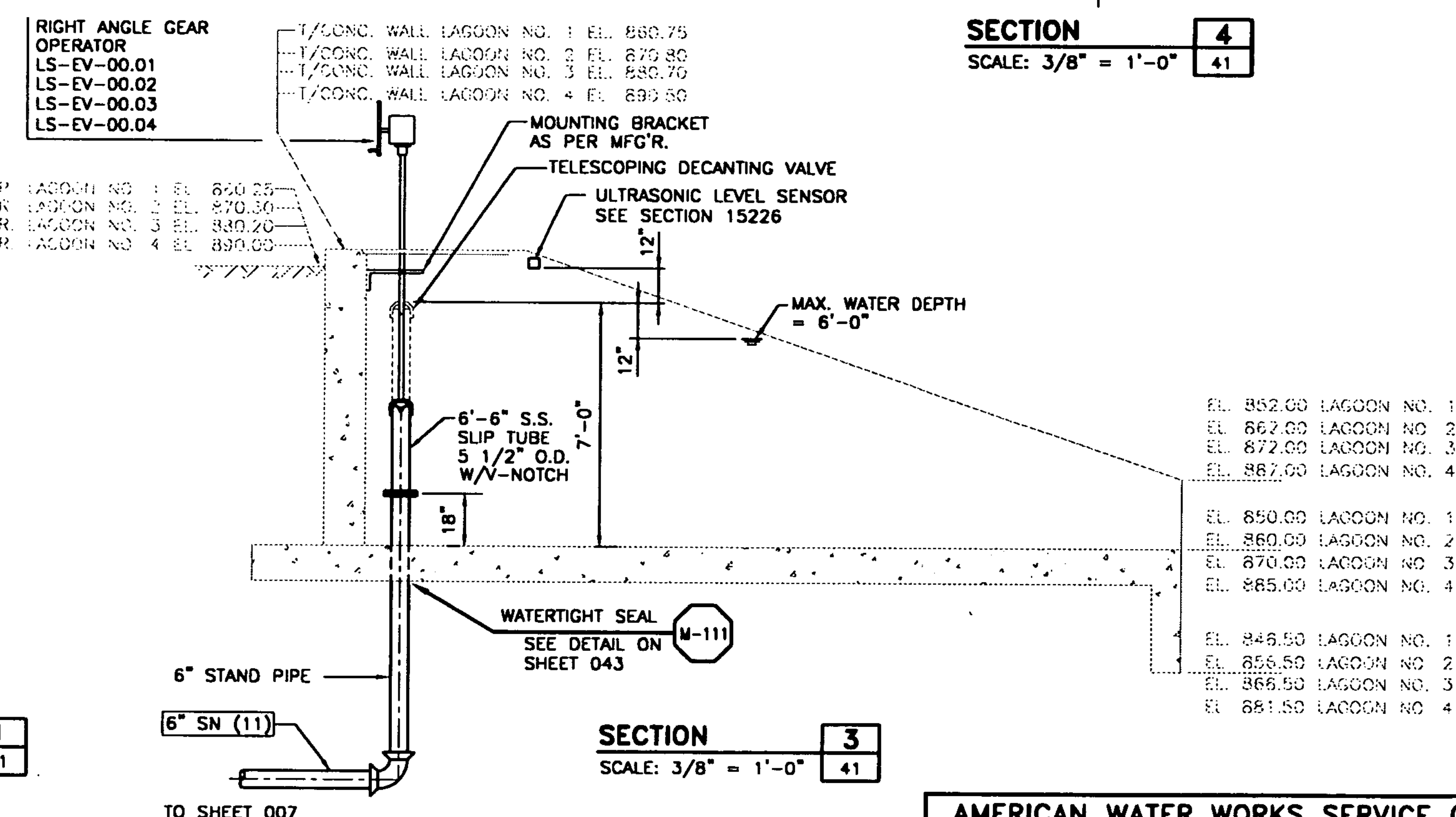
STILLING BASIN FOR PIPE INLET TO LAGOON No. 3
SCALE: NONE

NOTE:

MIN WALL THICKNESS = 10"
MIN BASE THICKNESS = 10"
MIN TOP SLAB THICKNESS = 10"
MIN REBAR #5@12" EWEF. (TYP.)



STILLING BASIN PLAN FOR LAGOON No. 3
SCALE: 1/2" = 1'-0"



SECTION 3/41
SCALE: 3/8" = 1'-0"

LAGOON DECANT STRUCTURE
(TYP. FOR 4 LAGOONS OF 4)

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN 19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
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IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

MECHANICAL
LAGOON IMPROVEMENTS

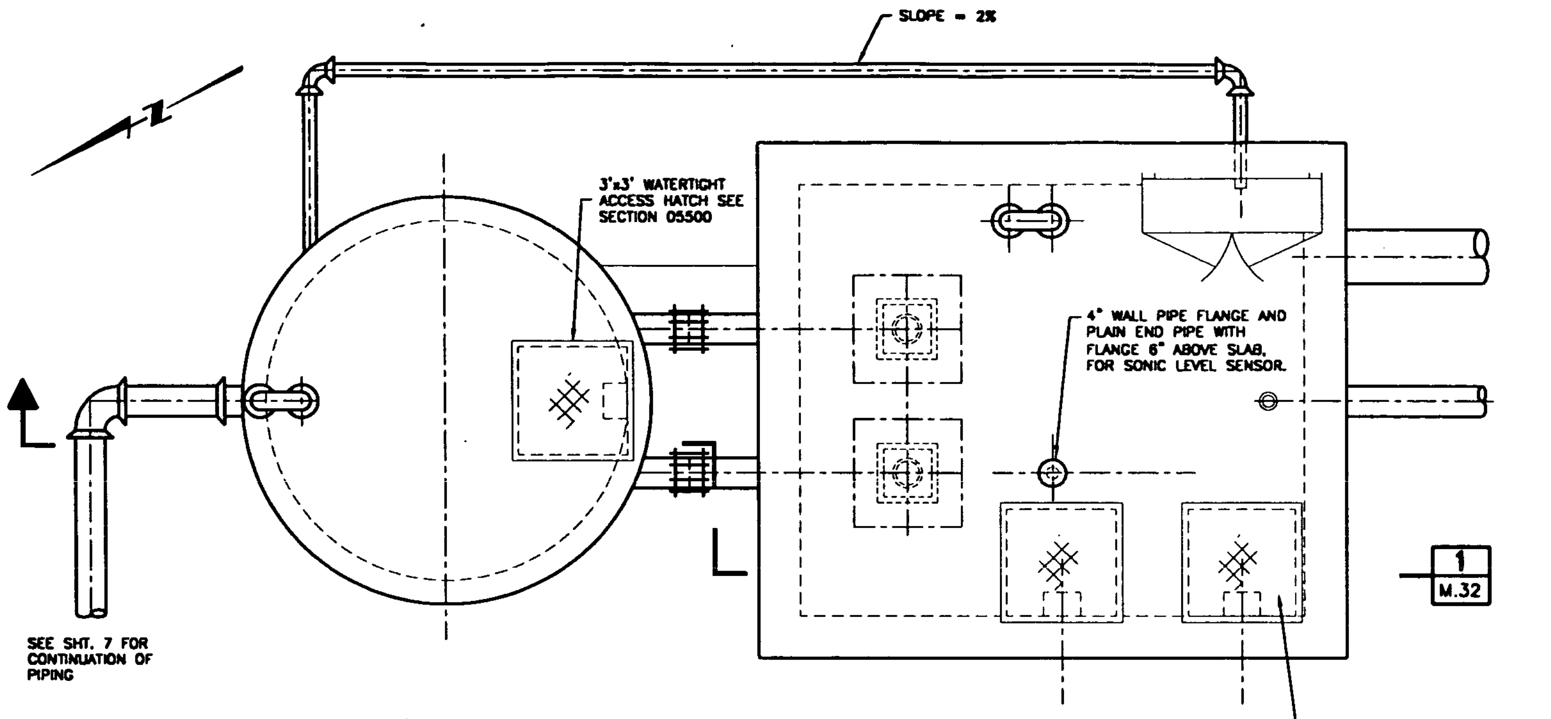
MONTGOMERY WATSON

DRAWN BY: MP
PROJECT ENG'R: GS
APPROVED: RGA

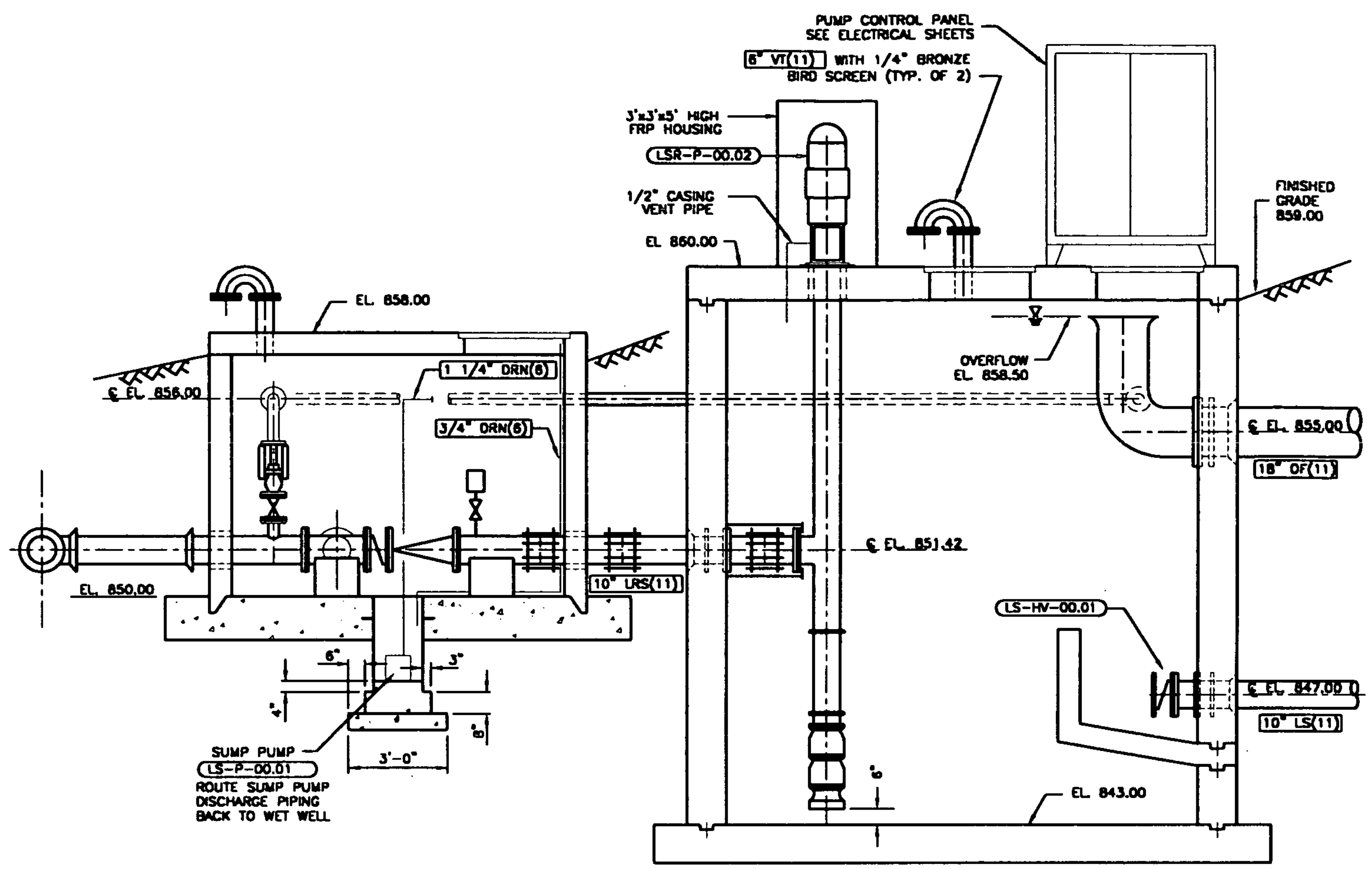
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

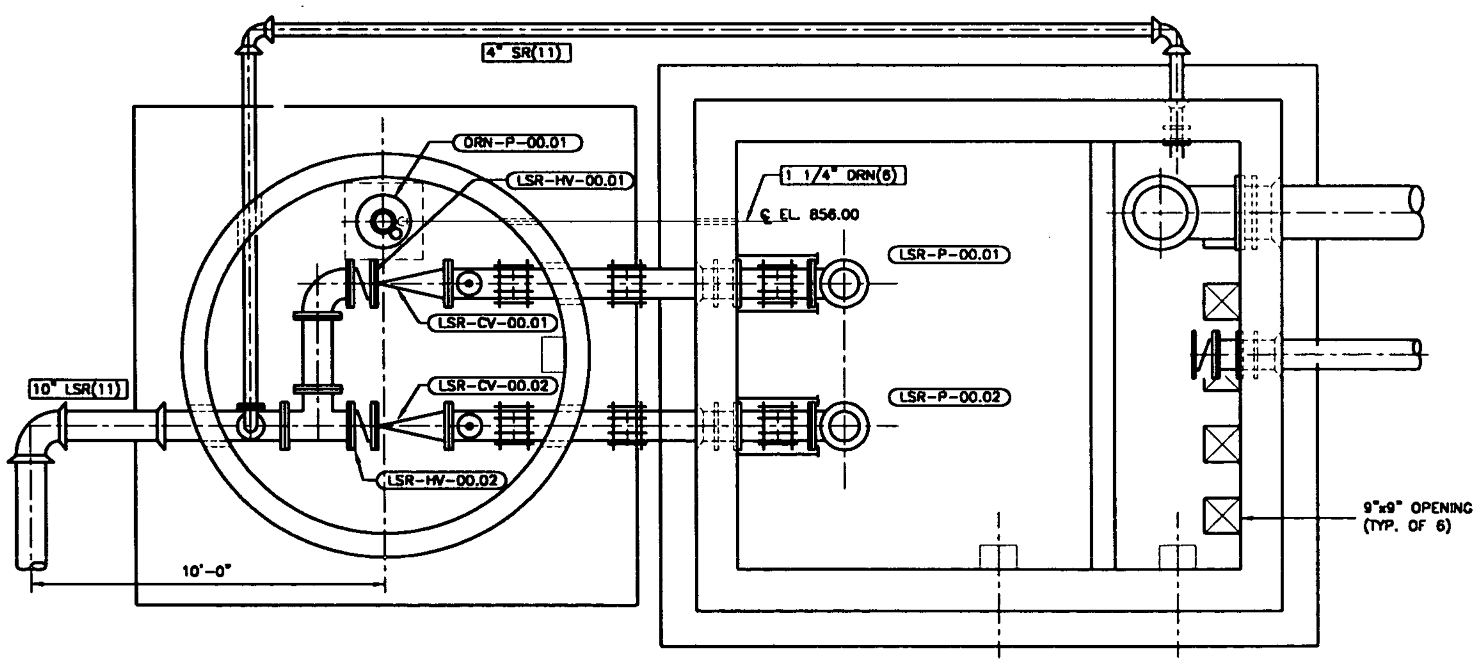
380-575-041



TOP PLAN
SCALE: 3/8" = 1'-0"



SECTION 1 / M.42
SCALE: 3/8" = 1'-0"



SECTIONAL PLAN
SCALE: 3/8" = 1'-0"

NOTE:

1. SEE SHEET 59 FOR COMPLETE PIPING AND VALVE SCHEMATIC.
2. SEE SHEET 19 FOR DIMENSIONS.

DATE	REVISIONS

STATE OF KENTUCKY RICHARD GEORGE ATOULIKIAN 19947 REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

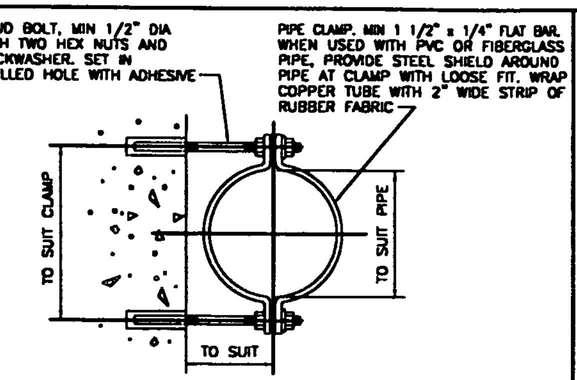
MECHANICAL
LAGOON SUPERNATANT VAULT No. 2

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: KMM
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

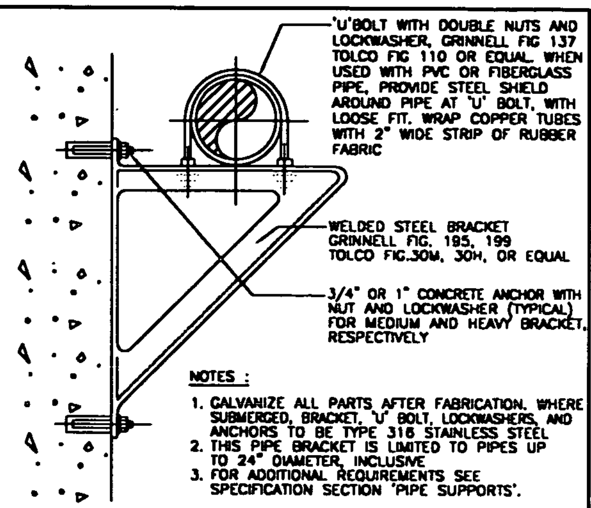
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-042



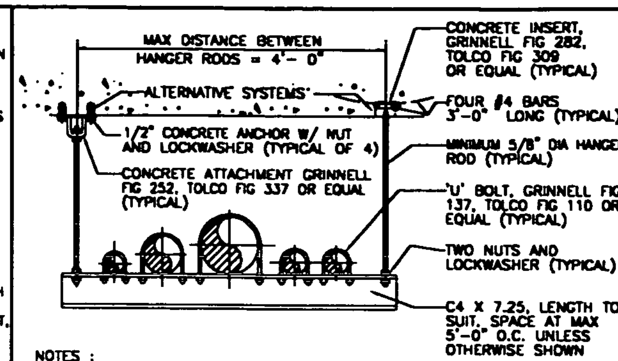
NOTES :
1. GALVANIZE ALL PARTS AFTER FABRICATION. WHERE SUBMERGED, PIPE CLAMP, NUTS, LOCKWASHERS, ANCHORS AND SHIELDS TO BE TYPE 316 STAINLESS STEEL
2. THIS PIPE CLAMP IS LIMITED TO PIPES UP TO 6" DIAMETER INCLUSIVE
3. FOR ADDITIONAL REQUIREMENTS SEE SPECIFICATIONS SECTION 'PIPE SUPPORTS'

PIPE CLAMP
REV 010199 M-101



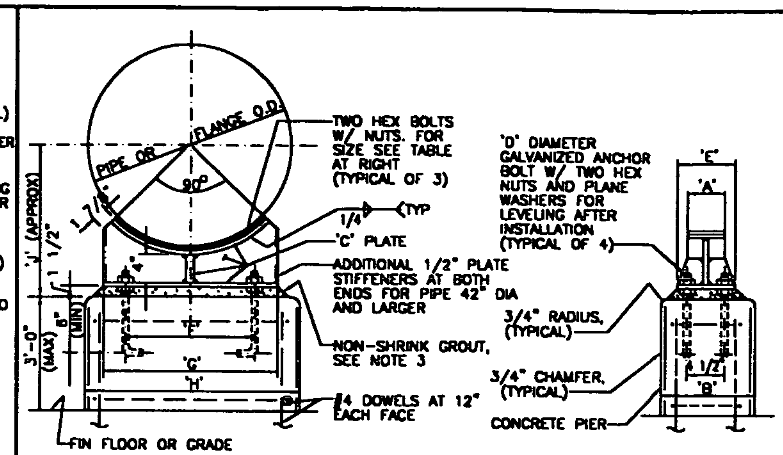
NOTES :
1. GALVANIZE ALL PARTS AFTER FABRICATION. WHERE SUBMERGED, BRACKET, 'U' BOLT, LOCKWASHERS, AND ANCHORS TO BE TYPE 316 STAINLESS STEEL
2. THIS PIPE BRACKET IS LIMITED TO PIPES UP TO 24" DIAMETER, INCLUSIVE
3. FOR ADDITIONAL REQUIREMENTS SEE SPECIFICATION SECTION 'PIPE SUPPORTS'.

PIPE BRACKET
REV 010199 M-104



NOTES :
1. GALVANIZE ALL PARTS AFTER FABRICATION
2. FOR ADDITIONAL REQUIREMENTS SEE SPECIFICATION SECTION 'PIPE SUPPORTS'
3. THIS PIPE HANGER IS LIMITED TO PIPE SIZES 8" THRU 24" DIAMETER
4. THIS PIPE HANGER NOT SUITABLE FOR PRECAST TEE BEAMS
5. FOR PVC OR FIBERGLASS PIPES PROVIDE STEEL SHIELD AROUND PIPE AT 'U' BOLT, WITH LOOSE FIT. WRAP COPPER TUBES WITH 2" WIDE STRIP OF RUBBER FABRIC

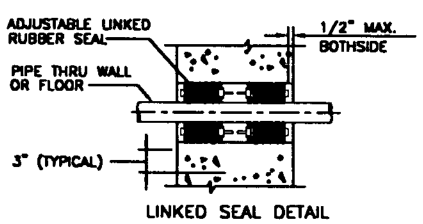
TRAPEZE PIPE HANGER
REV 010199 M-106



DIMENSIONS IN INCHES													
NOMINAL PIPE SIZE						SUPPORTING PIPE				SUPPORTING FLANGE			
	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'J'	'F'	'G'	'H'	'J'
6	4	12	3/8	5/8	6	4 1/2	6	12	10	6 1/2	9	16	13
8	4	12	3/8	5/8	6	5	8	13	11	7 1/2	9	16	14
10	4	12	3/8	5/8	6	6	9	15	12	9	13	18	15
12	4	12	3/8	5/8	6	7	11	17	13	10	15	20	16
14	4	12	3/8	5/8	6	8	12	17	14	11	16	21	17
16	4	12	3/8	5/8	6	9	13	19	15	12	18	24	18
18	4	12	3/8	5/8	6	10	14	20	16	13	19	24	19
20	5	12	3/8	5/8	6	10	15	21	17	15	21	26	21
22	5	12	3/8	5/8	6	12	18	24	18	16	23	28	22
24	5	12	3/8	5/8	6	13	19	24	19	16	24	30	23
26	5	12	3/8	3/4	6	14	21	27	20	18	26	32	24
30	5	12	3/8	3/4	6	16	23	28	22	20	29	34	26
34	5	15	3/8	3/4	6	18	26	32	24	22	33	39	29
36	6	15	3/8	3/4	6	19	27	32	25	24	34	40	30
42	6	18	1/2	1	8	21	31	36	28	27	39	45	33
48	6	18	1/2	1	8	24	36	42	31	30	44	50	37
54	6	18	1/2	1	8	28	40	46	34	34	48	56	40
60	6	18	1/2	1 1/8	8	32	45	52	37	38	54	60	44
66	6	18	1/2	1 1/8	8	33	49	56	40	40	59	66	47
72	6	18	1/2	1 1/8	8	36	53	60	43	44	63	70	50

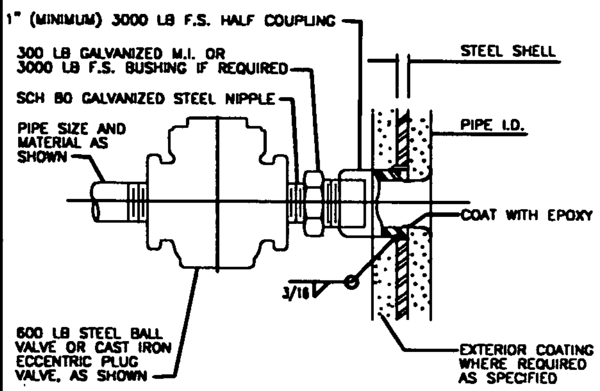
NOTES :
1. WHEN SUPPORTING PIPE AND FLANGE ALTERNATELY ON THE SAME LINE, CONCRETE PIERS FOR PIPE SUPPORTS SHALL ALL HAVE THE SAME DIMENSION 'H' FOR FLANGE SUPPORT
2. PIPE SUPPORTS SHALL BE LOCATED IN PLAN AT POINTS MARKED THUS: (X)
3. WHERE DIFFERENTIAL SETTLEMENT IS LIKELY TO OCCUR, OMIT GROUT AS DIRECTED BY THE ENGINEER
4. GALVANIZE ALL PARTS AFTER FABRICATION
5. WHERE DIRECTED BY THE STRUCTURAL ENGINEER, BOTTOM OF PIERS SHALL EXTEND BELOW BOTTOM OF SLAB
6. WHERE PIPE SUPPORT OCCURS ON GRADE REFER TO STRUCTURAL DRAWINGS FOR DETAILS

PIPE SUPPORT
REV 010199 M-109

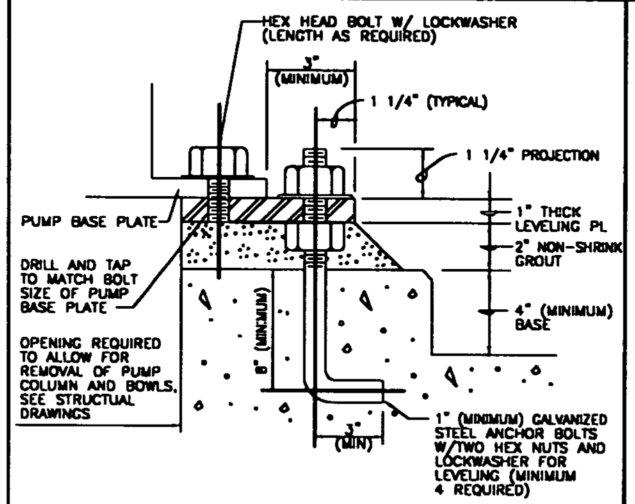


LINKED SEAL DETAIL

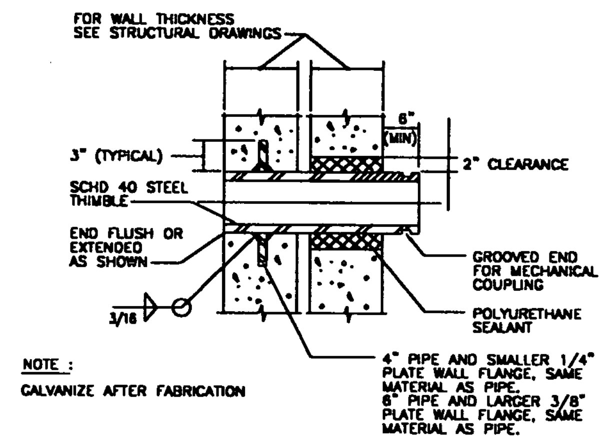
SLEEVED PIPE OPENING
REV 010199 M-111



PIPE CONNECTION 2 1/2" AND SMALLER
REV 010199 M-120

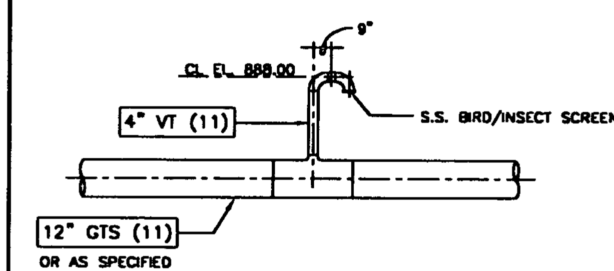


VERTICAL PUMP MOUNTING BASE
REV 010199 M-135



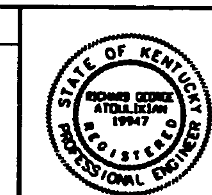
NOTE :
GALVANIZE AFTER FABRICATION

PIPE THROUGH TWO WALLS
REV 010199 M-123



TYP. AIR RELEASE PIPE DETAIL

DATE	REVISIONS



WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

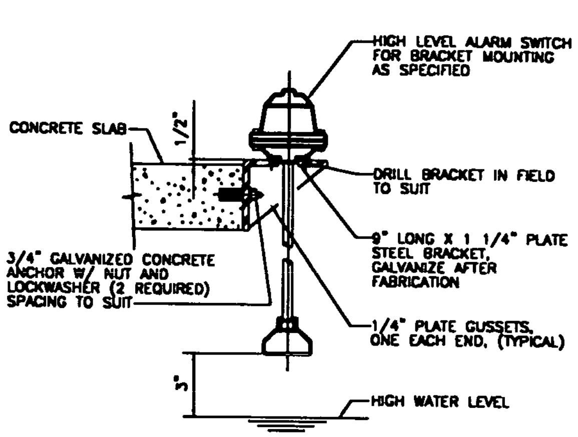
MECHANICAL
MISCELLANEOUS DETAILS

MONTGOMERY WATSON

DRAWN BY: MP
PROJECT ENG'R: GS
APPROVED: RGA
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE NONE

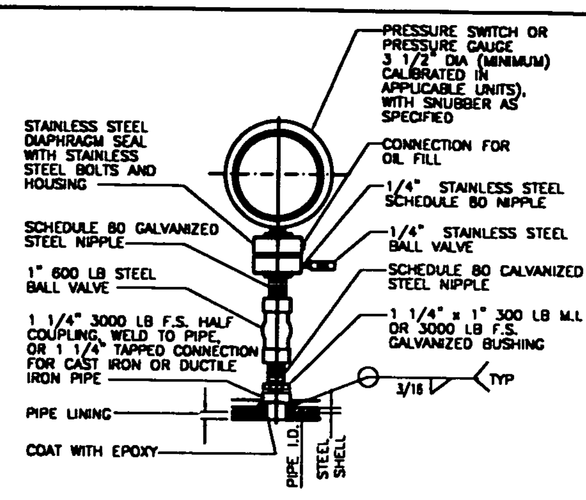
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-043



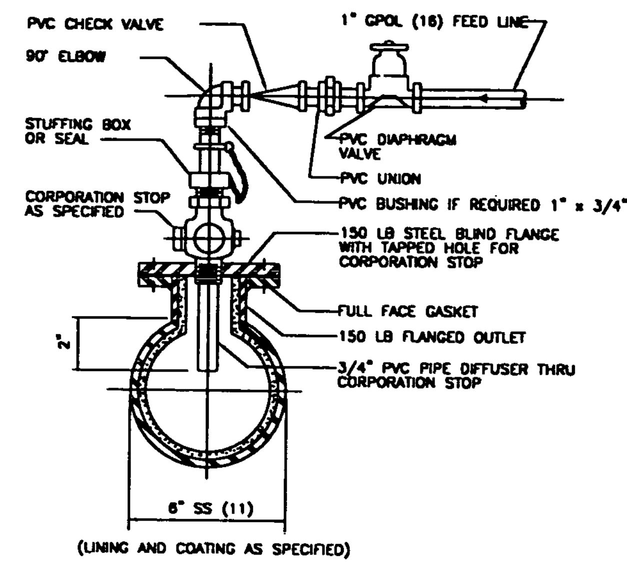
HIGH LEVEL ALARM SWITCH, BRACKET MOUNTED

REV 010199 M-604



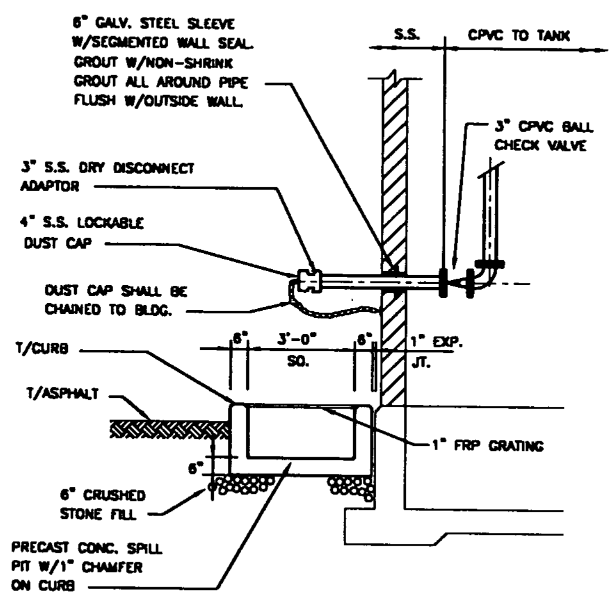
PRESSURE GAUGE OR PRESSURE SWITCH WITH DIAPHRAGM SEAL

REV 010199 M-608



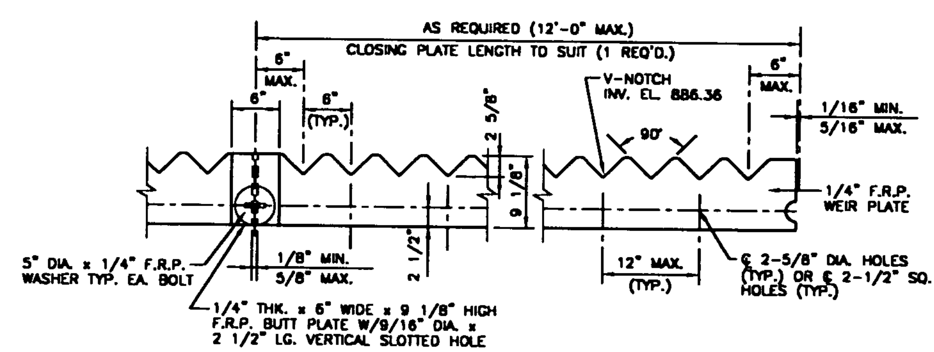
CHEMICAL DIFFUSER

REV 010199 M-707



TANK FILL STATION DETAIL

SCALE: 3/8" = 1'-0"



V-NOTCH WEIR PLATE DETAIL

NO SCALE

DATE	REVISIONS

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

MECHANICAL
MISCELLANEOUS DETAILS

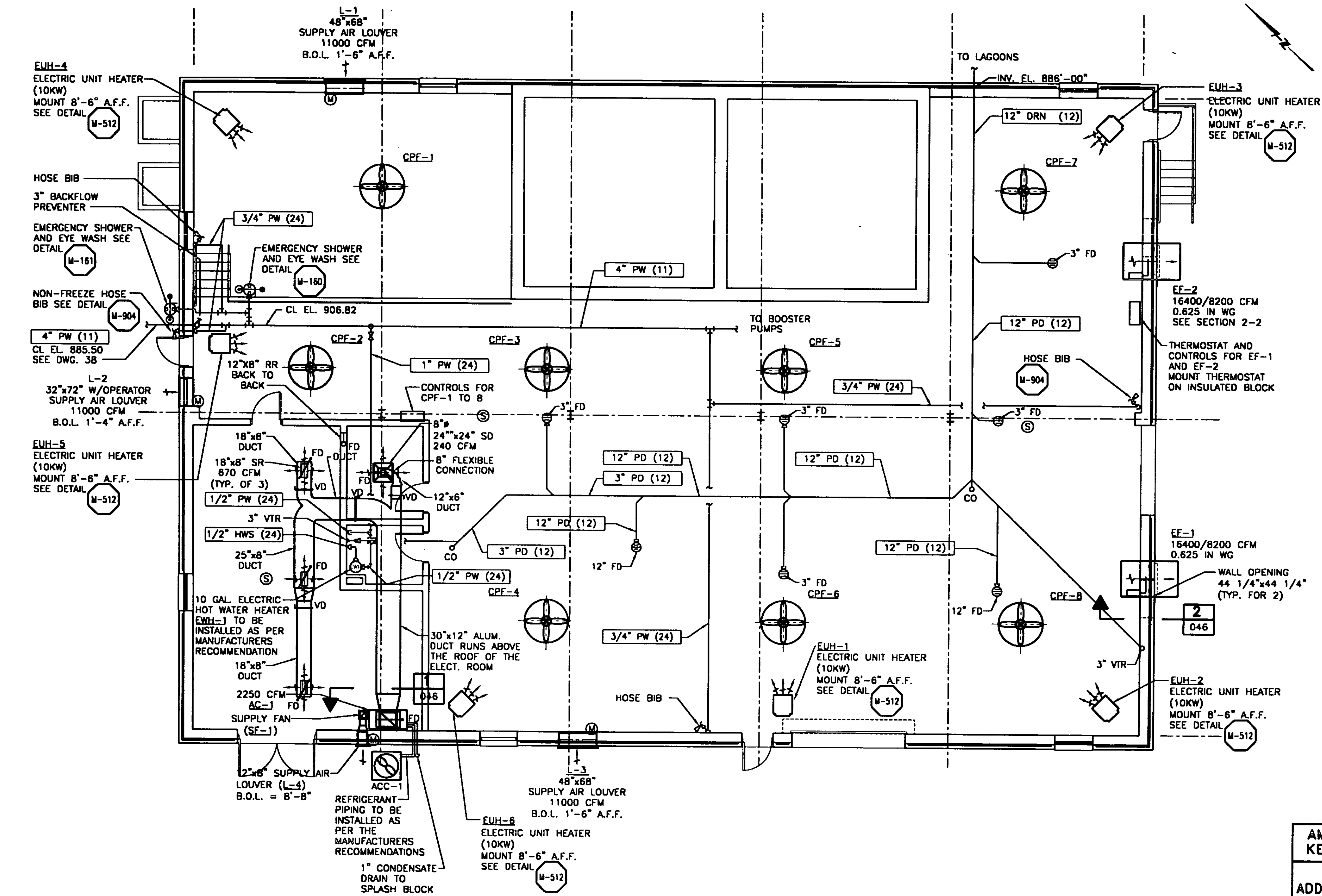
MONTGOMERY WATSON

DRAWN BY: SB
PROJECT ENG'R: GS
APPROVED: RGA

DATE: JUNE 1999 USE DIMENSIONS ONLY SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-044



ABBREVIATIONS

B.O.L. = BOTTOM OF LOUVER
A.F.F. = ABOVE FINISH FLOOR
E.F. = EXHAUST FAN
S.F. = SUPPLY FAN
T = THERMOSTAT
EUH = ELECTRIC UNIT HEATER
EWH = ELECTRIC HOT WATER HEATER
AC = SPLIT A/C UNIT EVAPORATOR/BLOWER
ACC = SPLIT A/C UNIT CONDENSING UNIT
E.S.P. = EXTERNAL STATIC PRESSURE
E.D.B. = ENTERING DRY BULB TEMPERATURE
E.W.B. = ENTERING WET BULB TEMPERATURE
L.D.B. = LEAVING DRY BULB TEMPERATURE
L.W.B. = LEAVING WET BULB TEMPERATURE
P.W. = POTABLE WATER
HWS = HOT WATER SUPPLY
CFM = CUBIC FEET PER MINUTE
SR = SUPPLY REGISTER
RR = RETURN REGISTER
S.D. = SUPPLY DIFFUSER
DRN = DRAIN
M.H. = MAN HOLE
S = SMOKE DETECTOR
FD/AD = FIRE DAMPER/ACCESS DOOR
CPF = CEILING PADDLE FAN
CD = CONDENSATE DRAIN

NOTES:

1. DUCTWORK FIFTEEN FEET DOWNSTREAM OF AC-1 SHALL BE ACCOUSTICALLY LINED.

2. CONTRACTOR TO COORDINATE THE INSTALLATION OF THE CEILING PADDLE FANS TO AVOID ANY OBSTACLES.

DATE	REVISIONS

STATE OF KENTUCKY REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

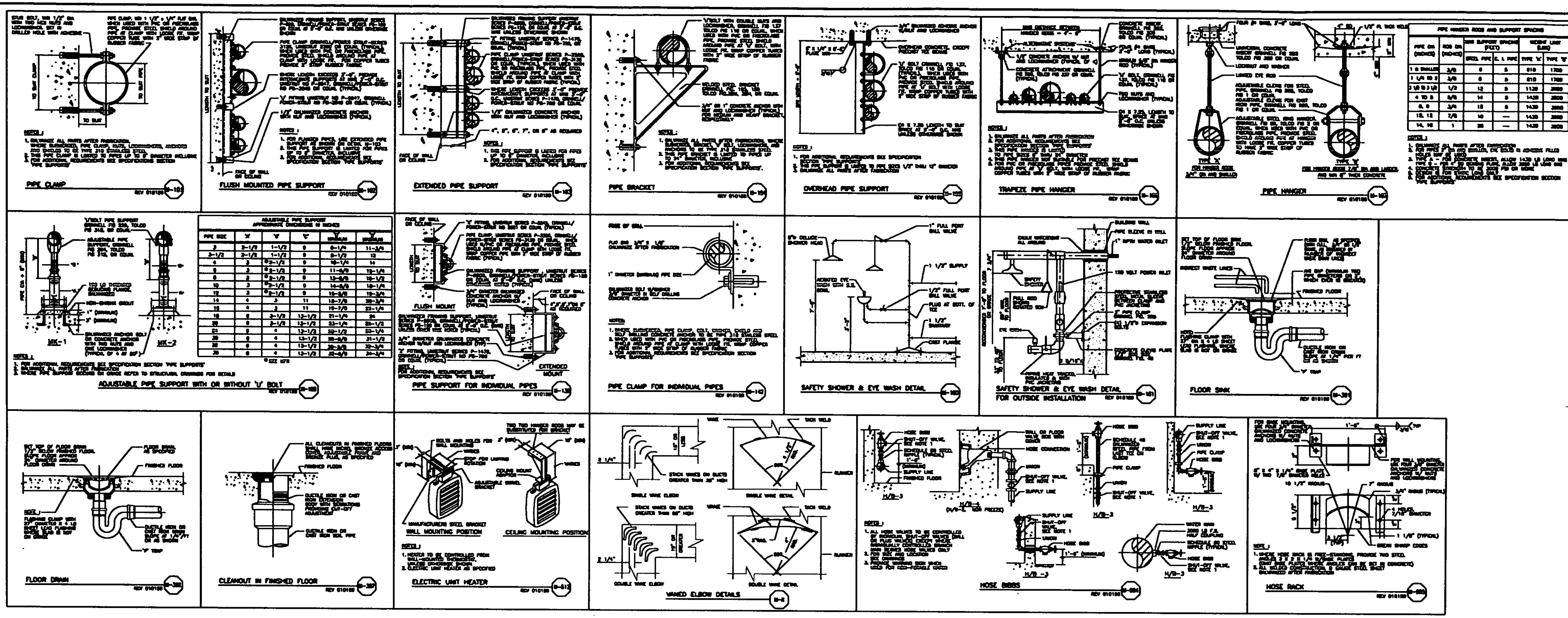
HVAC/P
DEWATERING BUILDING PLAN AND ABBREVIATIONS

MONTGOMERY WATSON

DRAWN BY: RCB
PROJECT ENG'R: SS
APPROVED: RGA
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-045



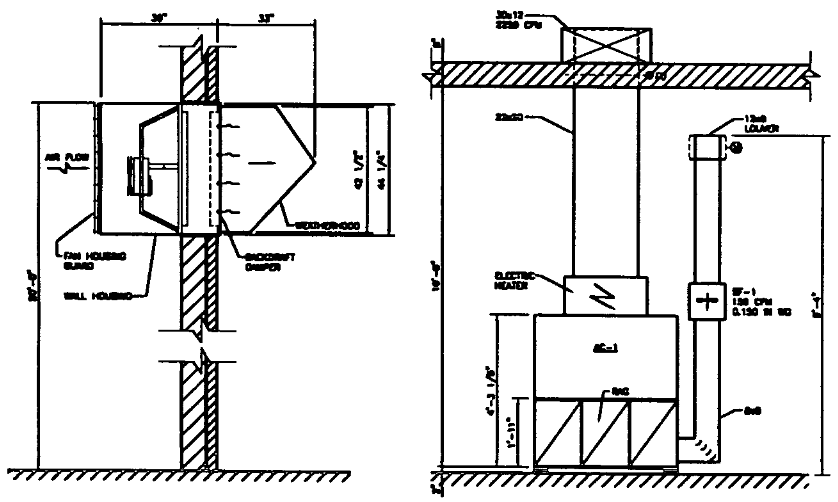
LOUVER SCHEDULE				
LOUVER NO.	DESCRIPTION	SIZE (WxH)	MATERIAL FINISH	COMMENTS
L-1	ADJUSTABLE BLADE	48"x48"	ALUM.	WITH MOTOR OPERATOR
L-2	ADJUSTABLE BLADE	36"x60"	ALUM.	WITH MOTOR OPERATOR
L-3	ADJUSTABLE BLADE	12"x8"	ALUM.	WITH MOTOR OPERATOR
L-4	ADJUSTABLE BLADE	48"x48"	ALUM.	WITH MOTOR OPERATOR

ELECTRICAL WATER HEATER			
UNIT NO.	CAPACITY	RECOVERY RATE	VOLTAGE, PHASE
EWH-1	10 GAL.	20 GPH @100°F RISE	460, 3

ELECTRIC UNIT HEATERS MOUNTING HEIGHT ABOVE THE FINISHED FLOOR				
UNIT NO.	CAPACITY	VOLTAGE, PHASE	HEIGHT ABOVE FINISHED FLOOR	HEIGHT ABOVE UNIT (MIN.)
EUH-1	10KW	460, 3	8'-6"	18"
EUH-2	10KW	460, 3	8'-6"	18"
EUH-3	10KW	460, 3	8'-6"	18"
EUH-4	10KW	460, 3	8'-6"	18"
EUH-5	10KW	460, 3	8'-6"	18"
EUH-6	10KW	460, 3	8'-6"	18"

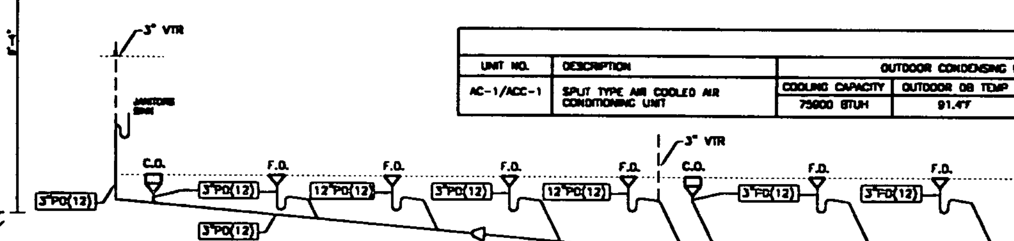
SUPPLY AND EXHAUST FAN SCHEDULE						
FAN NO.	DESCRIPTION	SIZE (HP)	CAPACITY	VOLTAGE, PHASE	MOTOR RPM	COMMENTS
SF-1	SUPPLY AIR INLINE FAN	1/45	150 CFM@0.125 WC	120, 1	1050	-
EF-1	EXHAUST AIR PROPELLER WALL FAN	3	18400/9200 CFM@0.625 WC	460, 3	1750/875	2 SPEED
EF-2	EXHAUST AIR PROPELLER WALL FAN	3	18400/9200 CFM@0.625 WC	460, 3	1750/875	2 SPEED

UNIT SPLIT AIR CONDITIONING UNIT															
UNIT NO.	DESCRIPTION	OUTDOOR CONDENSING UNIT			INDOOR EVAPORATOR BLOWER										
		COOLING CAPACITY	OUTDOOR DB TEMP	POWER SUPPLY	TOTAL COOLING CAPACITY	SENSIBLE CAPACITY	TOTAL SUPPLY AIR	OUTSIDE AIR	E.S.P.	E.D.B.	E.W.B.	L.D.B.	L.W.B.	ELECTRIC HEAT CAPACITY
AC-1/ACC-1	SPLIT TYPE AIR COOLED AIR CONDITIONING UNIT	75900 BTUH	91.4°F	460-3-60	75900 BTUH	60500 BTUH	2250 CFM	150 CFM	0.75/WG	78.7°F	64.7°F	56.1°F	54.8°F	10 KW



SECTION 2
SCALE: 3/8"=1'-0" 045

SECTION 1
SCALE: 3/8"=1'-0" 045



NOTES:
1. ALL TRAPS SHALL BE "P" TRAPS.
2. FLOOR DRAINS SHALL BE M-302 TYPE.
3. ALL CLEANOUTS SHALL BE M-307 TYPE.

SANITARY SCHEMATIC

DATE	REVISIONS

STATE OF KENTUCKY
RICHARD GEORGE ATOULIKIAN 19947
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

HVAC/P
DEWATERING BUILDING SECTIONS AND DETAILS

MONTGOMERY WATSON

DRAWN BY: SB
PROJECT ENG'R: SS
APPROVED: DN
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

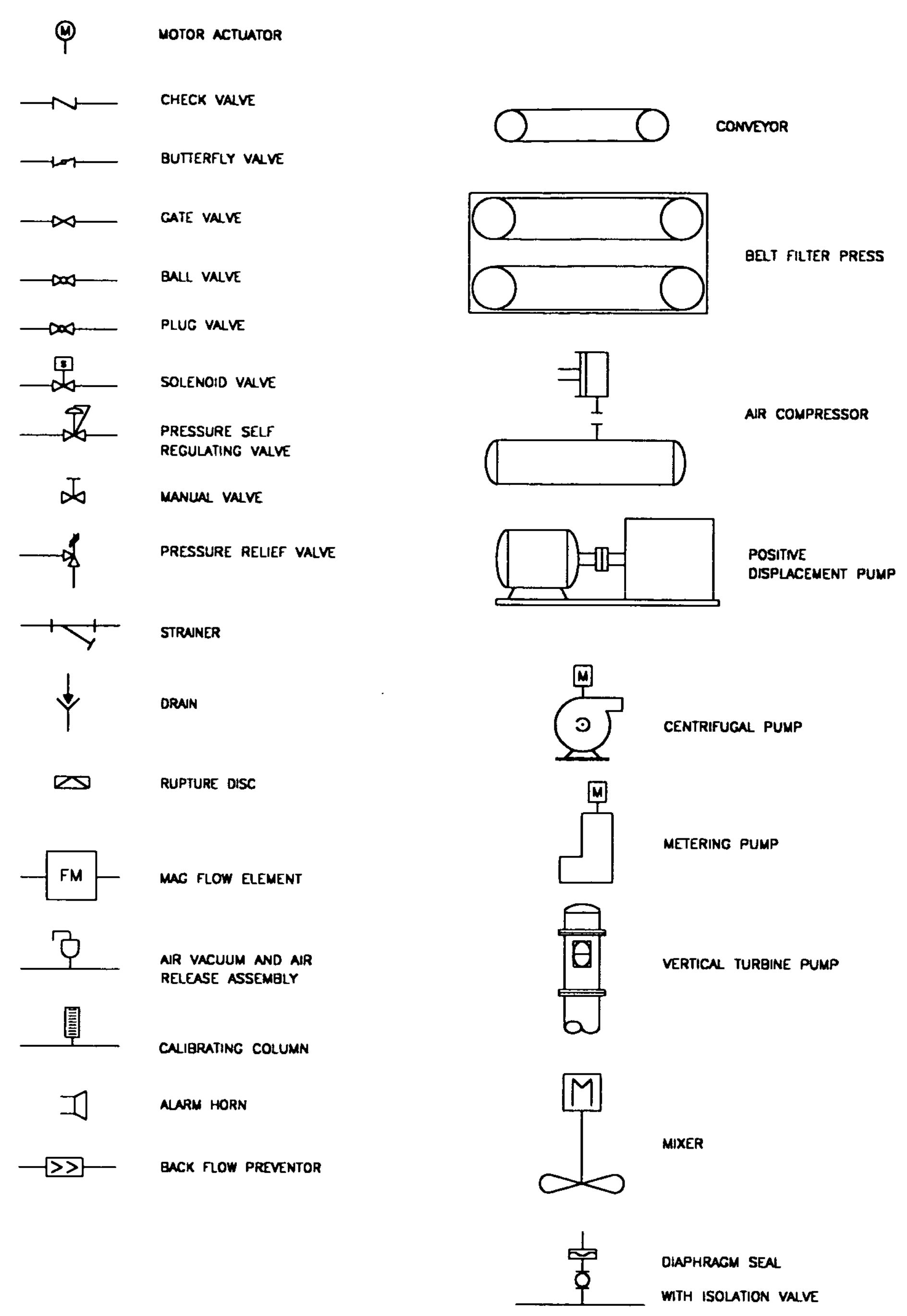
380-575-046

INSTRUMENT IDENTIFICATION LEGEND

	FIRST LETTER		SUCCEEDING LETTERS,		
	MEASURED OR INITIATING VARIABLE,	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS,		ALARM		
B	BURNER FLAME		NOT USED	NOT USED	NOT USED
C	CONDUCTIVITY (ELECTRICAL)			CONTROL	CLOSED
D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		PRIMARY ELEMENT		
F	FLOW RATE	RATIO (FACTION)			
G	GAGING (DIMENSIONAL)		GLASS GAGE (UNCALIBRATED)		
H	HAND (MANUALLY INITIATED)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME OR TIME SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOISTURE OR HUMIDITY				MIDDLE OR INTER-MEDIATE
N	NOT USED		READY	NOT USED	NOT USED
O	NOT USED		ORIFICE (RESTRICTION)		OPEN
P	PRESSURE OR VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE OR TOTALIZE	TOTALIZE		
R	RADIOACTIVITY		RECORD OR PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION			VALVE, DAMPER OR LOUVER	
W	WEIGHT OR FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT STATUS	Y AXIS		RELAY OR COMPUTE	
Z	POSITION			DRIVE, ACTUATE OR UNCLASSIFIED FINAL CONTROL ELEMENT	

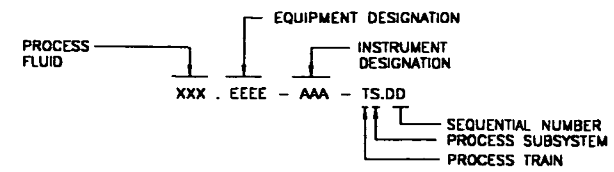
I/O TAG PROCESS ABBREVIATIONS

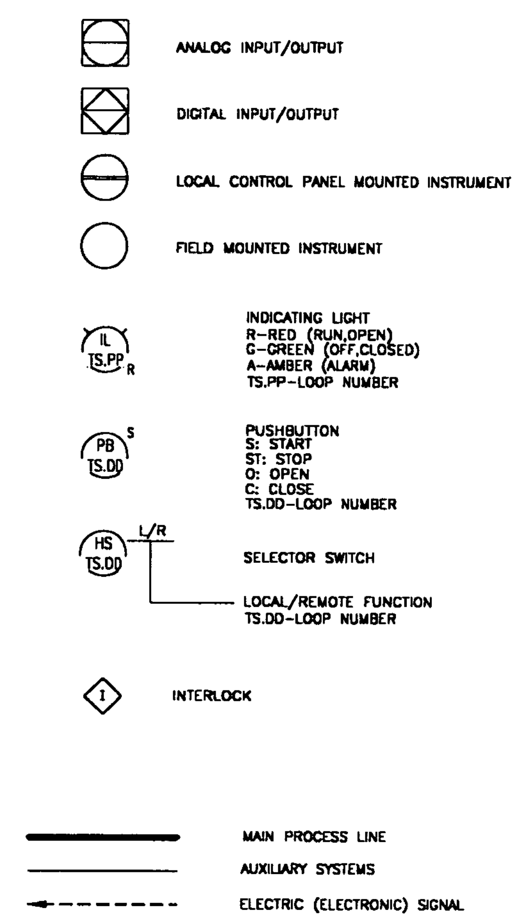
SW	SLUDGE WELL
GT1	GRAVITY THICKENER 1
GT2	GRAVITY THICKENER 2
BFT1	BATCH FEED TANK 1
BFT2	BATCH FEED TANK 2
LSRV2	LAGOON SUPERNATENT RETURN VAULT 2
LAG1	LAGOON 1
LAG2	LAGOON 2
LAG3	LAGOON 3
LAG4	LAGOON 4



INSTRUMENT TAG NUMBERING SYSTEM

SYMBOLS AND TAG NUMBERS ARE BASICALLY THE SAME AS ISA (INSTRUMENT SOCIETY OF AMERICA) STANDARD INSTRUMENT TAG NUMBER DETAILS.





NOTES: PROCESS, PIPING AND VALVE ABBRIVATIONS SEE DRAWING SHT.005

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

INSTRUMENTATION
LEGENDS, SYMBOLS AND ABBREVIATIONS

MONTGOMERY WATSON

DRAWN BY: MMP
PROJECT ENG'R: DLS
APPROVED: DM
DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-047

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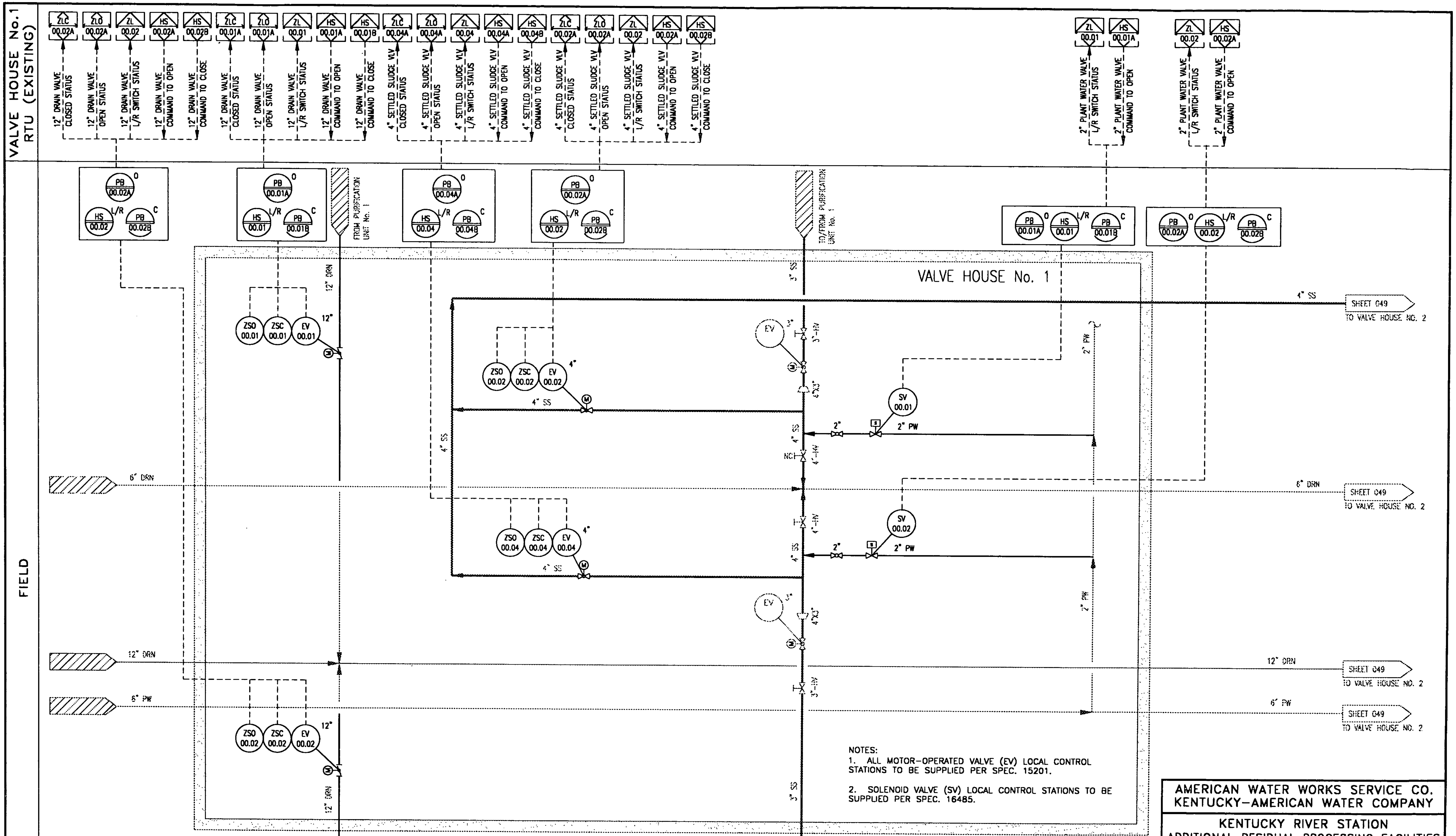


NOTES:
1. ALL MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 15201.
2. SOLENOID VALVE (SV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 18941 REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

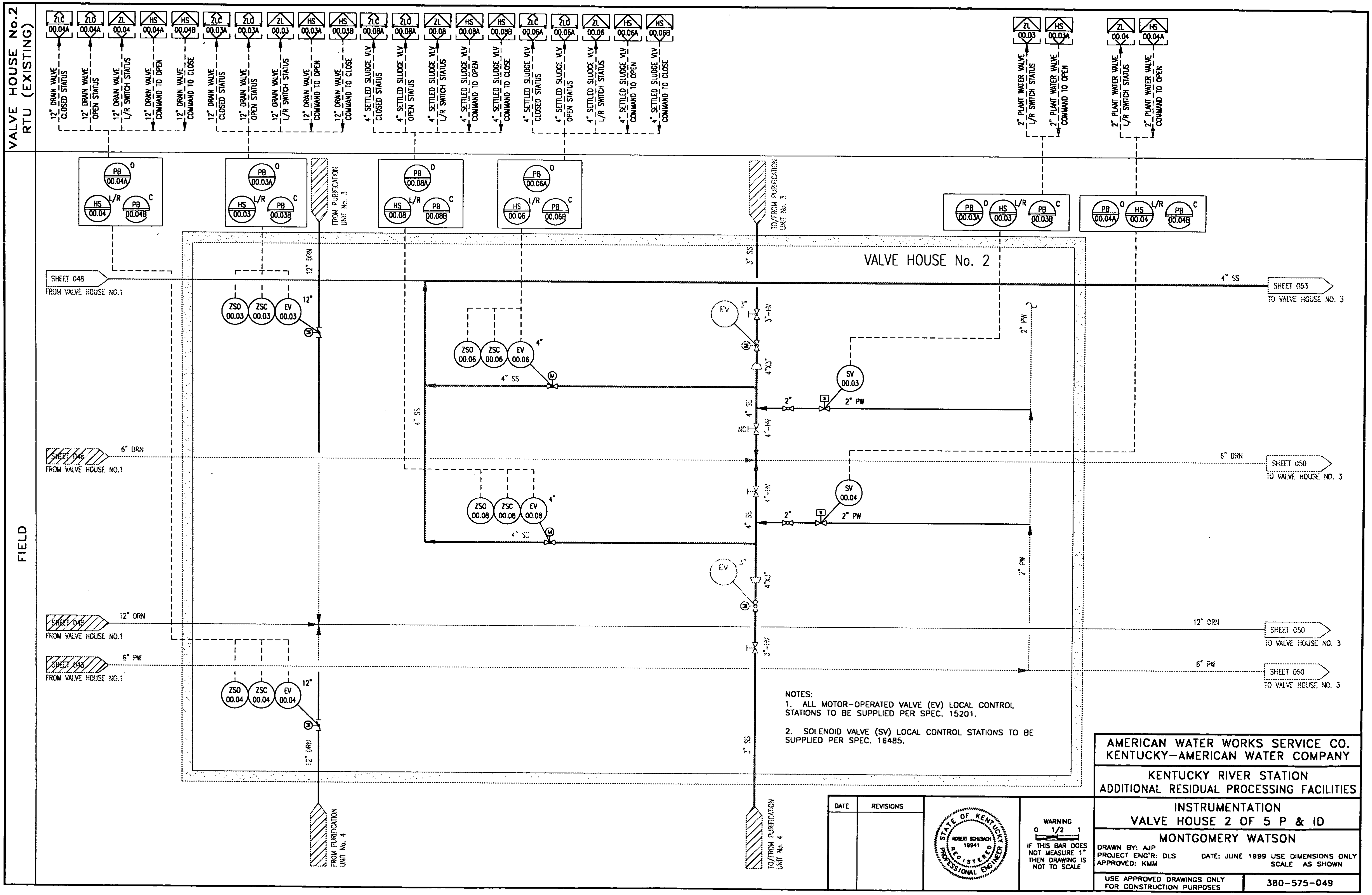
INSTRUMENTATION
VALVE HOUSE 1 OF 5 P & ID

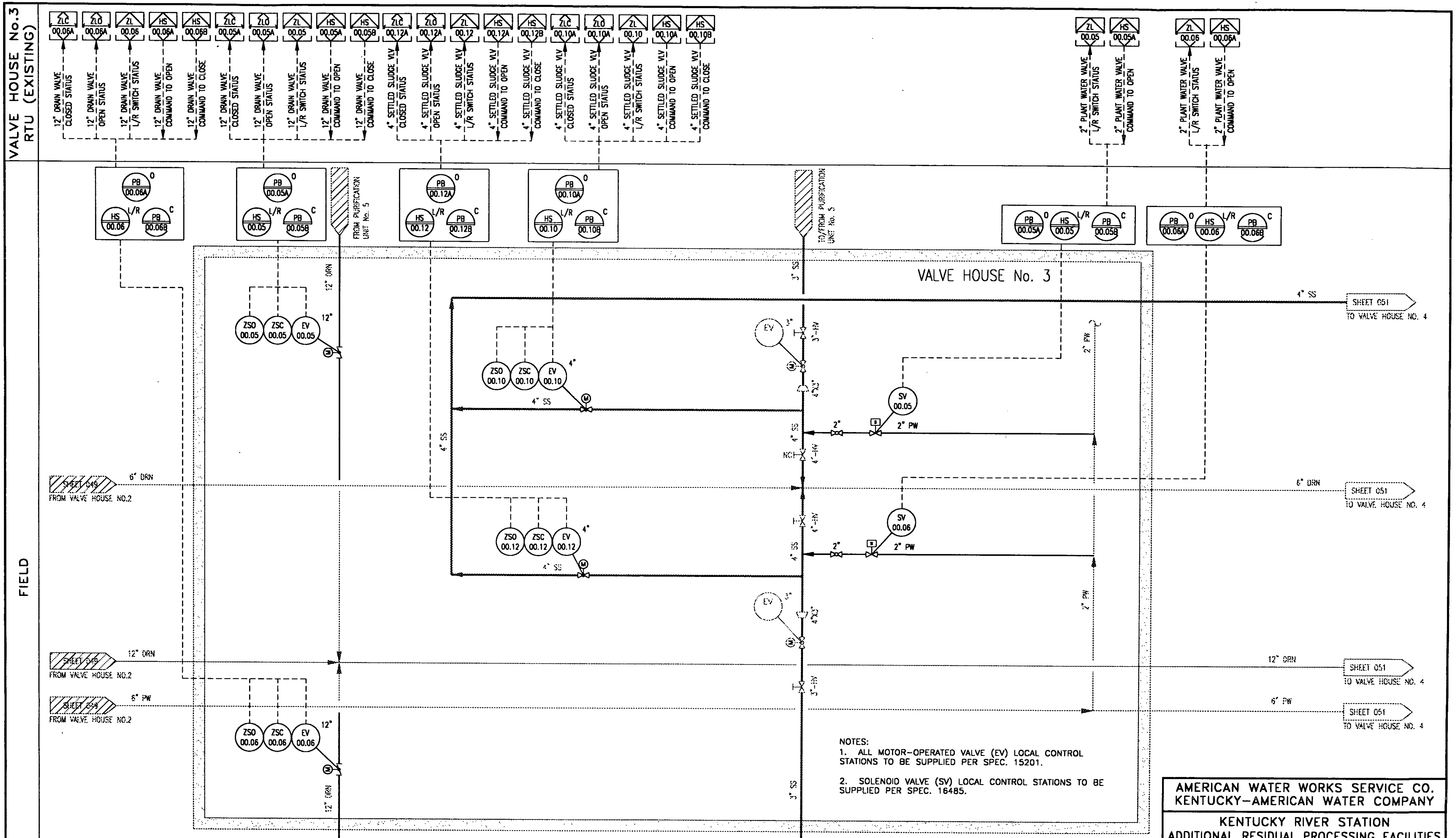
MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-048


VALVE HOUSE No.2
RTU (EXISTING)
FIELD
12" DRAIN VALVE CLOSED STATUS
12" DRAIN VALVE OPEN STATUS
12" DRAIN VALVE L/R SWITCH STATUS
12" DRAIN VALVE COMMAND TO OPEN
12" DRAIN VALVE COMMAND TO CLOSE
4" SETTLED SLUDGE VLV CLOSED STATUS
4" SETTLED SLUDGE VLV OPEN STATUS
4" SETTLED SLUDGE VLV L/R SWITCH STATUS
4" SETTLED SLUDGE VLV COMMAND TO OPEN
4" SETTLED SLUDGE VLV COMMAND TO CLOSE
2" PLANT WATER VALVE L/R SWITCH STATUS
2" PLANT WATER VALVE COMMAND TO OPEN
VALVE HOUSE No. 2
SHEET 048 FROM VALVE HOUSE NO.1
SHEET 053 TO VALVE HOUSE NO. 3
SHEET 050 TO VALVE HOUSE NO. 3
FROM PURIFICATION UNIT No. 3
TO/FROM PURIFICATION UNIT No. 3
FROM PURIFICATION UNIT No. 4
TO/FROM PURIFICATION UNIT No. 4
4" SS
6" DRN
12" DRN
6" PW
2" PW
3" SS
NOTES:
1. ALL MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 15201.
2. SOLENOID VALVE (SV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.
DATE
REVISIONS
STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER
WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE
AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES
INSTRUMENTATION
VALVE HOUSE 2 OF 5 P & ID
MONTGOMERY WATSON
DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES
380-575-049



NOTES:
1. ALL MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 15201.

2. SOLENOID VALVE (SV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

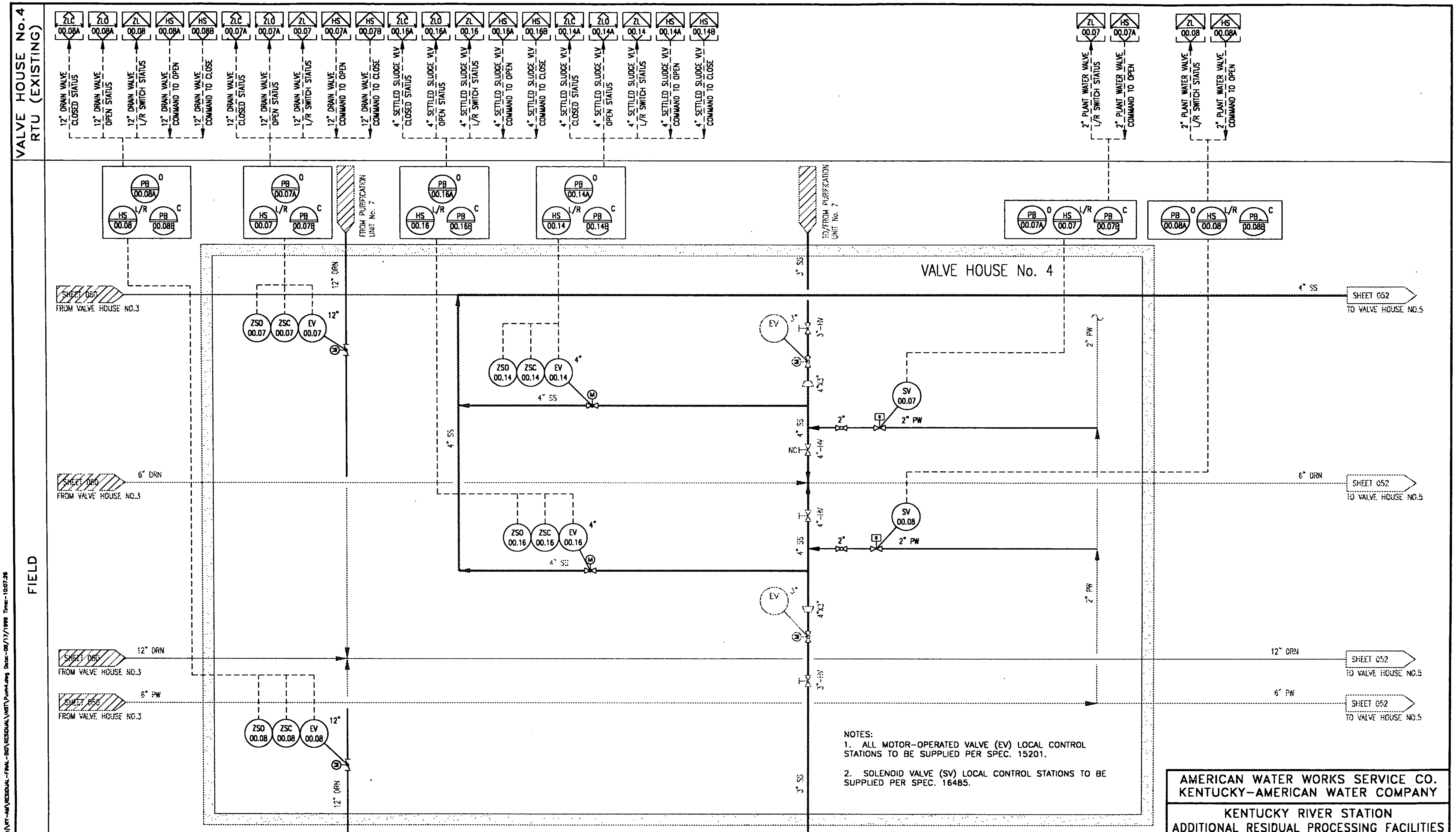
INSTRUMENTATION
VALVE HOUSE 3 OF 5 P & ID

MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-050



NOTES:

1. ALL MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 15201.

2. SOLENOID VALVE (SV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

INSTRUMENTATION
VALVE HOUSE 4 OF 5 P & ID

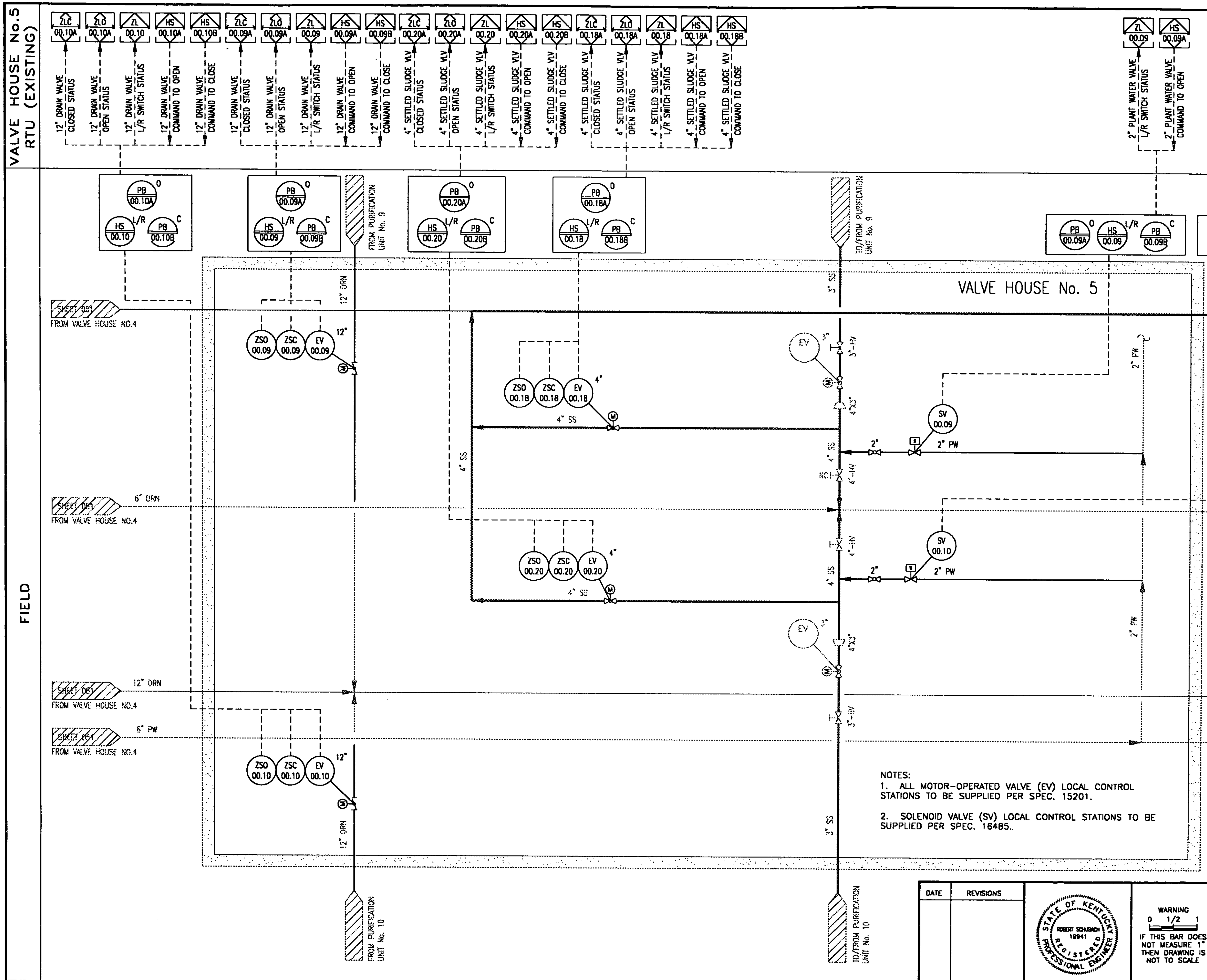
MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-051



NOTES:
1. ALL MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 15201.

2. SOLENOID VALVE (SV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

INSTRUMENTATION
VALVE HOUSE 5 OF 5 P & ID

MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-052

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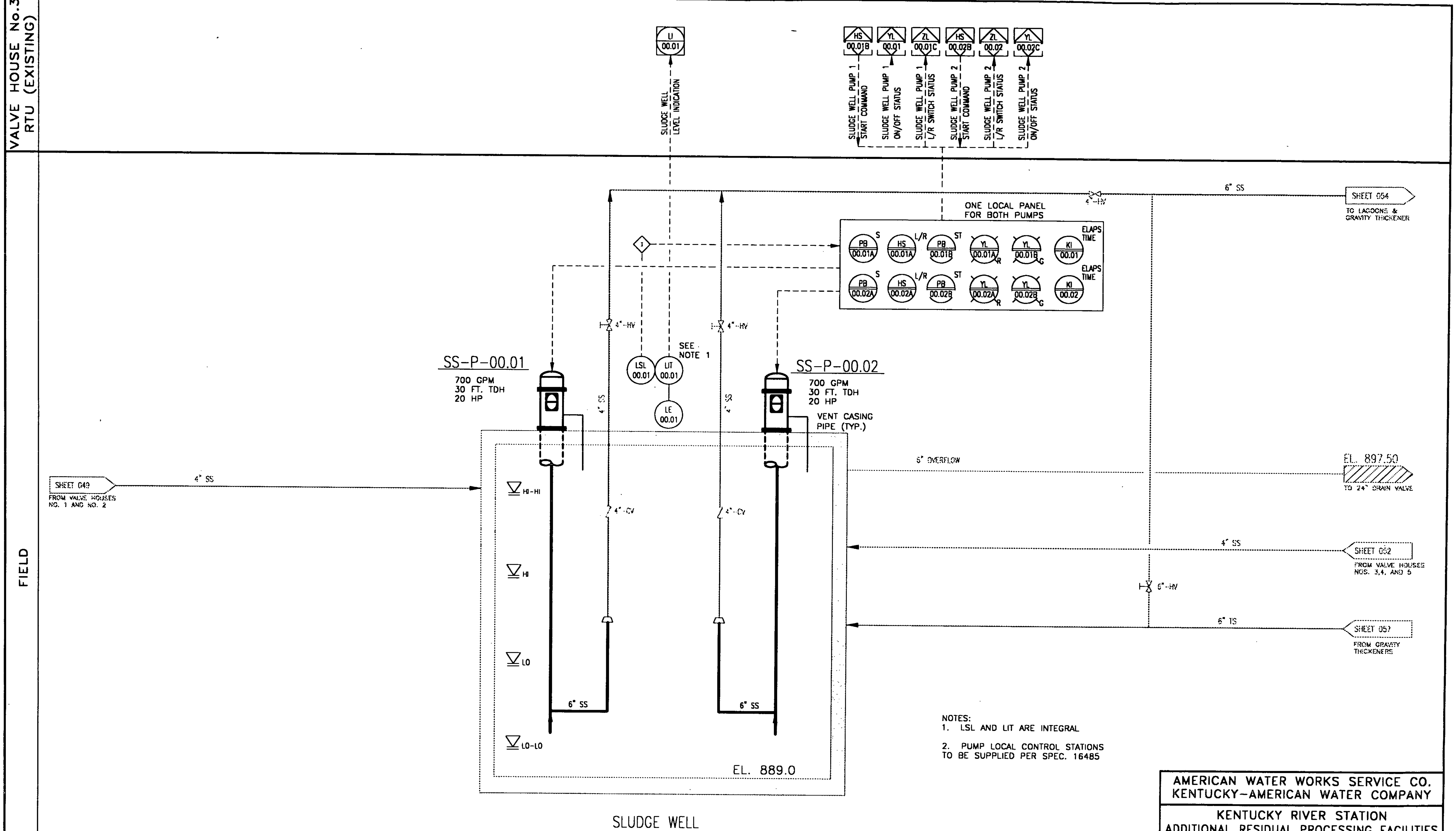


NOTES:
1. LSL AND LIT ARE INTEGRAL
2. PUMP LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUSACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

INSTRUMENTATION
SLUDGE WELL P & ID

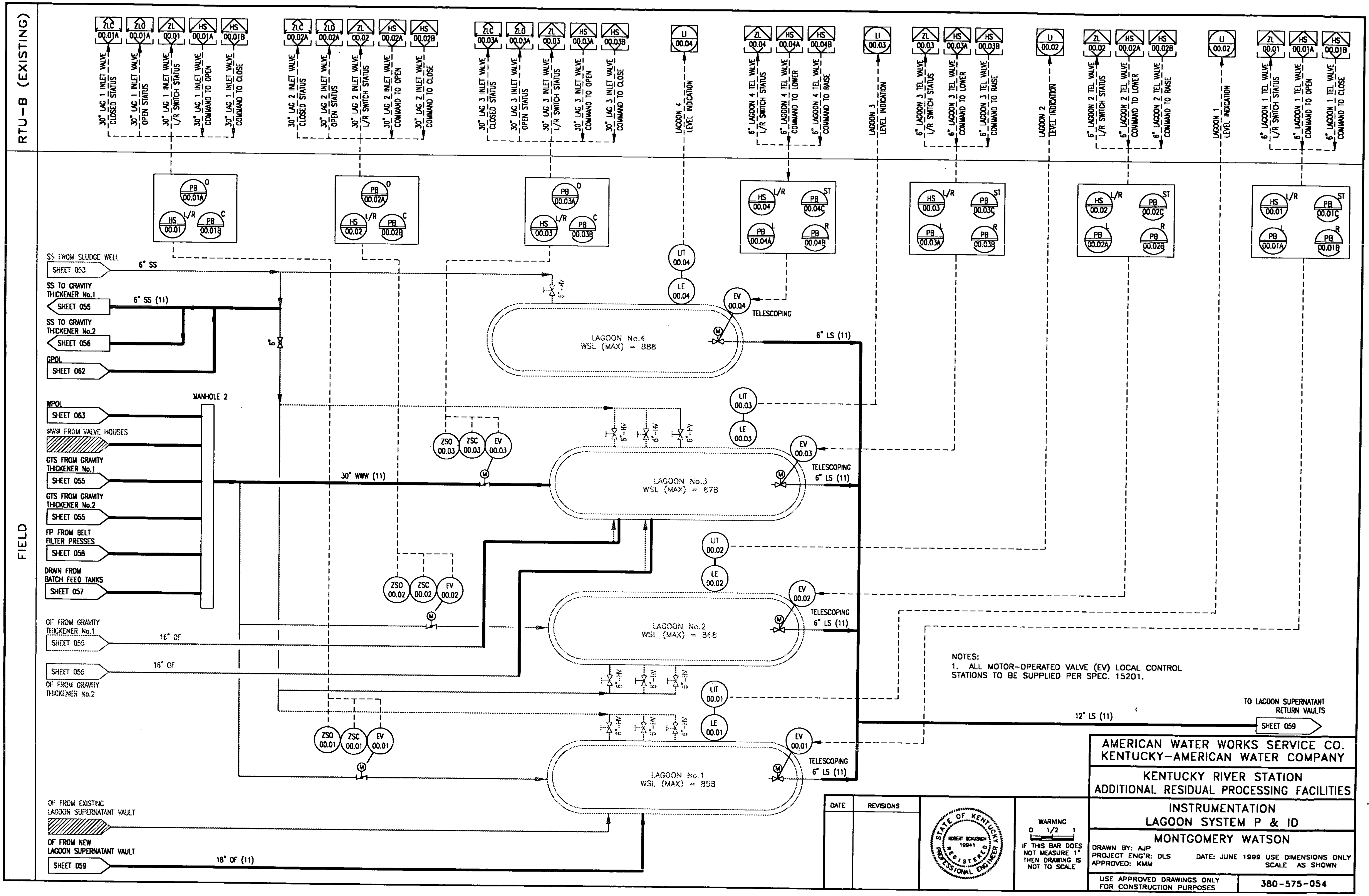
MONTGOMERY WATSON

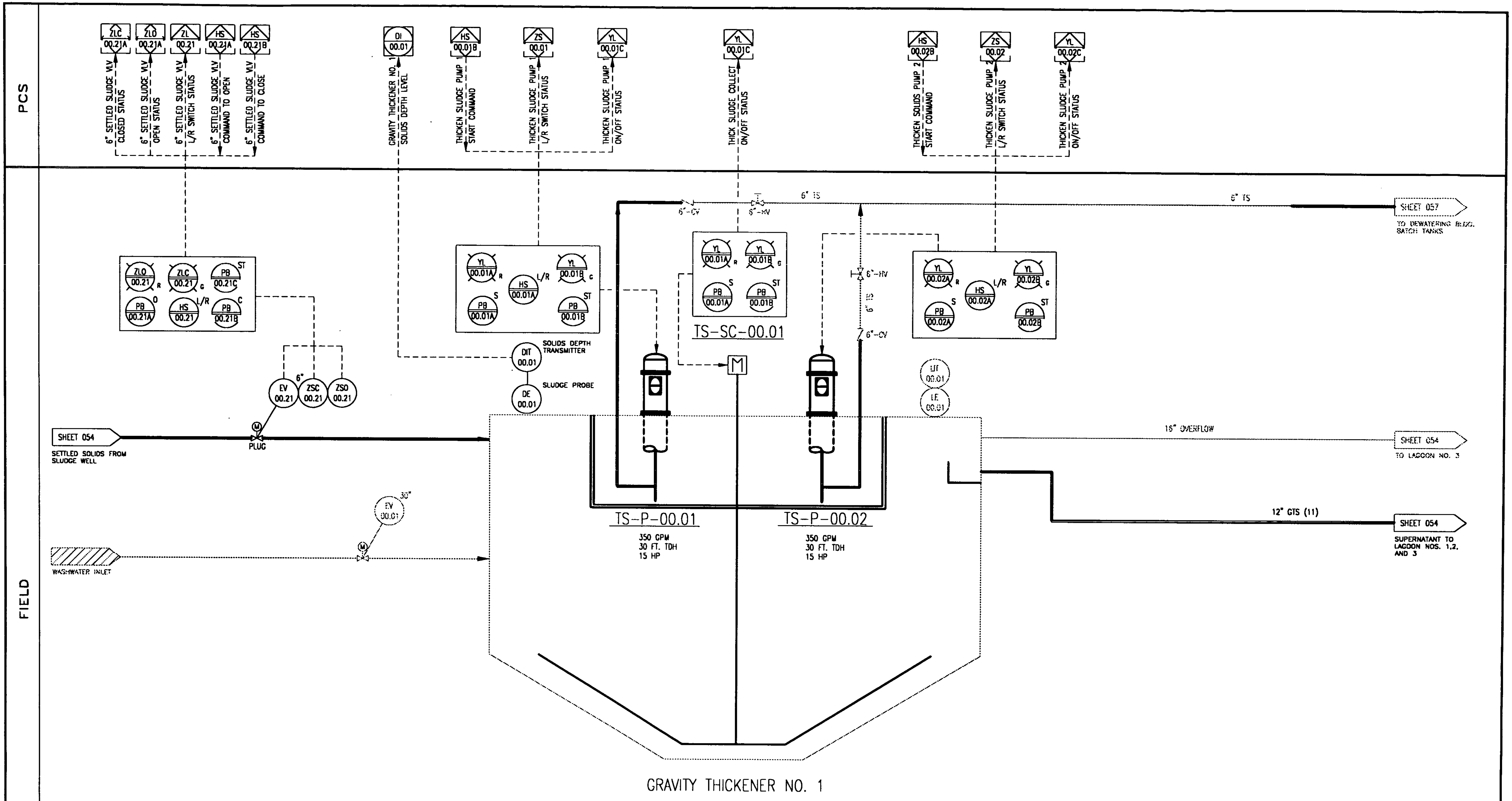
DRAWN BY: DLS
PROJECT ENG'R: DLS
APPROVED: KM

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-053


RTU-B (EXISTING)
FIELD
30" LAG 1 INLET VALVE CLOSED STATUS
30" LAG 1 INLET VALVE OPEN STATUS
30" LAG 1 INLET VALVE L/R SWITCH STATUS
30" LAG 1 INLET VALVE COMMAND TO OPEN
30" LAG 1 INLET VALVE COMMAND TO CLOSE
30" LAG 2 INLET VALVE CLOSED STATUS
30" LAG 2 INLET VALVE OPEN STATUS
30" LAG 2 INLET VALVE L/R SWITCH STATUS
30" LAG 2 INLET VALVE COMMAND TO OPEN
30" LAG 2 INLET VALVE COMMAND TO CLOSE
30" LAG 3 INLET VALVE CLOSED STATUS
30" LAG 3 INLET VALVE OPEN STATUS
30" LAG 3 INLET VALVE L/R SWITCH STATUS
30" LAG 3 INLET VALVE COMMAND TO OPEN
30" LAG 3 INLET VALVE COMMAND TO CLOSE
LAGOON 4 LEVEL INDICATION
6" LAGOON 4 TEL VALVE L/R SWITCH STATUS
6" LAGOON 4 TEL VALVE COMMAND TO LOWER
6" LAGOON 4 TEL VALVE COMMAND TO RAISE
LAGOON 3 LEVEL INDICATION
6" LAGOON 3 TEL VALVE L/R SWITCH STATUS
6" LAGOON 3 TEL VALVE COMMAND TO LOWER
6" LAGOON 3 TEL VALVE COMMAND TO RAISE
LAGOON 2 LEVEL INDICATION
6" LAGOON 2 TEL VALVE L/R SWITCH STATUS
6" LAGOON 2 TEL VALVE COMMAND TO LOWER
6" LAGOON 2 TEL VALVE COMMAND TO RAISE
LAGOON 1 LEVEL INDICATION
6" LAGOON 1 TEL VALVE L/R SWITCH STATUS
6" LAGOON 1 TEL VALVE COMMAND TO OPEN
6" LAGOON 1 TEL VALVE COMMAND TO CLOSE
SS FROM SLUDGE WELL SHEET 053
6" SS
SS TO GRAVITY THICKENER No.1 SHEET 055
6" SS (11)
SS TO GRAVITY THICKENER No.2 SHEET 056
GPOL SHEET 062
MANHOLE 2
WPOL SHEET 063
WWW FROM VALVE HOUSES
GTS FROM GRAVITY THICKENER No.1 SHEET 055
GTS FROM GRAVITY THICKENER No.2 SHEET 055
FP FROM BELT FILTER PRESSES SHEET 058
DRAIN FROM BATCH FEED TANKS SHEET 057
OF FROM GRAVITY THICKENER No.1 SHEET 055
16" OF
SHEET 056 OF FROM GRAVITY THICKENER No.2
OF FROM EXISTING LAGOON SUPERNATANT VAULT
OF FROM NEW LAGOON SUPERNATANT VAULT SHEET 059
18" OF (11)
30" WWW (11)
LAGOON No.4 WSL (MAX) = 888
LAGOON No.3 WSL (MAX) = 878
LAGOON No.2 WSL (MAX) = 868
LAGOON No.1 WSL (MAX) = 858
TELESCOPING
6" LS (11)
12" LS (11)
TO LAGOON SUPERNATANT RETURN VAULTS SHEET 059
NOTES:
1. ALL MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 15201.
DATE
REVISIONS
STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER
WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE
AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES
INSTRUMENTATION
LAGOON SYSTEM P & ID
MONTGOMERY WATSON
DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES
380-575-054



DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

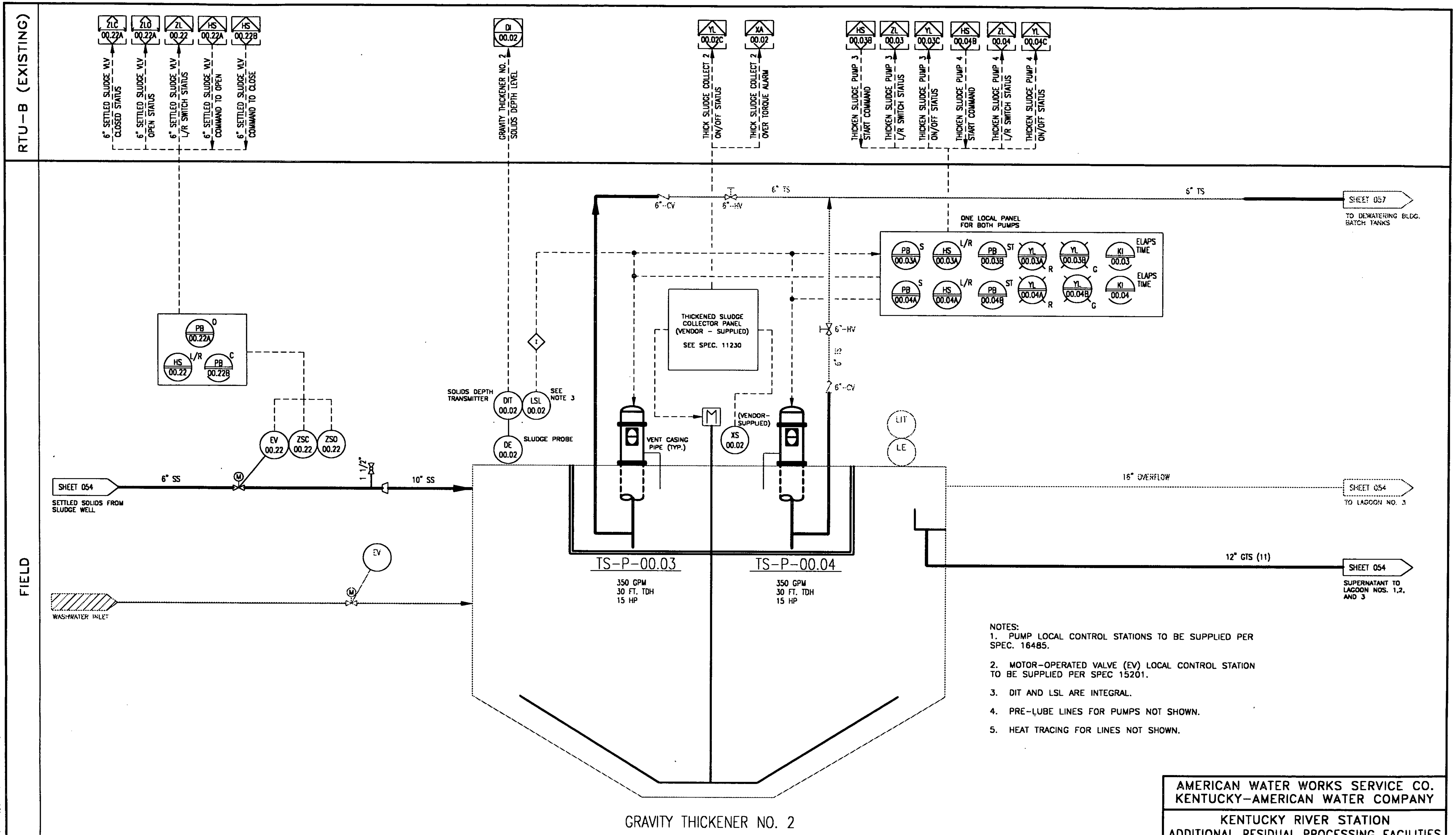
INSTRUMENTATION
GRAVITY THICKENER NO. 1

MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-055



GRAVITY THICKENER NO. 2

NOTES:
1. PUMP LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.
2. MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATION TO BE SUPPLIED PER SPEC 15201.
3. DIT AND LSL ARE INTEGRAL.
4. PRE-LUBE LINES FOR PUMPS NOT SHOWN.
5. HEAT TRACING FOR LINES NOT SHOWN.

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUSNOH 19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

INSTRUMENTATION
GRAVITY THICKENER NO. 2 P & ID

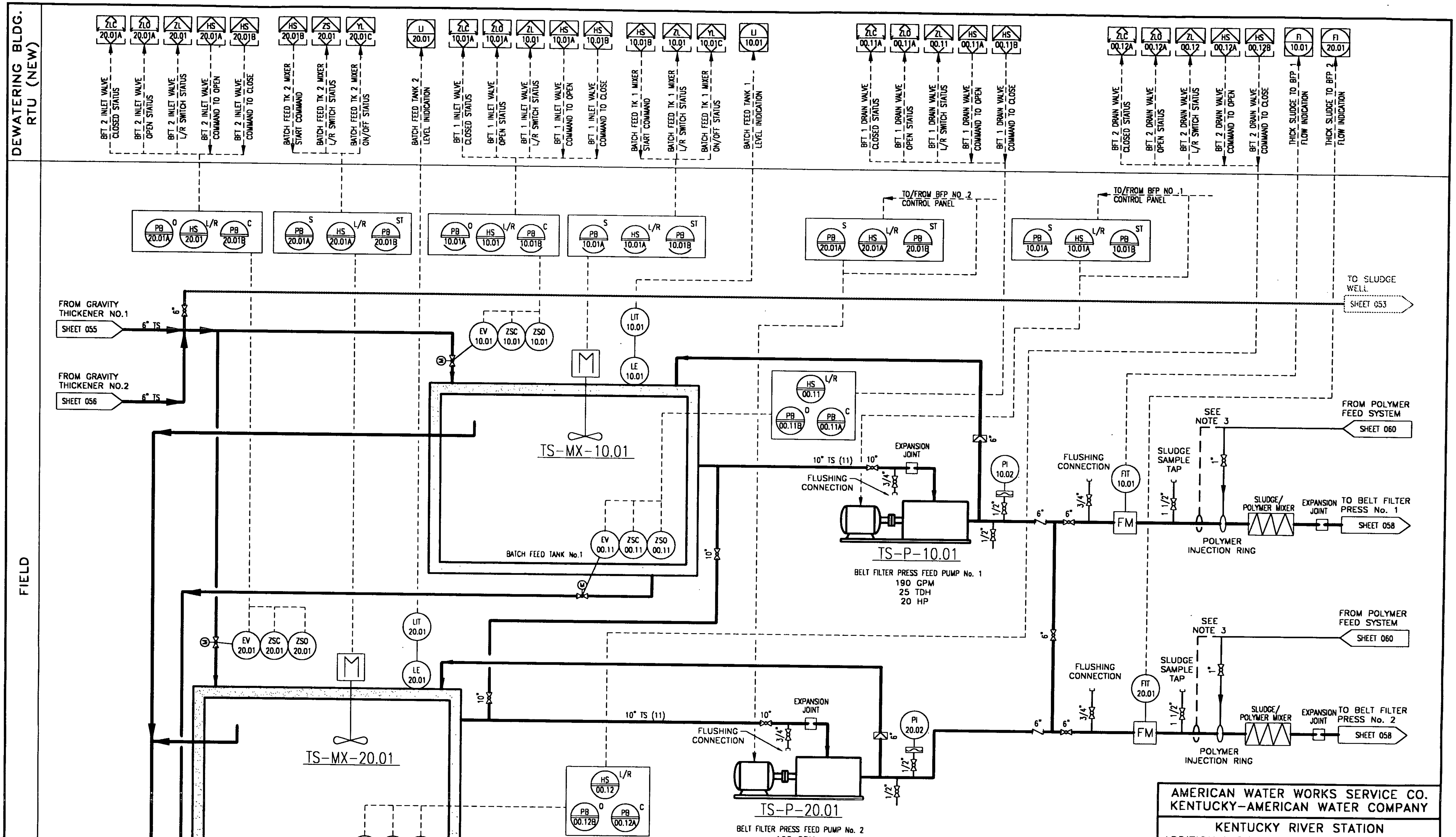
MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-056

[RTS]-<Loginname: rlachnal>> lit:\Robb_p\0014\PID_DWG\Pst1.dwg Date:-07/08/1999 Time:-13:40.38



NOTES:

1. PUMP OR MIXER LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC 16485.

2. MOTOR-OPERATED VALVE (EV) LOCAL CONTROL STATION TO BE SUPPLIED PER SPEC. 15201.

3. POSSIBLE FUTURE POLYMER INJECTION RING LOCATION (TEMPORARY SPOOL PIECE)

DATE	REVISIONS

STATE OF KENTUCKY — ROBERT SCHUBACH — 19941 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

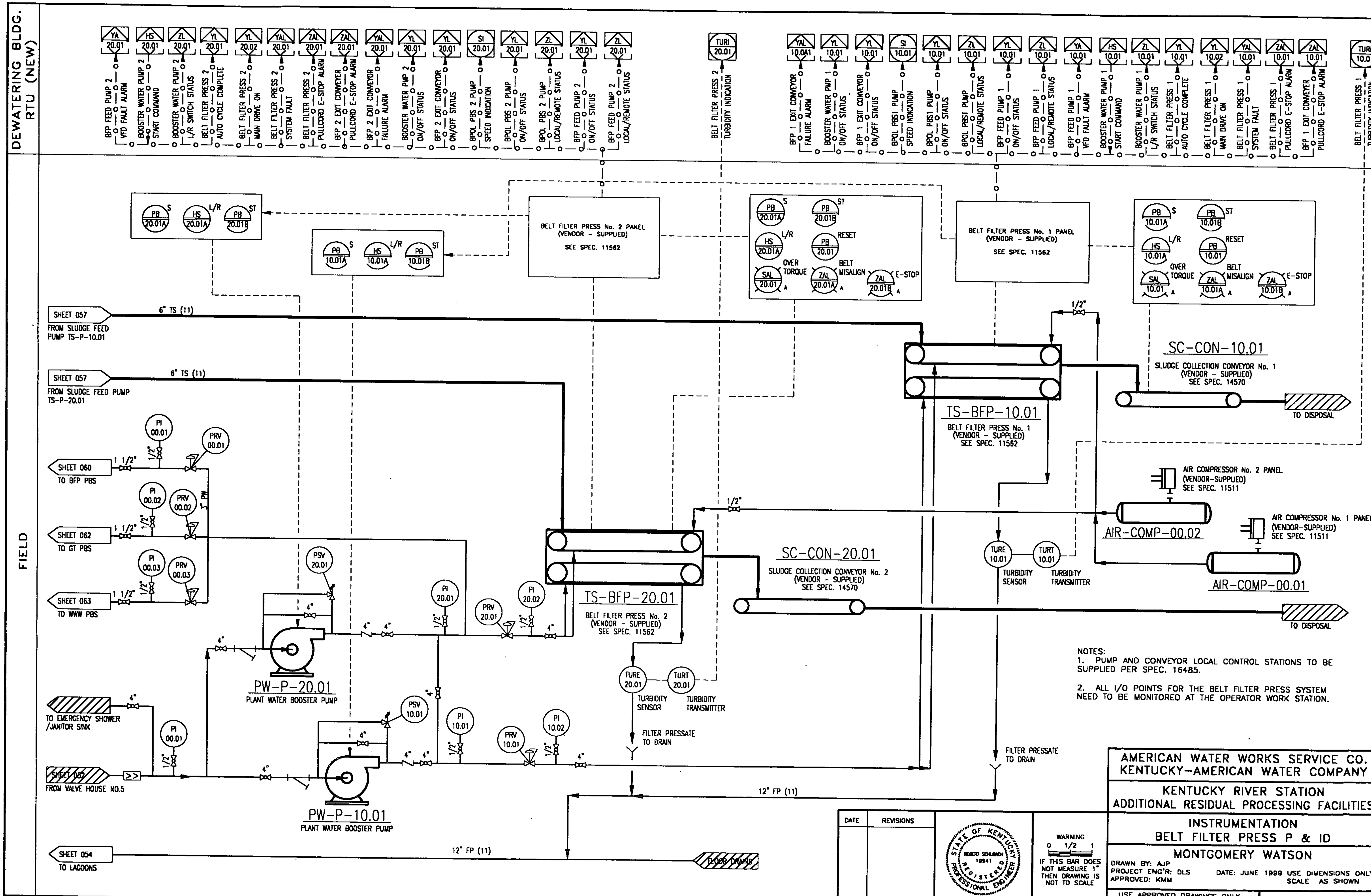
INSTRUMENTATION
THICKENED SLUDGE FEED SYSTEM P & ID

MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-057



NOTES:
1. PUMP AND CONVEYOR LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.
2. ALL I/O POINTS FOR THE BELT FILTER PRESS SYSTEM NEED TO BE MONITORED AT THE OPERATOR WORK STATION.

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

INSTRUMENTATION
BELT FILTER PRESS P & ID

MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM

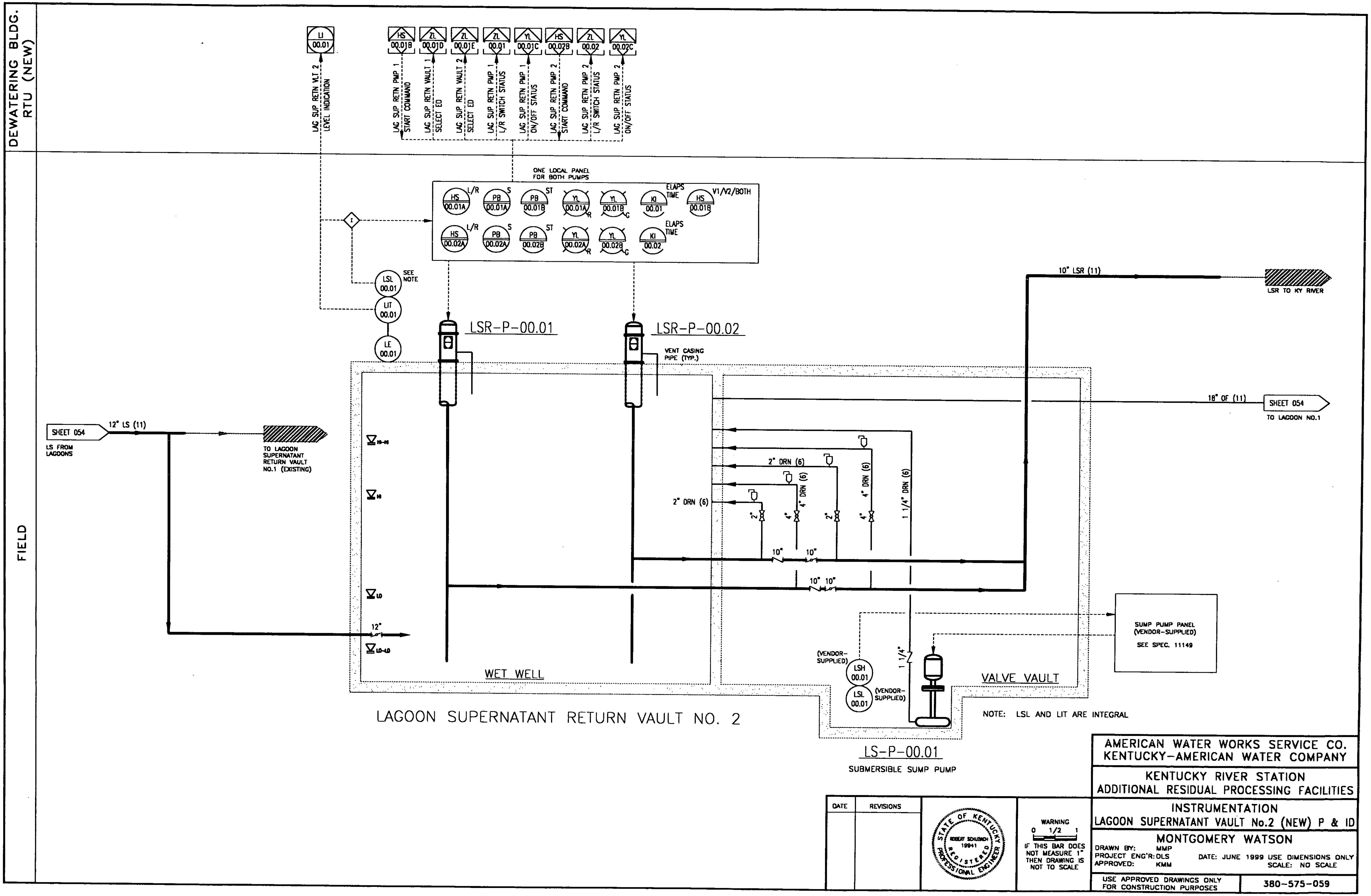
DATE: JUNE 1999 USE DIMENSIONS ONLY SCALE AS SHOWN

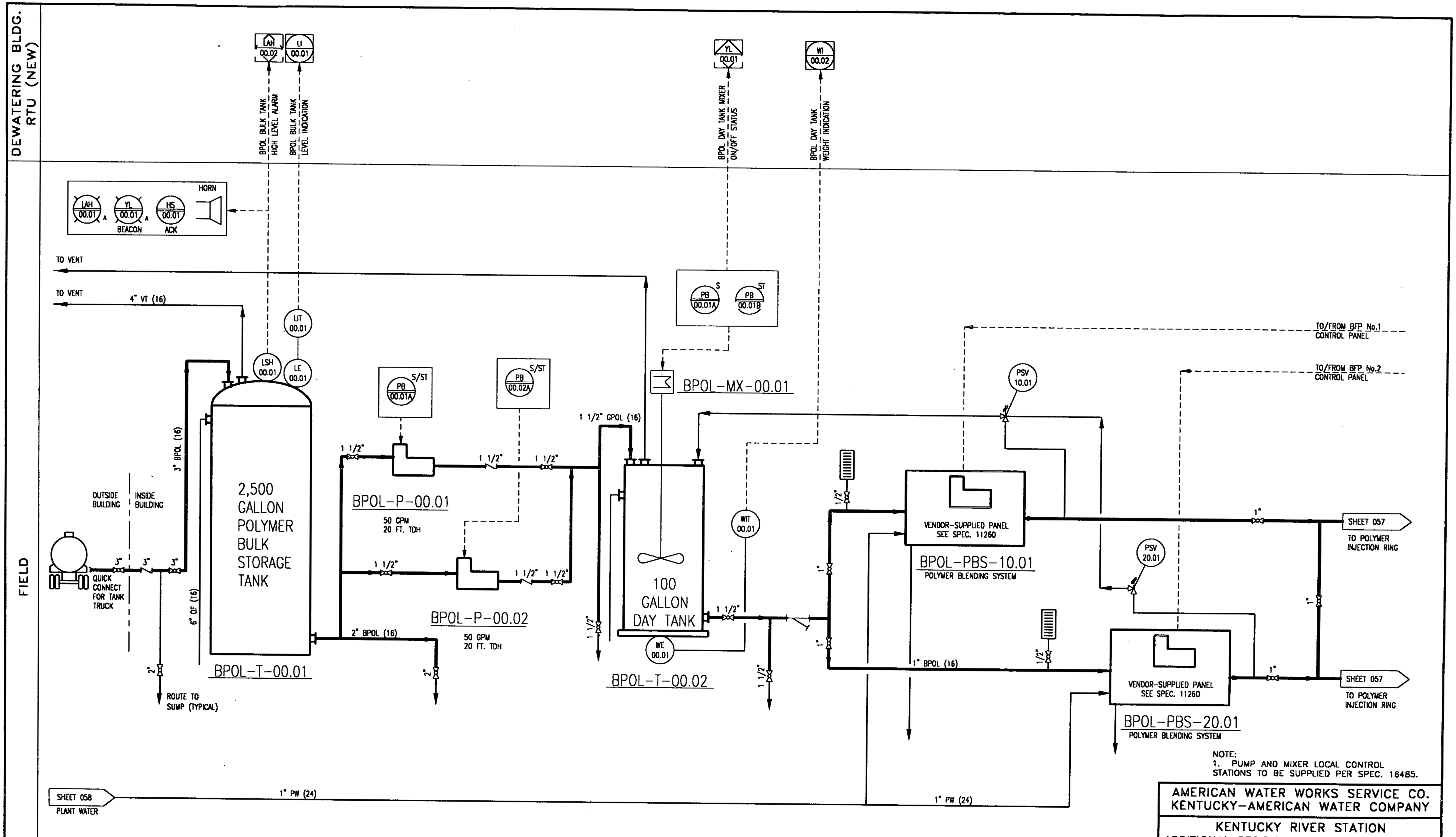
WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DATE	REVISIONS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-058


DEWATERING BLDG.
RTU (NEW)
FIELD
LI 00.01
LAG SUP RETN VLT 2 LEVEL INDICATION
HS 00.01B LAG SUP RETN PMP 1 START COMMAND
ZL 00.01D LAG SUP RETN VAULT 1 SELECT ED
ZL 00.01E LAG SUP RETN VAULT 2 SELECT ED
ZL 00.01 LAG SUP RETN PMP 1 L/R SWITCH STATUS
YL 00.01C LAG SUP RETN PMP 1 ON/OFF STATUS
HS 00.02B LAG SUP RETN PMP 2 START COMMAND
ZL 00.02 LAG SUP RETN PMP 2 L/R SWITCH STATUS
YL 00.02C LAG SUP RETN PMP 2 ON/OFF STATUS
ONE LOCAL PANEL FOR BOTH PUMPS
HS 00.01A L/R
PB 00.01A S
PB 00.01B ST
YL 00.01A R
YL 00.01B G
KI 00.01 ELAPS TIME
HS 00.01B V1/V2/BOTH
HS 00.02A L/R
PB 00.02A S
PB 00.02B ST
YL 00.02A R
YL 00.02B G
KI 00.02 ELAPS TIME
LSL 00.01 SEE NOTE
LIT 00.01
LE 00.01
LSR-P-00.01
LSR-P-00.02
VENT CASING PIPE (TYP.)
10" LSR (11)
LSR TO KY RIVER
18" OF (11)
SHEET 054 TO LAGOON NO.1
SHEET 054 LS FROM LAGOONS
12" LS (11)
TO LAGOON SUPERNATANT RETURN VAULT NO.1 (EXISTING)
HI-HI
HI
LO
LO-LO
12"
2" DRN (6)
4" DRN (6)
1 1/4" DRN (6)
2"
4"
10"
1 1/4"
WET WELL
VALVE VAULT
(VENDOR-SUPPLIED) LSH 00.01
LSL 00.01 (VENDOR-SUPPLIED)
SUMP PUMP PANEL (VENDOR-SUPPLIED)
SEE SPEC. 11149
LAGOON SUPERNATANT RETURN VAULT NO. 2
LS-P-00.01
SUBMERSIBLE SUMP PUMP
NOTE: LSL AND LIT ARE INTEGRAL
DATE
REVISIONS
STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED PROFESSIONAL ENGINEER
WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE
AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY
KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES
INSTRUMENTATION
LAGOON SUPERNATANT VAULT No.2 (NEW) P & ID
MONTGOMERY WATSON
DRAWN BY: MMP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE: NO SCALE
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES
380-575-059



NOTE:
1. PUMP AND MIXER LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
18941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

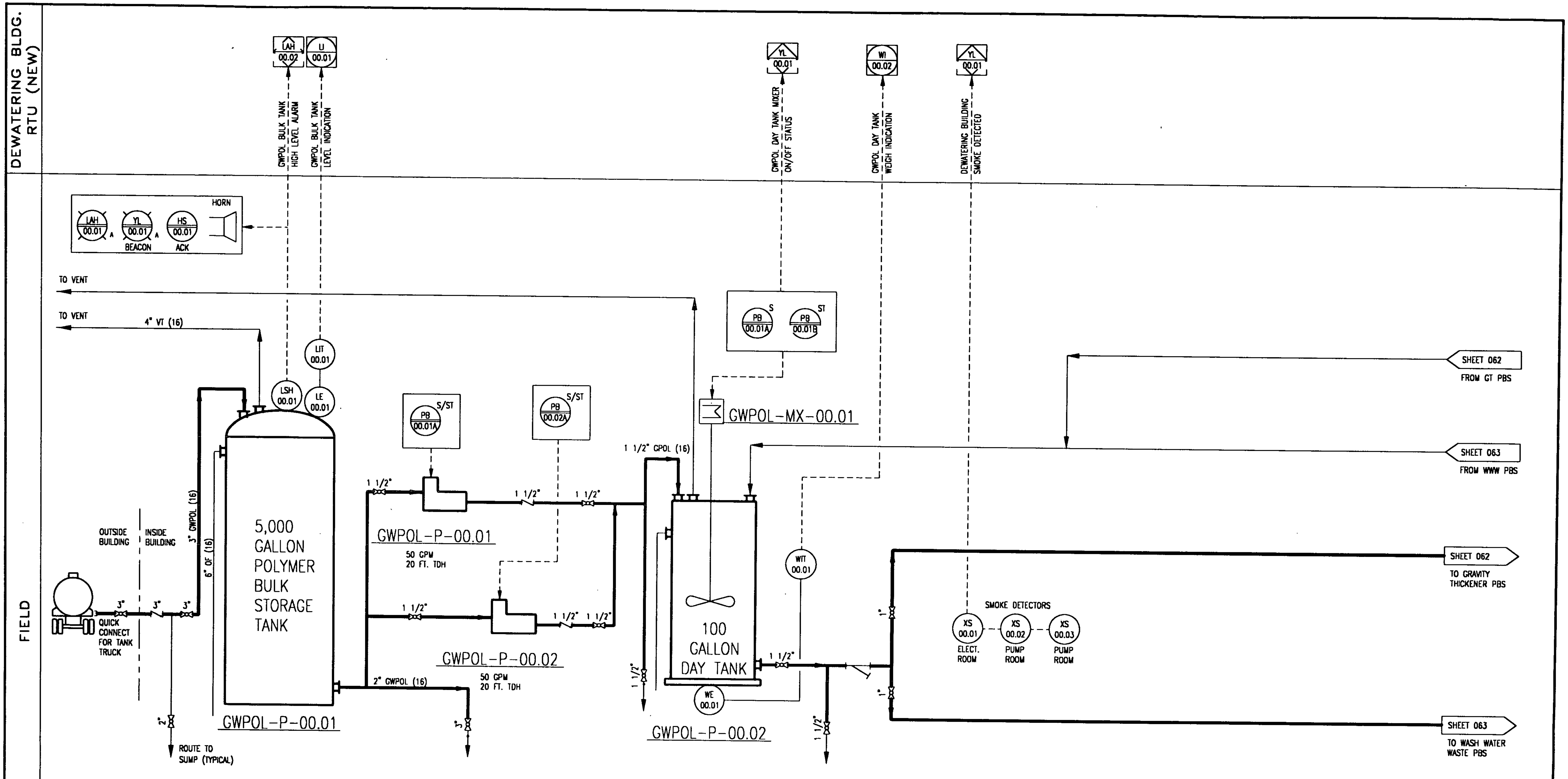
INSTRUMENTATION
BFP POLYMER FEED SYSTEM P & ID

MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-060



NOTE:
1. PUMP AND MIXER LOCAL CONTROL STATIONS TO BE SUPPLIED PER SPEC. 16485.

DATE	REVISIONS

STATE OF KENTUCKY REGISTERED PROFESSIONAL ENGINEER ROBERT SCHUBACH 19941

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

INSTRUMENTATION
GT & WWW POLYMER FEED SYSTEM P & ID

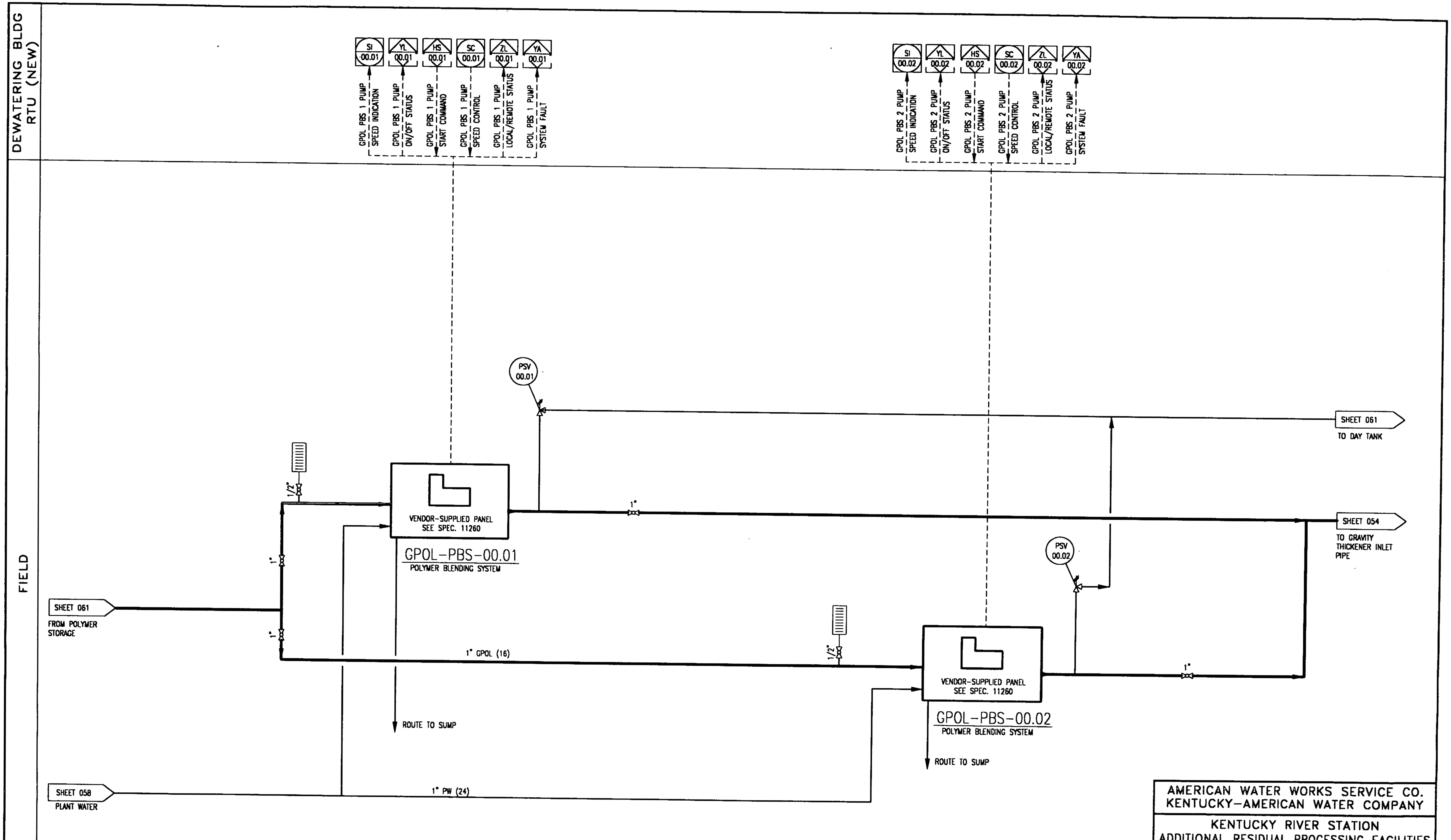
MONTGOMERY WATSON

DRAWN BY: AJP
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-061

[AP]--<<Loginname:-- a]pop>> T:\pro\KY-AM\RESIDUAL-FINAL-BID\RESIDUAL\INST\Depot.dwg Date:-08/17/1999 Time:-11:34:31



DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

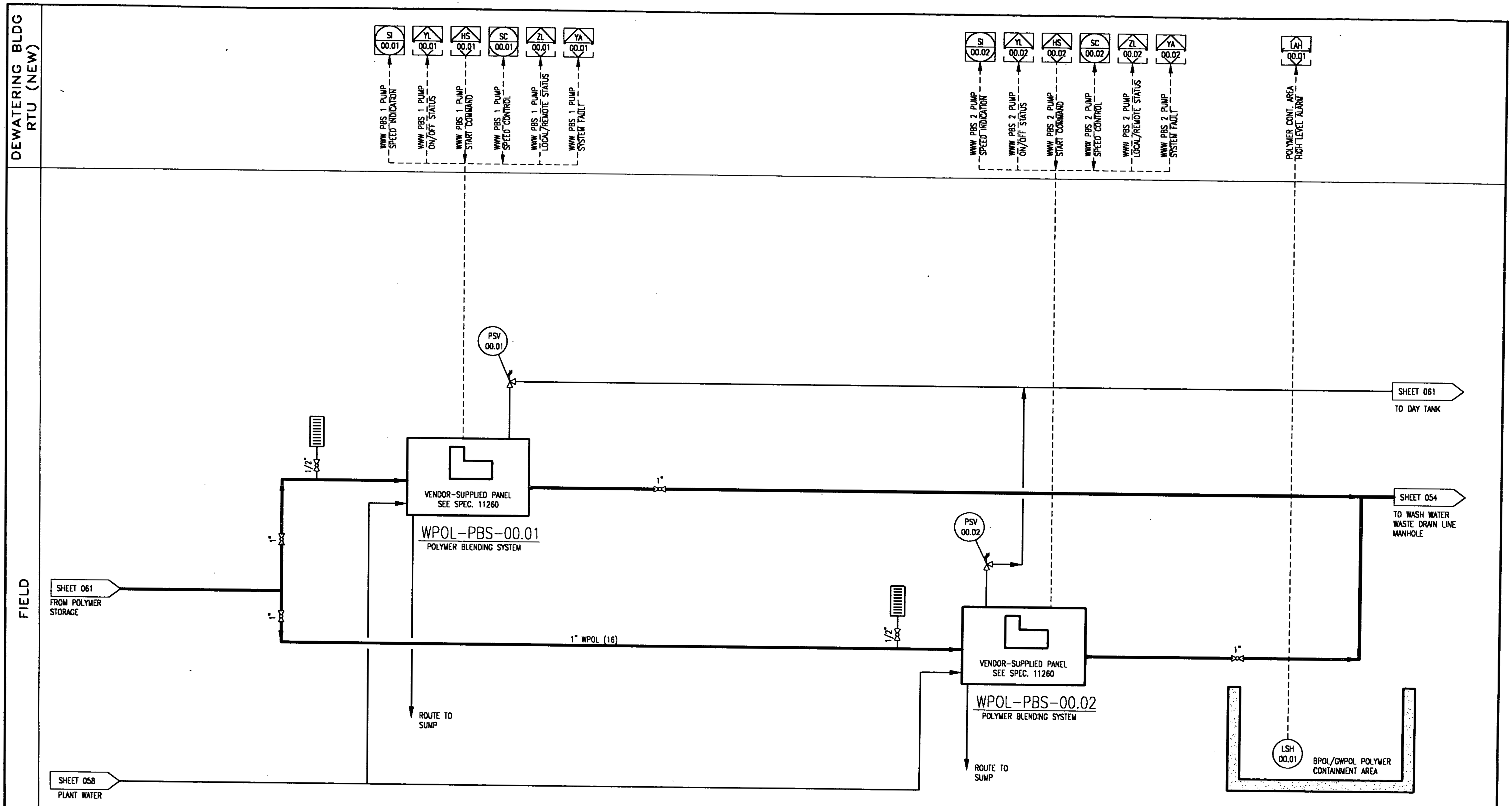
INSTRUMENTATION
GRAVITY THICKENER PBS P & ID

MONTGOMERY WATSON

DRAWN BY: DLS
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-062



DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

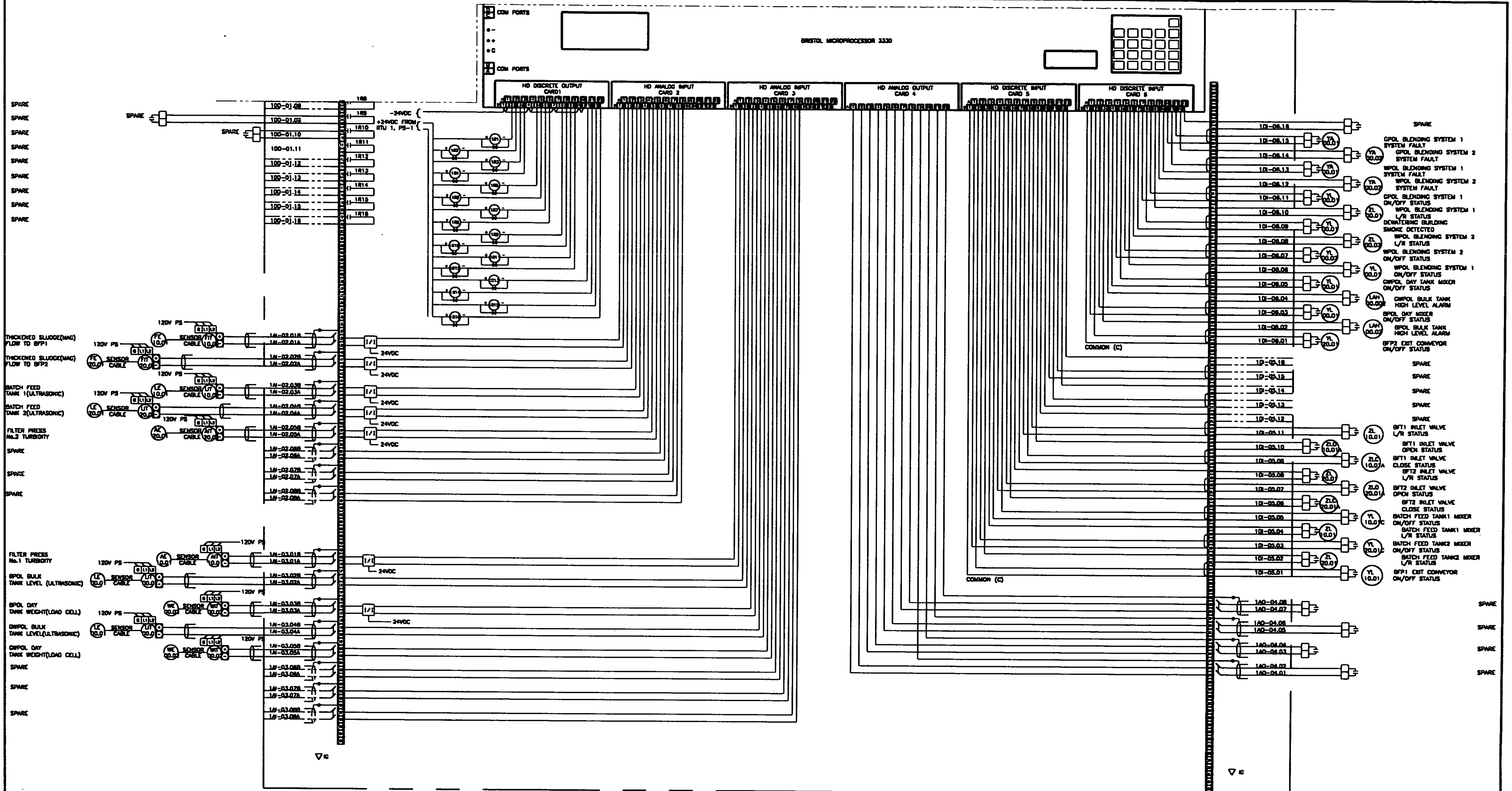
INSTRUMENTATION
WASH WATER WASTE PBS P & ID

MONTGOMERY WATSON

DRAWN BY: DLS
PROJECT ENG'R: DLS
APPROVED: KMM
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-063



NOTE:
ALL TERMINALS NUMBERS TO BE VERIFIED BY BRISTOL BABCOCK

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHLIEBACH
19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

DEWATERING BUILDING RTU (1 of 2) INTERCONNECTION DRAWING

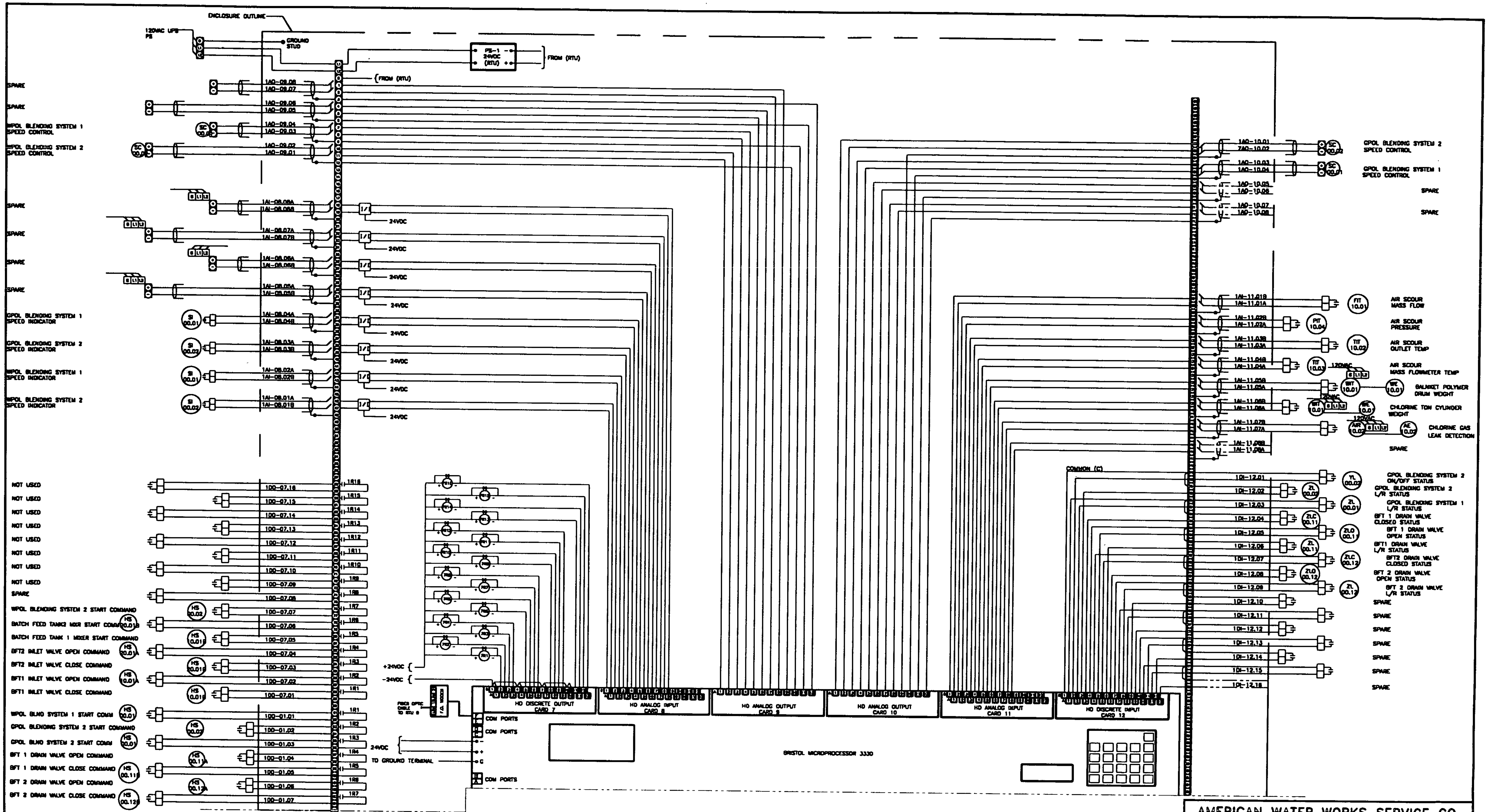
MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM

DATE: JUNE 1999 USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-064



NOTE:
ALL TERMINALS AND PORT NUMBERS TO BE VERIFIED BY BRISTOL BABCOCK

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY – AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

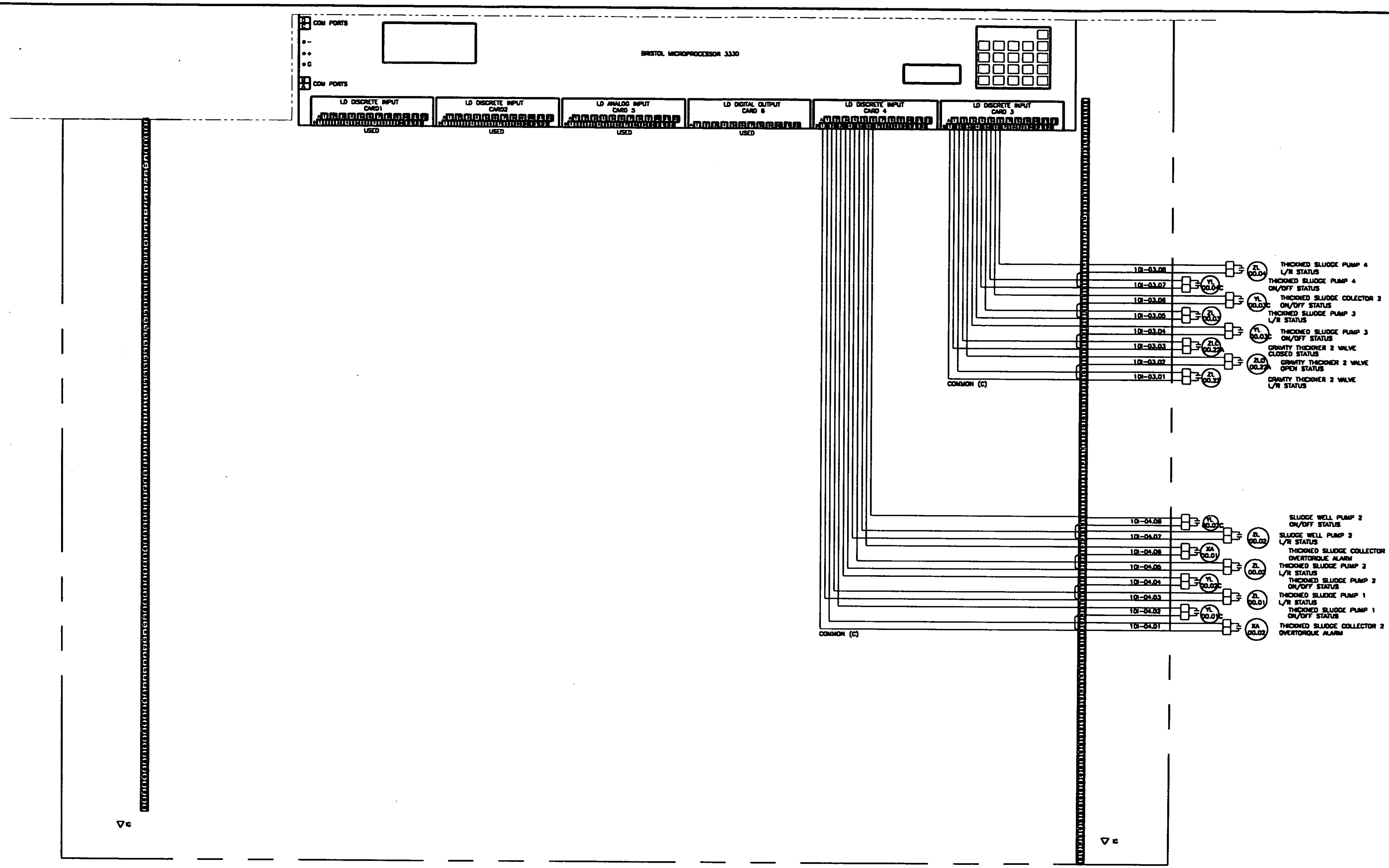
DEWATERING BUILDING RTU (2 OF 2)
INTERCONNECTION DRWAING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999 USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-065



NOTE:
ALL TERMINAL TO BE FIELD VERIFIED

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

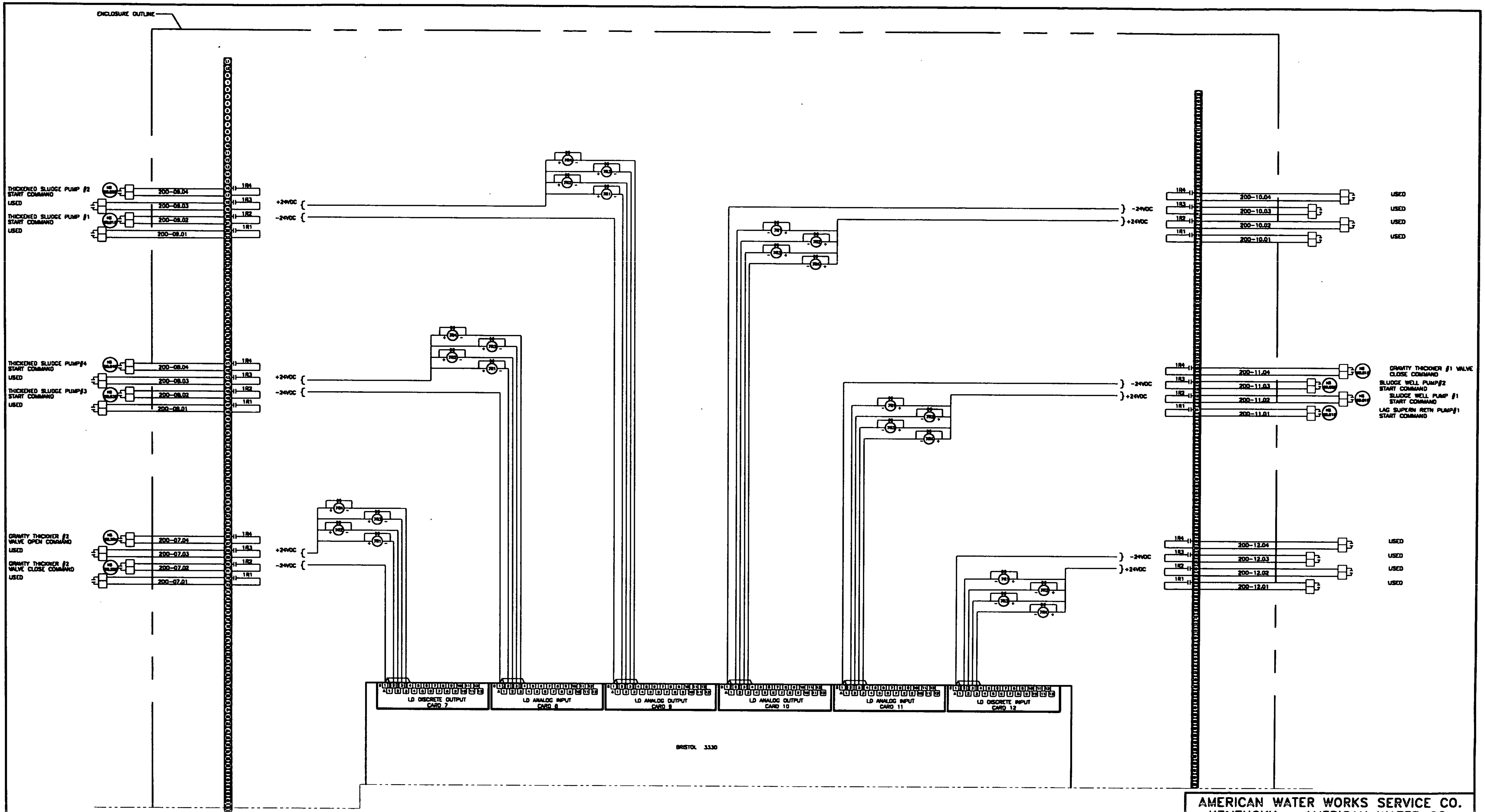
YARD RTU-B (EXISTING)(1 OF 4)
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999 USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-066



NOTE: ALL TERMINAL NUMBERS TO BE FIELD VERIFIED BY CONTRACTOR

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED
PROFESSIONAL ENGINEER

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY – AMERICAN WATER CO.

KENTUCKY RIVER STATION
ADDITIONAL RESIDUALS PROCESSING FACILITIES

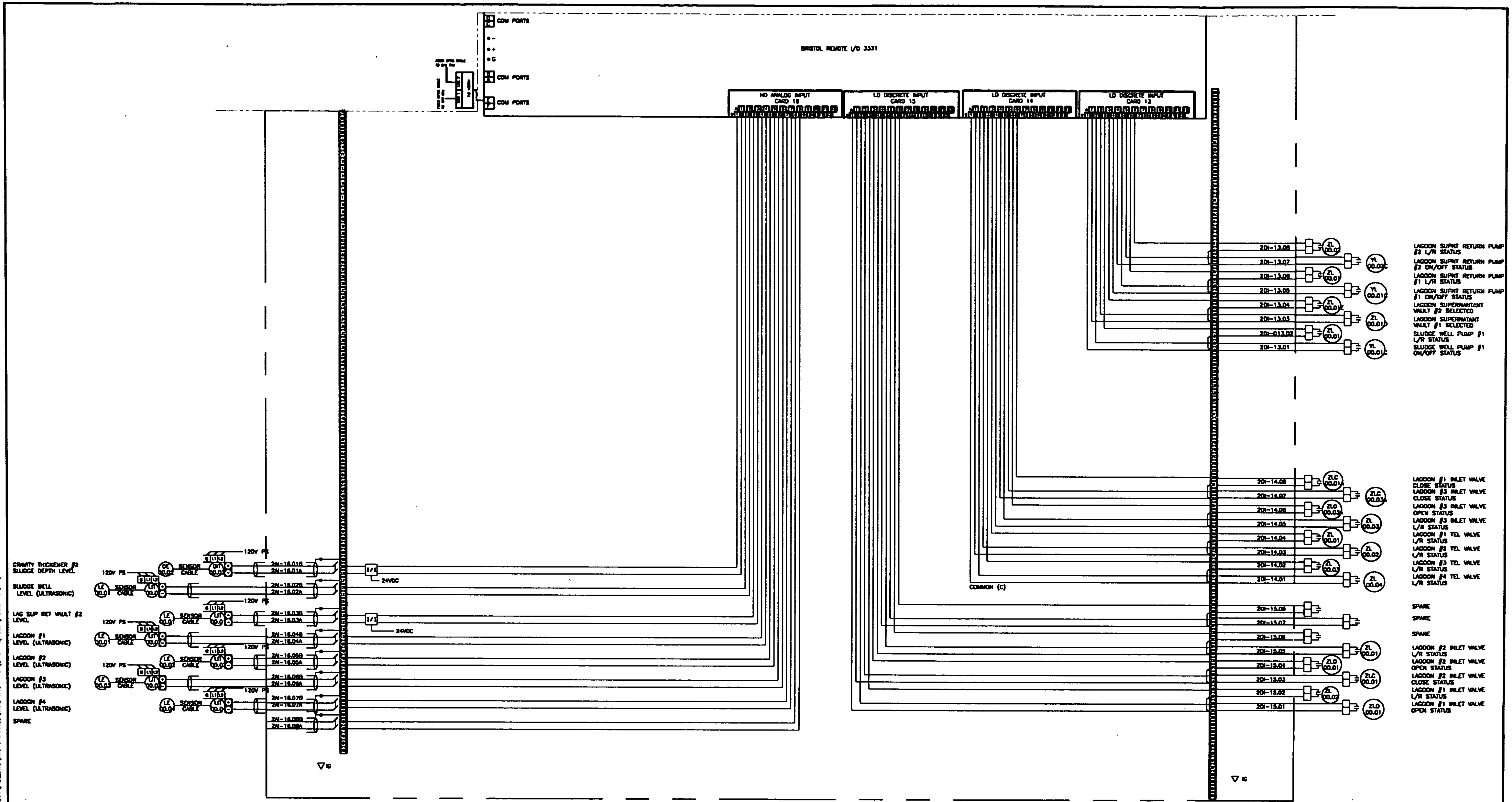
YARD RTU B(EXISTING) (2 OF 4)
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999
USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-067



NOTE:
1.CARD No. 16 IS EXISTING, AND IS A LOW DENSITY AI CARD.
THIS CARD MUST BE REPLACED WITH A HIGH DENSITY AI CARD
2. ALL TERMINAL AND PORT NUMBERS TO BE FIELD VERIFIED BY CONTRACTOR

DATE	REVISIONS

STATE OF KENTUCKY REGISTERED PROFESSIONAL ENGINEER 15941

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY - AMERICAN WATER CO.

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

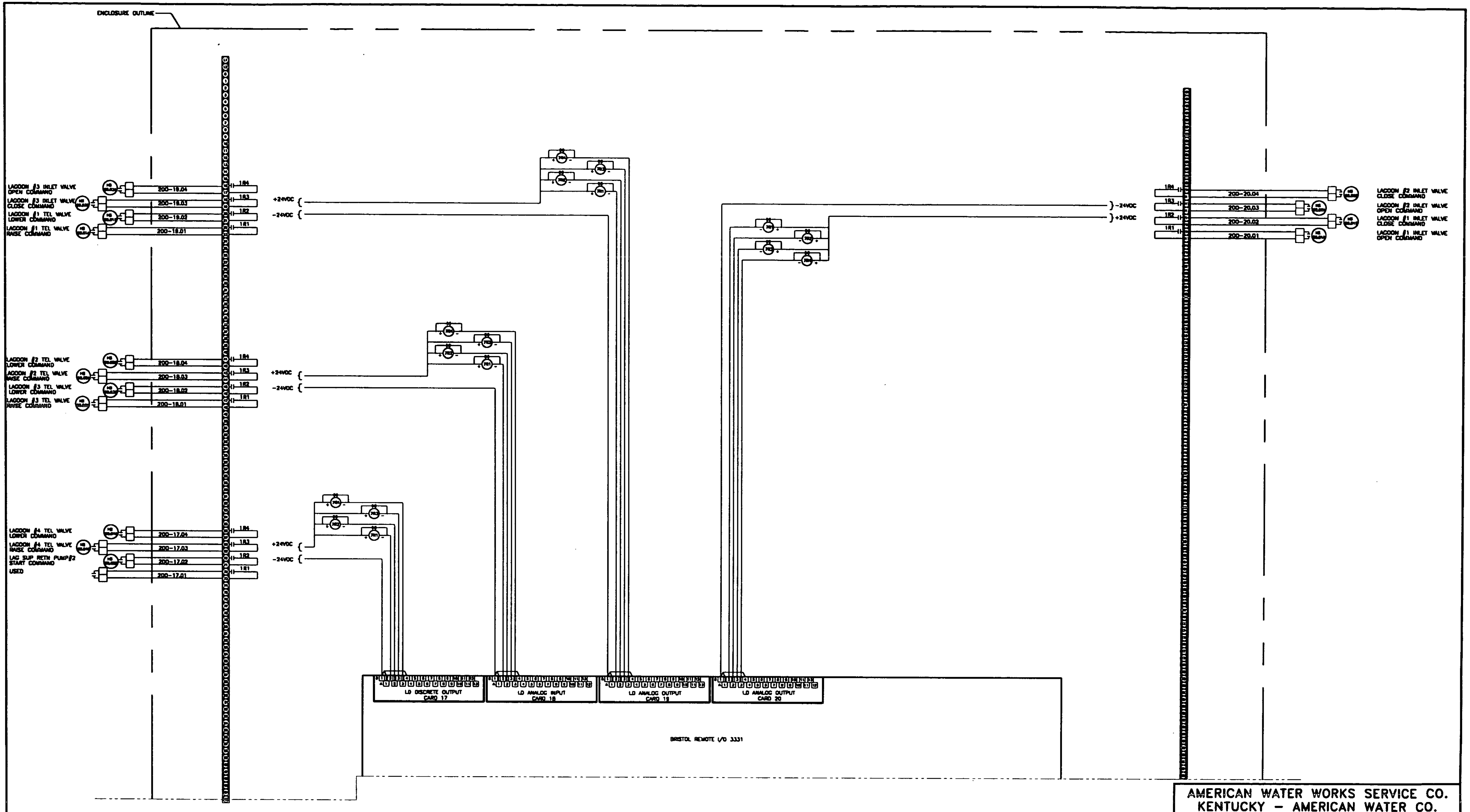
YARD RTU - B (EXISTING) (3 OF 4)
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999
USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-068



NOTE: ALL TERMINAL NUMBERS TO BE FILED VERIFIED BY CONTRACTOR

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED
PROFESSIONAL ENGINEER

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY - AMERICAN WATER CO.

KENTUCKY RIVER STATION
ADDITIONAL RESIDUALS PROCESSING FACILITIES

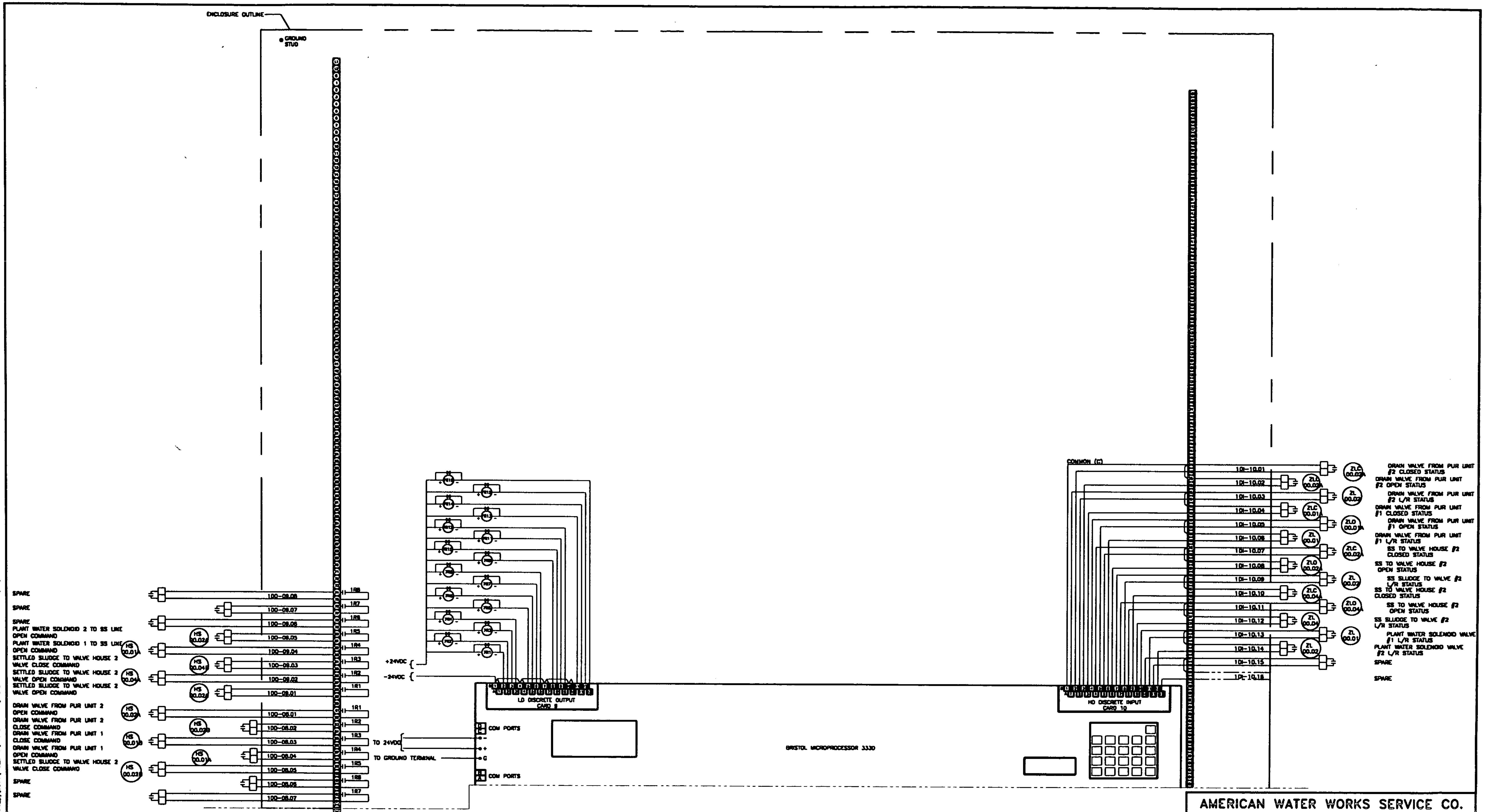
YARD RTU B(EXISTING) (4 OF 4)
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999
USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-069



DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY – AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

VALVE HOUSE No.1 RTU
INTERCONNECTION DRAWING

MONTGOMERY WATSON

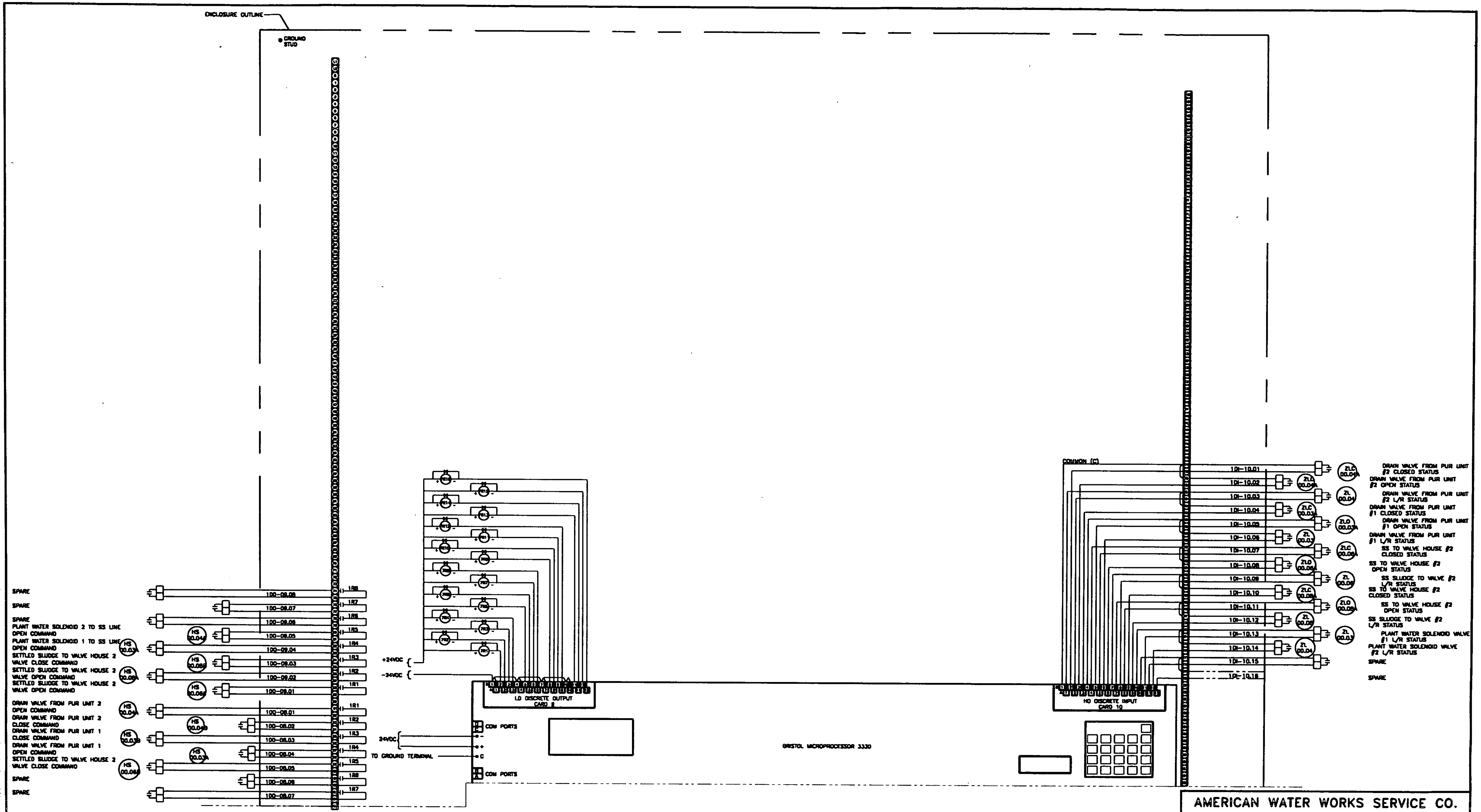
DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM

DATE: JUNE 1999 USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-070

NOTE: ALL FIELD TERMINAL NUMBERS TO BE FIELD VERIFIED FROM BY THE CONTRACTOR



NOTE: ALL FIELD TERMINALS TO BE VERIFIED BY THE CONTRACTOR

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY – AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

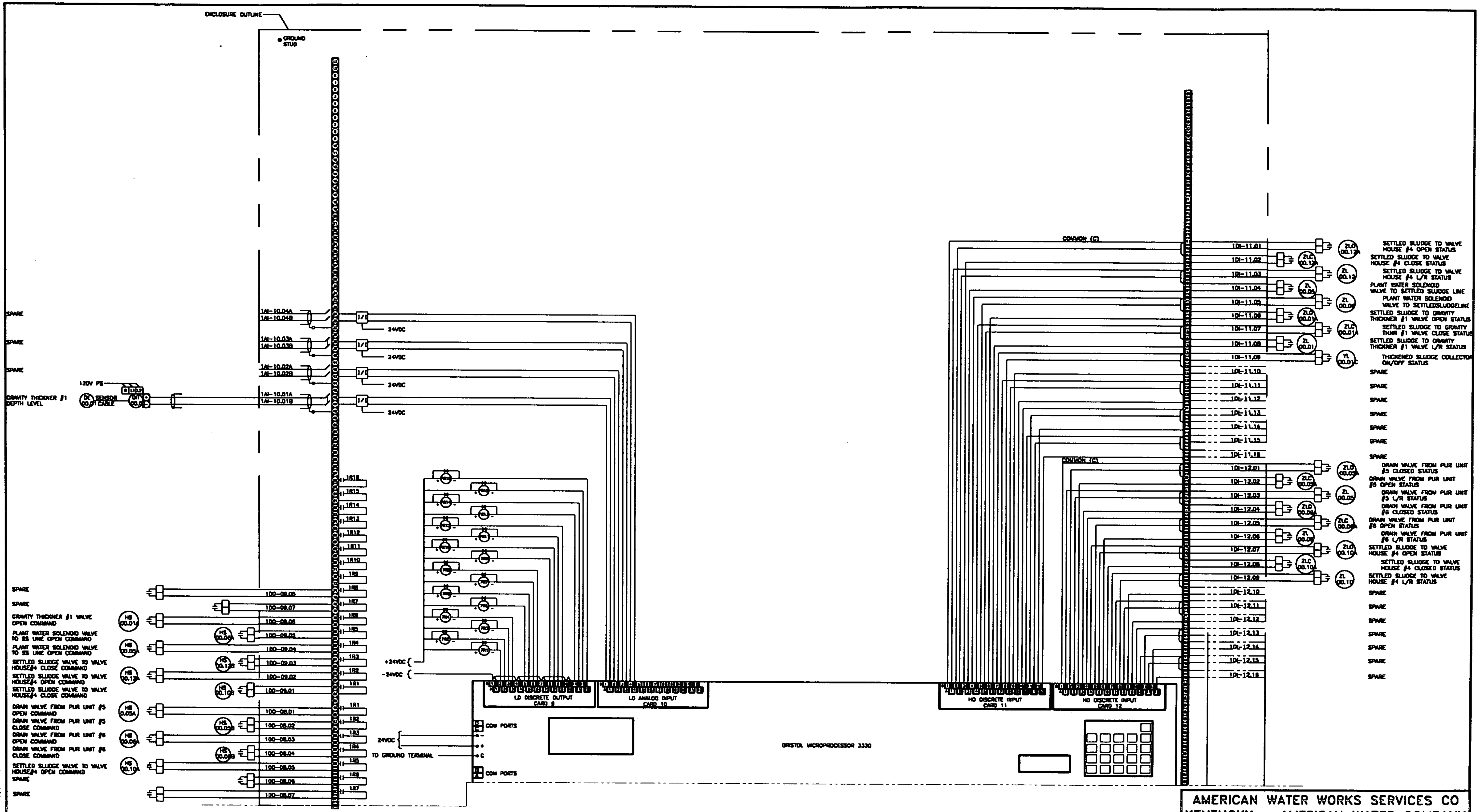
VALVE HOUSE No.2 RTU
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999
USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-071



NOTE: ALL FIELD TERMINAL NUMBERS TO BE VERIFIED BY CONTRACTOR

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICES CO
KENTUCKY – AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

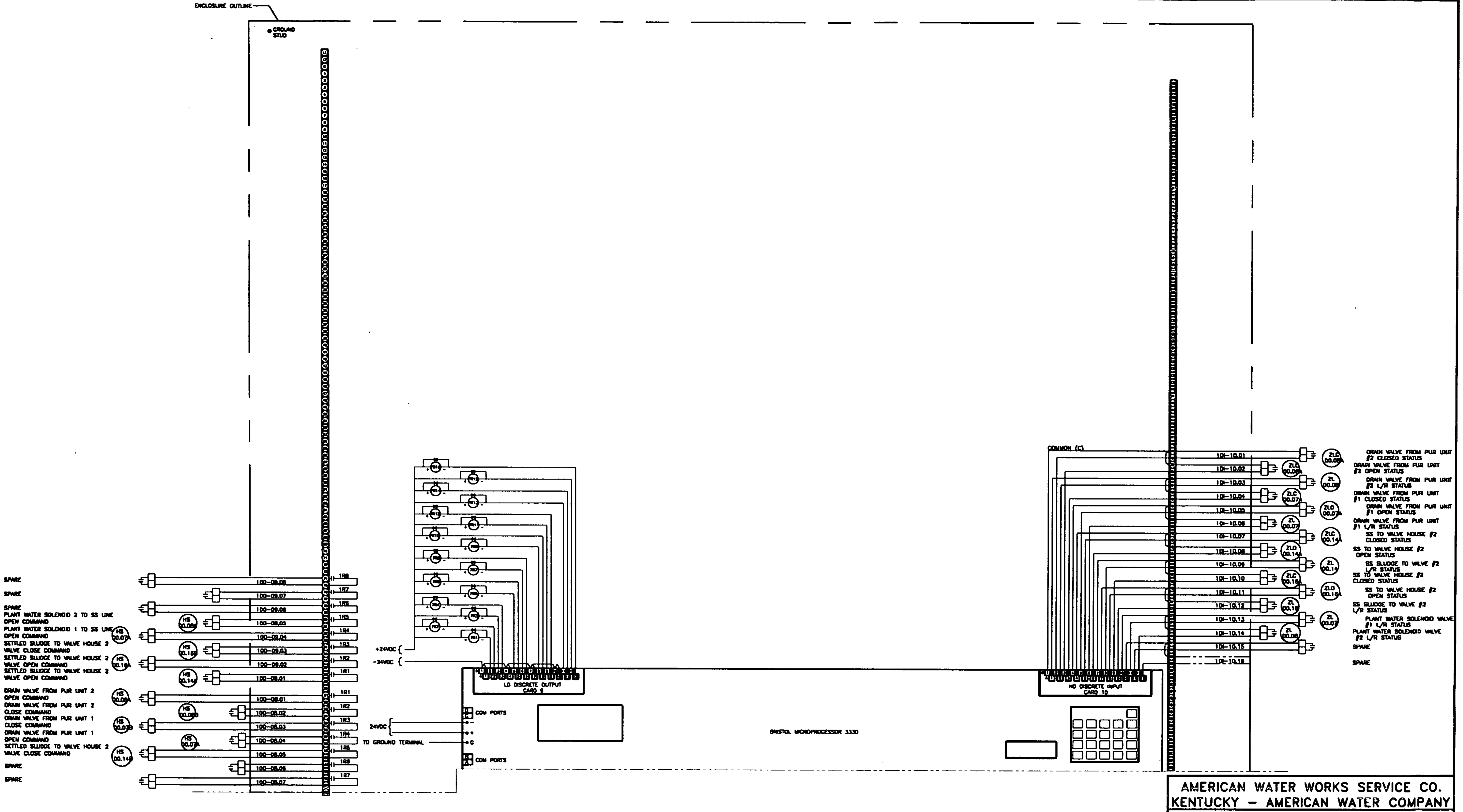
VALVE HOUSE NO.3 RTU
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999
USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-072



NOTE: ALL FIELDTERMINAL NUMBERS TO BE VERIFIED BY THE CONTRACTOR

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED
PROFESSIONAL ENGINEER

WARNING
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY – AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

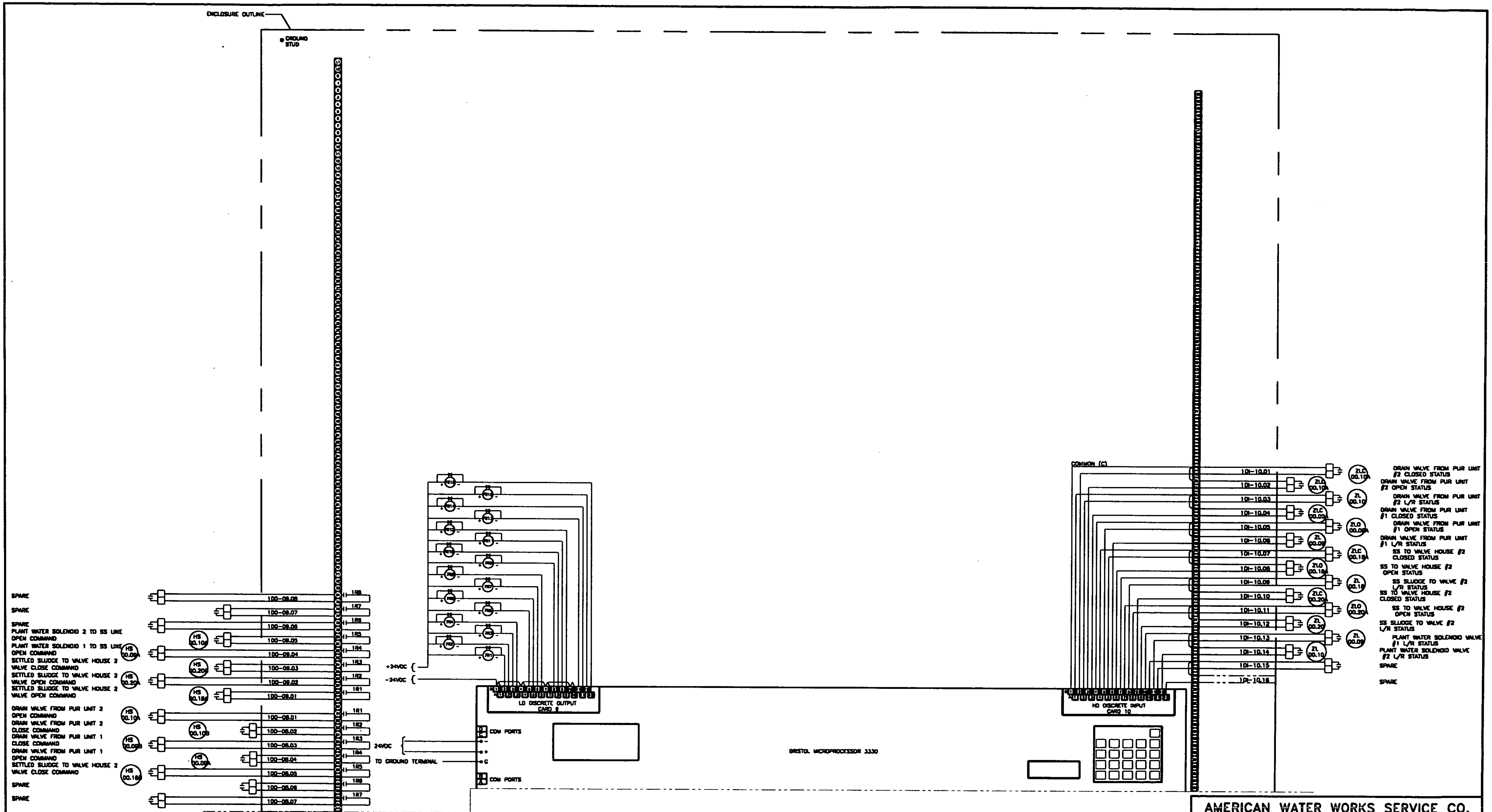
VALVE HOUSE No.4 RTU
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM
DATE: JUNE 1999 USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-073



NOTE: ALL FIELD TERMINAL NUMBERS TO BE VERIFIED BY CONTRACTOR

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUERICH
19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY – AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

VALVE HOUSE No.5 RTU
INTERCONNECTION DRAWING

MONTGOMERY WATSON

DRAWN BY: CJR
PROJECT ENG'R: DLS
APPROVED: KM

DATE: JUNE 1999 USE DIMENSIONS ONLY
NTS

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-074

GENERAL NOTES

1. ALL CONDUIT AND EQUIPMENT SHALL BE INSTALLED AND GROUNDED IN ACCORDANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRICAL CODE AND APPLICABLE LOCAL CODES.
2. CONDUIT RUNS ARE SHOWN DIAGRAMMATICALLY ONLY AND SHALL BE INSTALLED IN A MANNER TO PREVENT CONFLICTS WITH EQUIPMENT AND STRUCTURAL CONDITIONS. EXPOSED CONDUIT SHALL BE INSTALLED PARALLEL OR PERPENDICULAR TO BEAMS AND WALLS. REFER TO SPECIFICATION 16110.
3. CONDUITS SHALL BE TERMINATED SO AS TO PERMIT NEAT CONNECTIONS TO MOTORS AND OTHER EQUIPMENT.
4. THE WIRING DIAGRAMS, QUANTITY AND SIZE OF WIRES AND CONDUIT REPRESENT A SUGGESTED ARRANGEMENT BASED UPON SELECTED STANDARD COMPONENTS OF ELECTRICAL EQUIPMENT. MODIFICATIONS ACCEPTABLE TO THE OWNER MAY BE MADE BY THE CONTRACTOR TO ACCOMMODATE EQUIPMENT ACTUALLY PURCHASED. THE BASIC SEQUENCE AND METHOD OF CONTROL MUST BE MAINTAINED AS INDICATED ON THE DRAWINGS AND/OR SPECIFICATIONS.
5. ALL SURFACE MOUNTED PANELS AND PANELBOARDS SHALL BE MOUNTED SO AS TO MAINTAIN A 1/4" AIR SPACE BETWEEN THE ENCLOSURE AND THE WALL.
6. ALL PANELBOARDS SHALL BE MOUNTED SO THAT THE DISTANCE FROM THE TOP CIRCUIT BREAKER OPERATING HANDLE TO THE FLOOR SHALL NOT EXCEED 6'-6".
7. LIGHTING FIXTURES SHALL BE MOUNTED ACCORDING TO THE MOUNTING HEIGHT GIVEN ON THE DRAWINGS, WITH THE DISTANCE BEING MEASURED FROM THE BOTTOM OF THE LIGHTING FIXTURE TO THE FINISHED FLOOR.
8. FOR EXPLANATION OF INSTRUMENTATION SYMBOLS SHOWN IN ELECTRICAL DRAWINGS, SEE INSTRUMENTATION LEGEND AND NOTES SHEET.
9. OUTLETS, SWITCHES, JUNCTION, PULL, AND TERMINAL BOXES SHALL BE PROVIDED WITH NEMA ENCLOSURES AS INDICATED IN SPECIFICATION SECTIONS 16050 AND 16110.
10. ALL CONDUIT RUNS CROSSING EXPANSION JOINTS SHALL HAVE EXPANSION OR EXPANSION AND DEFLECTION TYPE FITTINGS. FOR EXACT LOCATIONS OF EXPANSION JOINTS, SEE STRUCTURAL DRAWINGS.
11. MCC COMPARTMENT DESIGNATIONS AS INDICATED BELOW:

    BLANK/SPACE: CONTAINS NECESSARY BUS AND HARDWARE FOR FUTURE ADDITION OF BREAKERS OR STARTERS.

    SPARE: CONTAINS A COMPLETE BREAKER OR STARTER INSTALLED. SIZE AS INDICATED, AVAILABLE FOR FUTURE USE.
12. ALL MOTOR STARTER CONTROL TRANSFORMERS SHALL BE SIZED TO PROVIDE SUFFICIENT VOLT-AMPERE CAPACITY FOR OPERATING ALL ELECTRICAL DEVICES ASSOCIATED WITH CONTROL OF THE MOTOR IN ADDITION TO THE STARTER COIL. IT SHALL INCLUDE RELAYS, TIMERS MOTOR HEATERS, INDICATING LIGHTS, ETC.
13. THE CONTRACTOR SHALL VERIFY EXACT LOCATION OF TERMINAL BOXES AND CONDUIT ENTRANCES OF ALL EQUIPMENT AGAINST SHOP DRAWINGS BEFORE STUBBING UP CONDUITS.
14. MOTOR CONTROL CENTERS AND ALL FREE STANDING PANELS SHALL BE SET ON CONCRETE PADS AND LEVELING CHANNELS EMBEDDED IN PAD.
15. ALL RECEPTACLES IN OUTDOOR AND ANTICIPATED WET AREAS SHALL BE GROUND FAULT CIRCUIT INTERRUPTER RECEPTACLES (GFCI).
16. LOCATION OF PULLBOXES ARE APPROXIMATE. CONTRACTOR SHALL COORDINATE EXACT LOCATION OF PULLBOXES WITH MECHANICAL PIPING AND SHALL BE AWAY FROM MECHANICAL PIPING FLOW LINES.
17. ONLY MAJOR PULL BOXES ARE SHOWN. CONTRACTOR SHALL PROVIDE ADDITIONAL PULLBOXES WHERE THEY ARE REQUIRED TO MAKE A WORKABLE INSTALLATION. ELECTRICAL CONTRACTOR SHALL PROVIDE SUITABLE JUNCTION BOX NEXT TO ANY ELECTRICAL DEVICE WITH PIG TAIL SUCH AS SOLENOID VALVE, PRESSURE SWITCH, LIMIT SWITCH, SMOKE DETECTOR, MOTORIZED VALVE, ETC. FOR PROPER ELECTRICAL CONNECTION. PROVIDE SUITABLE HARDWARE FOR MOUNTING OF JUNCTION BOX.
18. REFER TO SPECIFICATION 16110 FOR REQUIREMENTS RELATED TO FLEXIBLE CONDUIT INSTALLATION.
19. SEPARATE POWER AND LOW VOLTAGE SIGNAL WIRING.
    A. PROVIDE SEPARATE CONDUITS, PULL AND JUNCTION BOXES AS SHOWN ON THE DRAWINGS.
    B. PROVIDE SUITABLE CABLE BARRIER WITHIN PULL OR JUNCTION BOXES WHERE SEPARATION OF POWER AND LOW VOLTAGE WIRING IS NOT SHOWN ON THE DRAWINGS.
    C. SEPARATE CONDUITS WITH THERMOCOUPLE WIRES FROM 120V AND 480V POWER CONDUITS BY THE DISTANCE OF AT LEAST 12".
20. EQUIPMENT LOCK-OUTS SHALL BE IN STRICT ACCORDANCE WITH THE OWNER'S REQUIREMENTS.

ABBREVIATIONS

GENERAL

AM	AMMETER
AS	AMMETER SWITCH
C-B OR CB	CIRCUIT BREAKER
CM	FIELD CURRENT CALIBRATION MODULE
COM	COMMON
CRX	CONTROL RELAY X
CT	CURRENT TRANSFORMER
DACS	DATA AQUISITION AND CONTROL SYSTEM
DPS	DIFFERENTIAL PRESSURE SWITCH
EO	ELECTRICALLY OPERATED
ETM	ELAPSED TIME METER
F	FUSE
FS	FLOAT SWITCH
GND	GROUND
GFCT	GROUND FAULT CURRENT TRANSFORMER
HPS	HIGH PRESSURE SODIUM
HTR	HEATER
I/O	INPUT/OUTPUT
JB,J, OR PB	JUNCTION OR PULLBOX
KCMIL	THOUSAND CIRCULAR MIL
KAIC	THOUSAND AMPS INTERRUPTING CURRENT
KVA	KILOVOLT AMPERES
KW	KILOWATTS
LCS	LOCAL CONTROL STATION
LP	LIGHTING PANEL
LS	LIMIT SWITCH
LTG	LIGHTING
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR

ABBREVIATIONS

GENERAL (CONT'D)

MOD OR MOL	MOTOR OPERATED DAMPER OR LOUVER
MTD	MOUNTED
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
PLC	PROGRAMMABLE LOGIC CONTROLLER
PS	PRESSURE SWITCH
PT	POTENTIAL TRANSFORMER
PVC	POLY VINYL CHLORIDE
RBAS	RADIO BASED ALARM SYSTEM
REQ'D	REQUIRED
SCHED	SCHEDULE
SD	SMOKE DETECTOR
SPM	SYNCHRONOUS MOTOR PROTECTION AND CONTROL UNIT
SSM	SOLID STATE METERING DEVICE
SSMPU	SOLID STATE MOTOR PROTECTION UNIT
SV	SOLENOID VALVE
SW	SWITCH
TRY	TIME DELAY RELAY Y
UPS	UNINTERRUPTIBLE POWER SUPPLY
VFD	VARIABLE FREQUENCY DRIVE
VAC	VOLTS ALTERNATING CURRENT
W	WATTS
XFMR	TRANSFORMER

PLAN DRAWING SYMBOLS

INCANDESCENT OR HPS (SEE SUBSCRIPT LEGEND BELOW)

FLUORESCENT (SEE SUBSCRIPT LEGEND BELOW)

NIGHT LIGHT

NIGHT LIGHT

EMERGENCY LIGHTING UNIT BATTERY OPERATED, TWO LAMPS - ARROWS INDICATE DIRECTION OF LAMPS

WALL MOUNTED LIGHT

EXIT LIGHT

X A 5b — SUBSCRIPTS: X=FIXTURE TYPE, A=LIGHTING PANEL DESIGNATION 5=CIRCUIT NUMBER, b=SWITCH DESIGNATION

DUPLEX RECEPTACLE (NEMA 5-20R)

QUAD RECEPTACLE- 2 DUPLEX RECEPTACLES

1ø POWER, 208V RECEPTACLE

3ø POWER, 480V RECEPTACLE

A-5 B — SUBSCRIPTS: A=LIGHTING PANEL, 5=CIRCUIT NO. B=TYPE
- -WP WEATHERPROOF
- -XP EXPLOSION PROOF
- -GFCI GROUND FAULT CIRCUIT INTERRUPTER

S_3A-3a — LIGHT SWITCH
- SUB-CIRCUIT IDENTIFICATION
- LTG. PNL. CIRCUIT NO.
- LIGHTING PANEL LP-A
- 3-WAY SWITCH (4=4 WAY)

TELEPHONE OUTLET

LOUDSPEAKER

FIRE ALARM CABINET

FIRE ALARM PULL STATION

PLAN DRAWING SYMBOLS (CONT'D)

HD — HEAT DETECTOR

SD — SMOKE OR ION DETECTOR

—G— GROUND CONDUCTOR

GROUND ROD

F — FREEZESTAT

CONDUITS:
- EXPOSED
- ENCASED IN FLOOR, WALL OR BELOW GRADE
- CONCEALED IN CEILING OR BELOW FLOOR
- CONDUITS GROUPED TOGETHER, BUT SHOWN AS A SINGLE LINE FOR CLARITY

CONDUIT TURNING UP

CONDUIT TURNING DOWN

FROM FLOOR ABOVE TO FLOOR BELOW

CAPPED

5#12,1"C — NO. OF WIRES, WIRE SIZE, CONDUIT SIZE

X — X=CONDUIT NUMBER (SEE CONDUIT SCHEDULE FOR DETAILS)

TO LP-X, Y — CONDUIT NO. Y HOMERUN TO LP-X

OVERHEAD POWER LINE

J OR J — JUNCTION OR PULLBOX (SIZE AS REQ'D)

F — FIRE ALARM PULL BOX WITH XENON STROBE LIGHT

H — HORN ALARM

S — SIREN ALARM

POWER PANELBOARD 480V, 3ø

LIGHTING PANEL - LP-X ——— EQUIPMENT DESIGNATION (TYP) (VOLTAGE AS SHOWN IN SCHEDULE)

MOTOR CONTROL CENTER, CONTROL PANEL OR LOCAL CONTROL STATION(LCS) SIZE AS INDICATED ON DETAILS OR AS REQUIRED IF NOT INDICATED

MOTOR

TRANSFORMER

COMBINATION CIRCUIT BREAKER TYPE MOTOR STARTER

30 — UNFUSED DISCONNECT SWITCH, AMPERAGE RATING AS SHOWN

T — THERMOSTAT

S — SWITCH: FLOAT(LEVEL)-FS, LIMIT-LS PRESS & VACUUM-PS, TEMP-TS

SV — SOLENOID VALVE

M — MOTOR OPERATED DAMPER

XX YY ZZ.ZZ — FIELD MOUNTED DEVICE TAG NO. XX-YY-ZZ.ZZ REFER TO INSTRUMENTATION DRAWINGS

DATE	REVISIONS

STATE OF KENTUCKY — ROBERT SCHLEMER — 19941 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

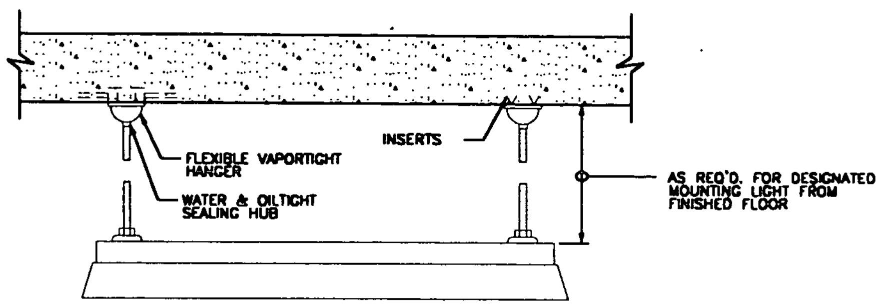
ELECTRICAL
GENERAL SYMBOLS AND NOTES I

MONTGOMERY WATSON

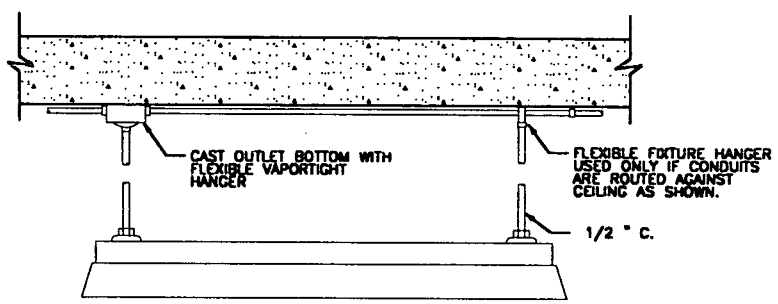
DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-075

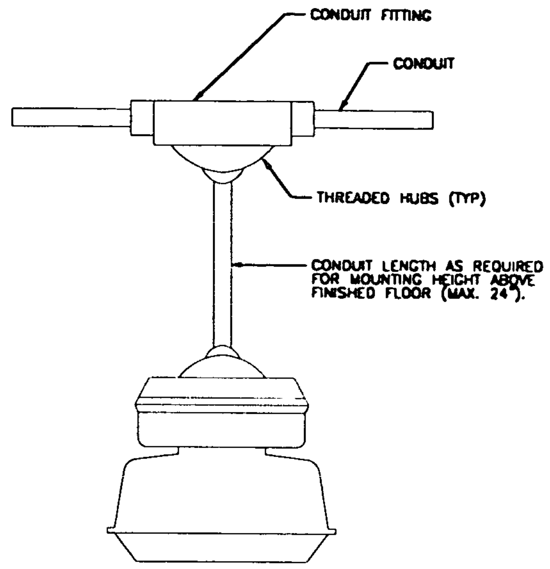


FOR CONCEALED CONDUIT

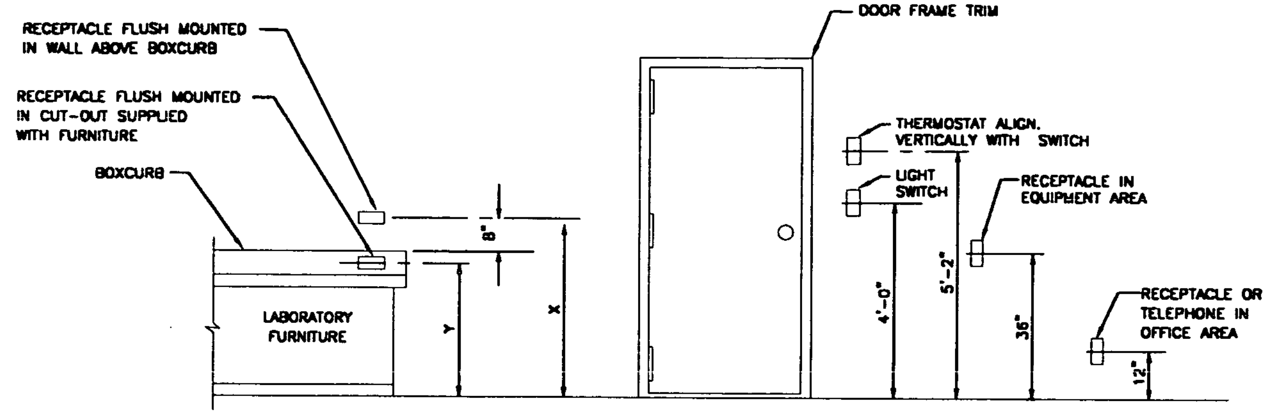


FOR EXPOSED CONDUIT

FIXTURE MOUNTING



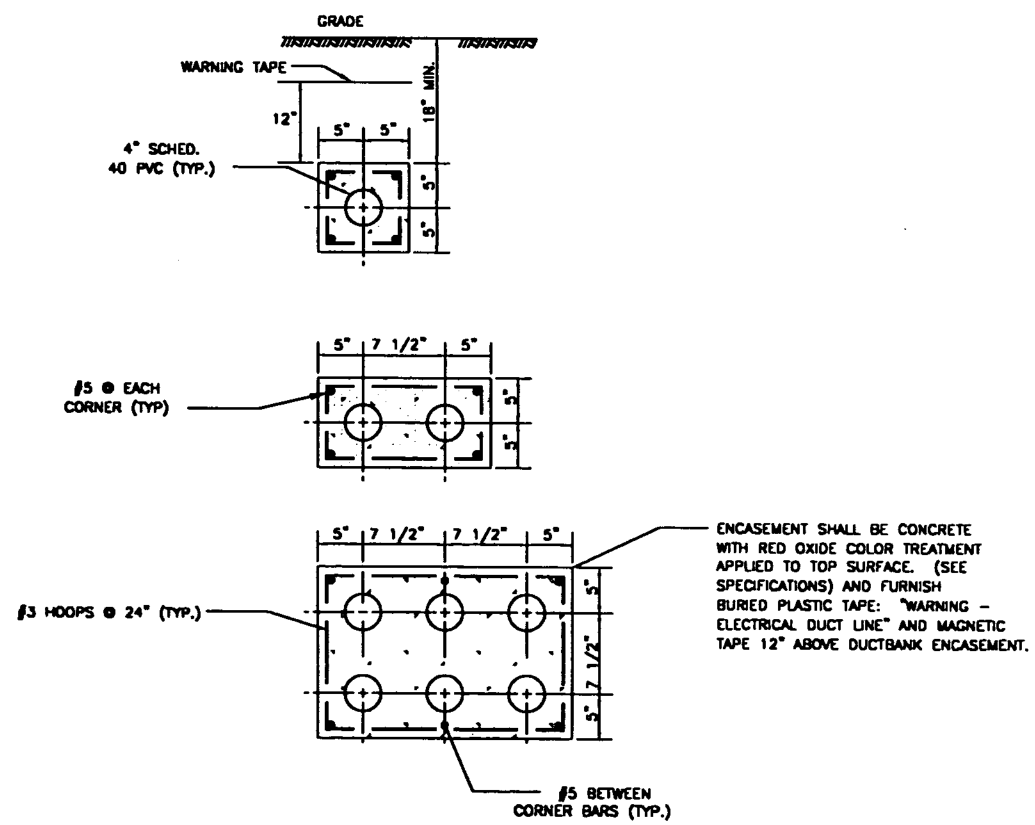
PENDANT MOUNTED LIGHTING FIXTURE



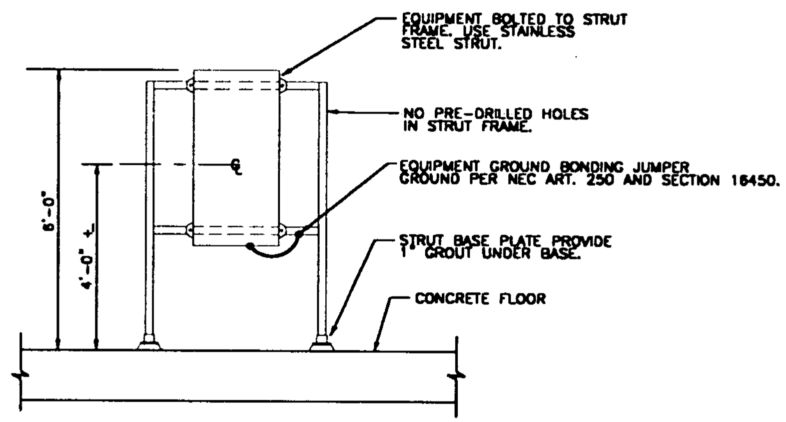
OUTLET BOX MOUNTING

X = CONTRACTOR SHALL DETERMINE OUTLET BOX MOUNTING HEIGHT TO SUIT LABORATORY EQUIPMENT FURNISHED FOR INSTALLATION.

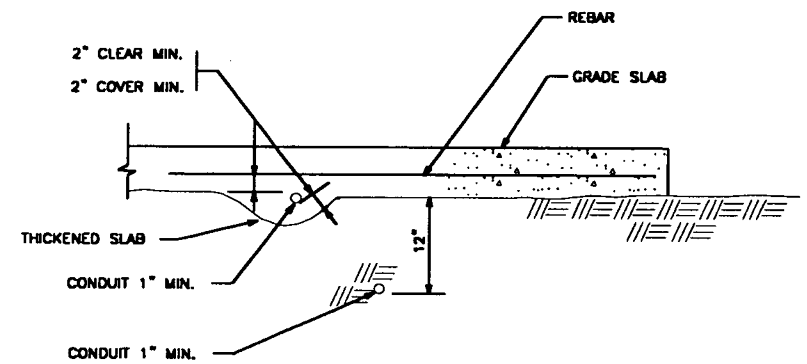
Y = HEIGHT TO MATCH CUTOUT IN FURNITURE.



TYPICAL DUCT BANK ENCASEMENT/
REINFORCEMENT

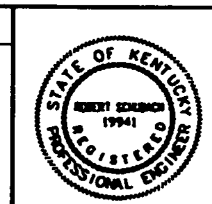


EQUIPMENT MOUNTING
(FREE STANDING)



CONDUIT PLACEMENT
AT GRADE SLAB

DATE	REVISIONS



WARNING
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
STANDARD DETAILS

MONTGOMERY WATSON

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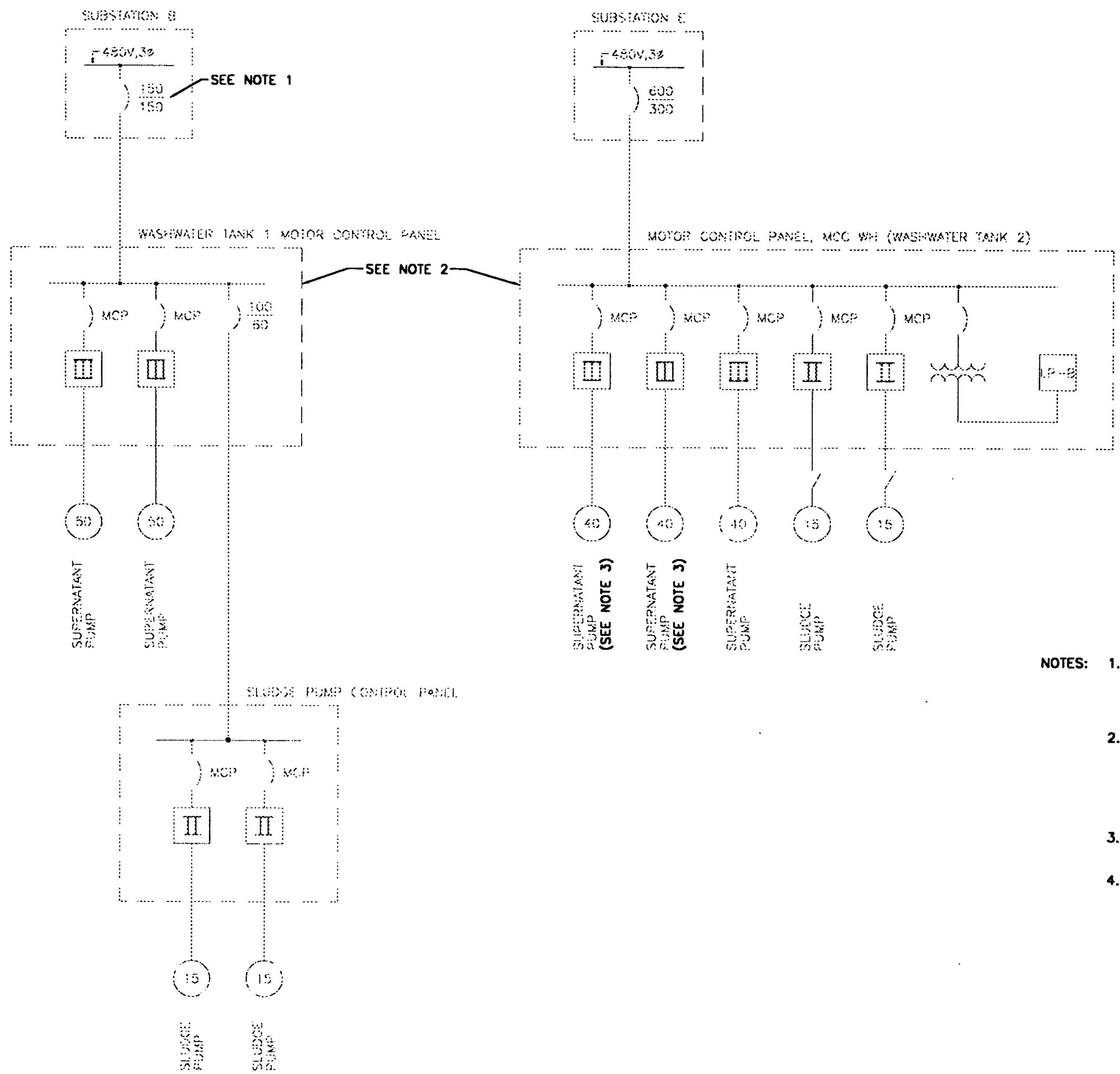
380-575-077



EXISTING PARTIAL ONE-LINES

NOTES:

1. DISCONNECT AND ABANDON THE EXISTING FEEDER CABLES TO THE EXISTING WASHWATER TANK 1 MOTOR CONTROL PANEL. REUSE CIRCUIT BREAKER TO FEED THE NEW SUPERNATANT RETURN VAULT.
2. REMOVE THE EXISTING WASHWATER TANK MOTOR CONTROL PANELS AND REPLACE WITH NEW 480V POWER PANEL AND 120/208 MINI POWER CENTER. CONNECT LOADS AS SCHEDULED ON SHEET 083. RECONNECT OTHER EXISTING LOADS FEED NOT SCHEDULED. (VERIFY EXISTING FEEDS TO LOCAL 480V VALVES AS WELL AS FEEDS TO EXISTING LIGHTING AND RECEPTACLES.
3. RELOCATE TWO OF THE WASHWATER TANK 2 SUPERNATANT PUMPS TO THE NEW LAGOON SUPERNATANT RETURN VAULT NO.2.
4. REFER TO SHEET 079 FOR REVISED PARTIAL ONE-LINES.

DATE	REVISIONS

STATE OF KENTUCKY — ROBERT SCHUBACH — 19941 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
EXISTING PARTIAL ONE-LINES

MONTGOMERY WATSON

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DATE: JUNE 99
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380-575-078

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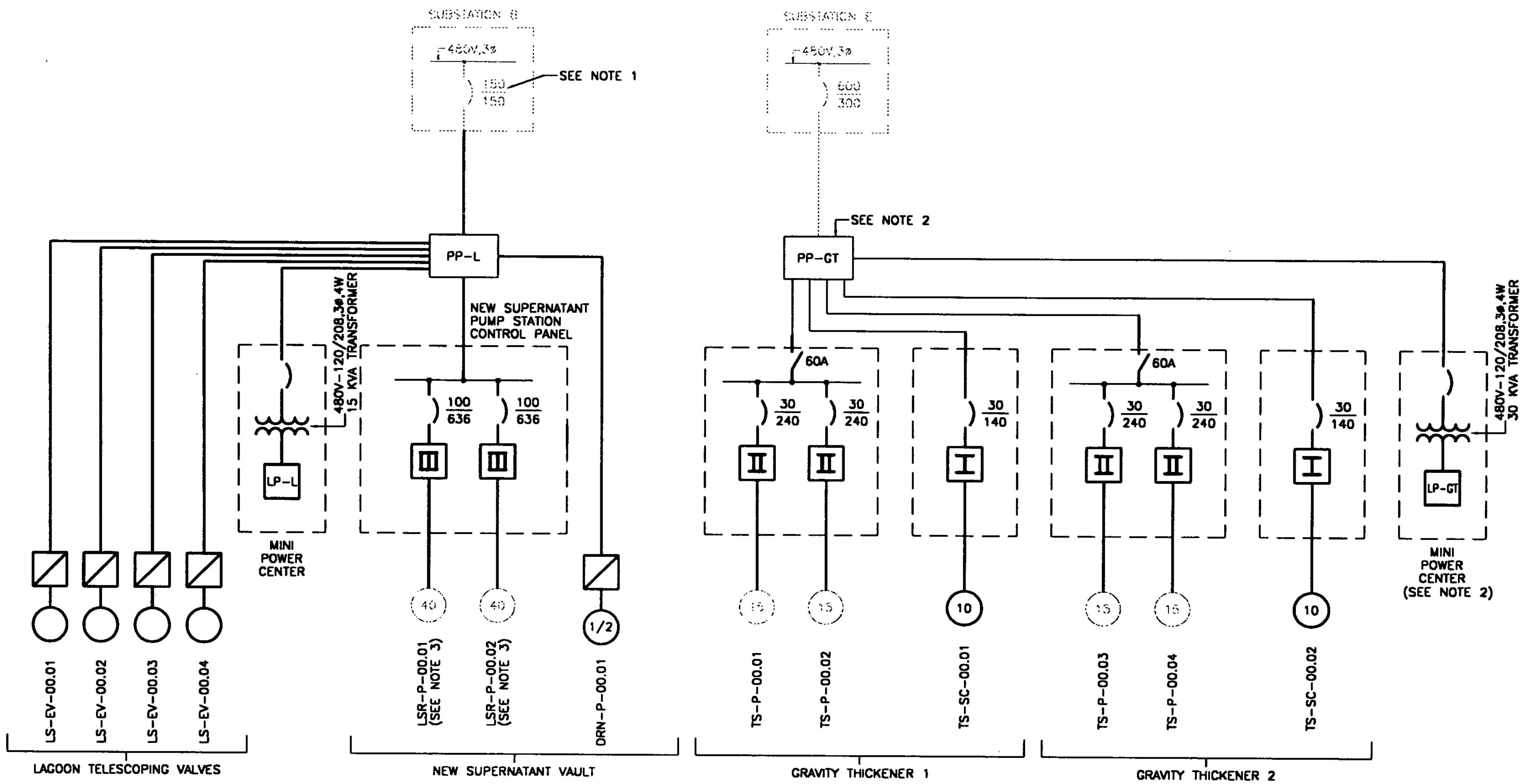

REVISED PARTIAL ONE-LINES

NOTES:

1. DISCONNECT AND ABANDON THE EXISTING FEEDER CABLES TO THE EXISTING WASHWATER TANK 1 MOTOR CONTROL PANEL. REUSE CIRCUIT BREAKER TO FEED THE NEW SUPERNATANT RETURN VAULT.
2. REMOVE THE EXISTING WASHWATER TANK MOTOR CONTROL PANELS AND REPLACE WITH NEW 480V POWER PANEL AND 120/208 MINI POWER CENTER. CONNECT LOADS AS SCHEDULED ON SHEET 083. RECONNECT OTHER EXISTING LOADS FEED NOT SCHEDULED. (VERIFY EXISTING FEEDS TO LOCAL VALVES AS WELL AS FEEDS TO EXISTING LIGHTING AND RECEPTACLES.
3. THE SUPERNATANT RETURN PUMP MOTORS ARE EXISTING PUMPS RELOCATED FROM THE GRAVITY THICKENER AREA.
4. REFER TO SHEET 078 FOR EXISTING PARTIAL ONE-LINES.

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHABACH 19941 REGISTERED PROFESSIONAL ENGINEER

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AMERICAN WATER WORKS SERVICE CO.
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KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
REVISED PARTIAL ONE-LINES

MONTGOMERY WATSON

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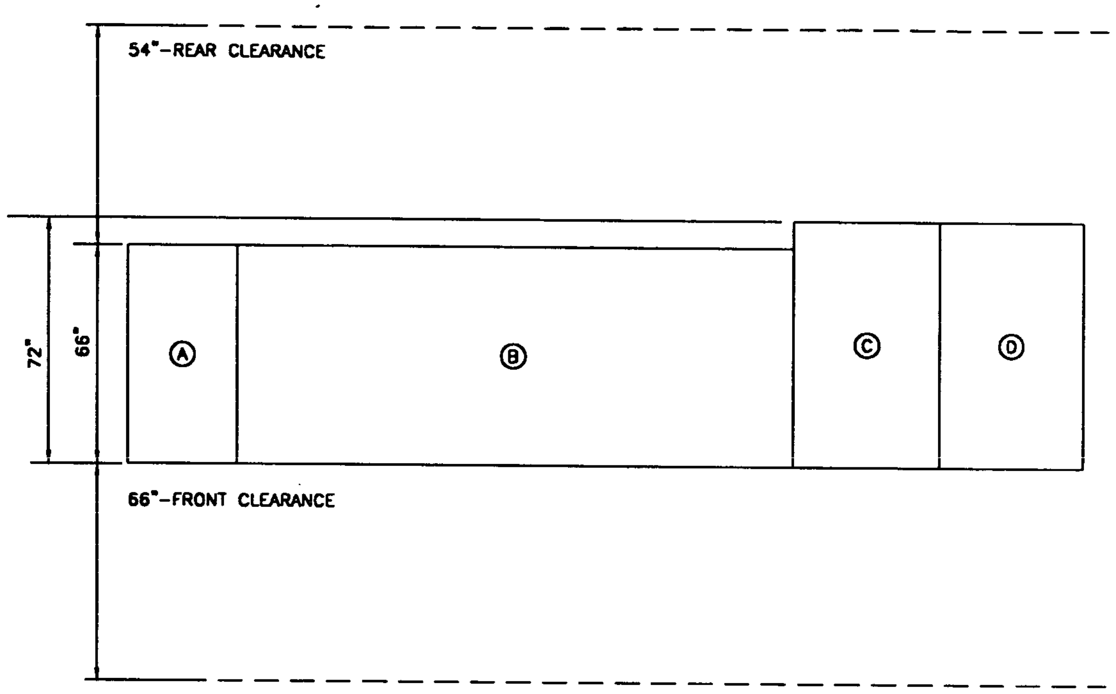
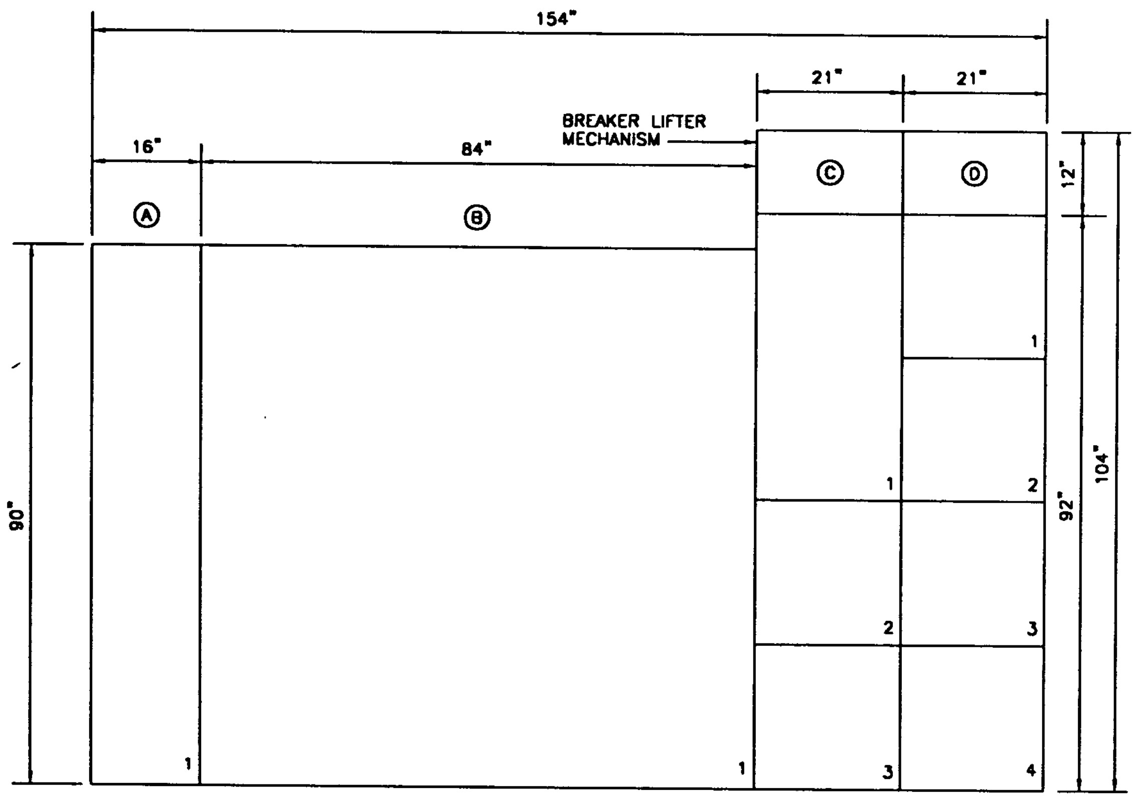
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

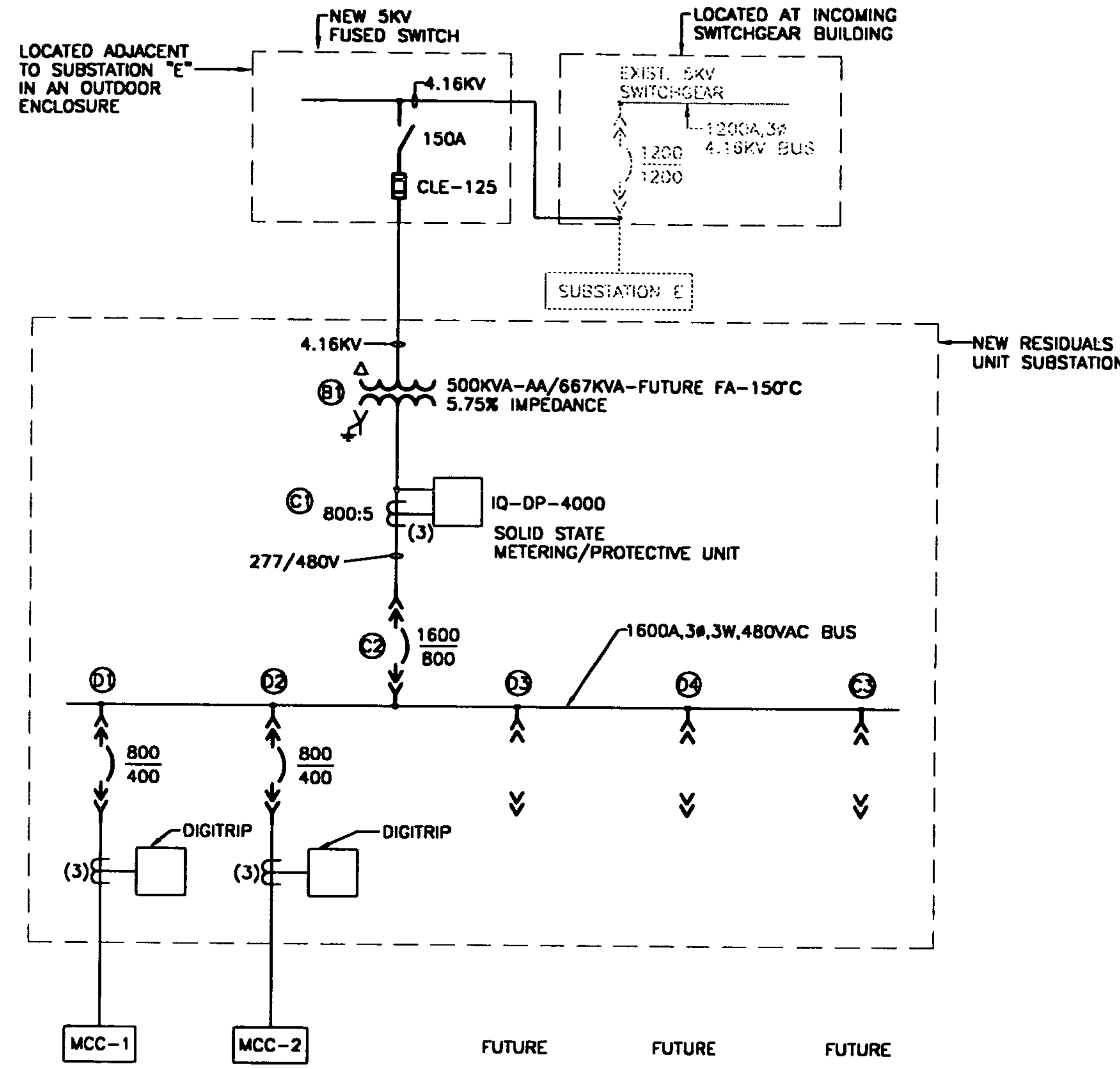
380-575-079



PLAN
NO SCALE



ELEVATION
NO SCALE



ONE-LINE - UNIT SUBSTATION

COMPARTMENT	DESCRIPTION
A1	AIR FILLED TERMINAL CHAMBER
B1	VENTILATED DRY-TYPE TRANSFORMER 500 KVA, 150° RISE, 4.16KV (Δ) - 277/480V (Y)
C1	METERING COMPARTMENT, SOLID STATE METERING AND PROTECTIVE UNIT
C2	MAIN C-B, 1600AF/1200AT, C-H DS II-508 OR EQUAL FROM NAMED MANUFACTURERS
C3	PROVISION FOR FUTURE 800AF FEEDER CIRCUIT BREAKER
D1	FEEDER C-B, MCC-1, 800AF/400AT - C-H DS II-308 OR EQUAL FROM NAMED MANUFACTURERS
D2	FEEDER C-B, MCC-2, 800AF/400AT - C-H DS II-308 OR EQUAL FROM NAMED MANUFACTURERS
D3	PROVISION FOR FUTURE 800AF FEEDER CIRCUIT BREAKER
D4	PROVISION FOR FUTURE 800AF FEEDER CIRCUIT BREAKER

SCHEDULE

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED
PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
ONE-LINE - UNIT SUBSTATION

MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

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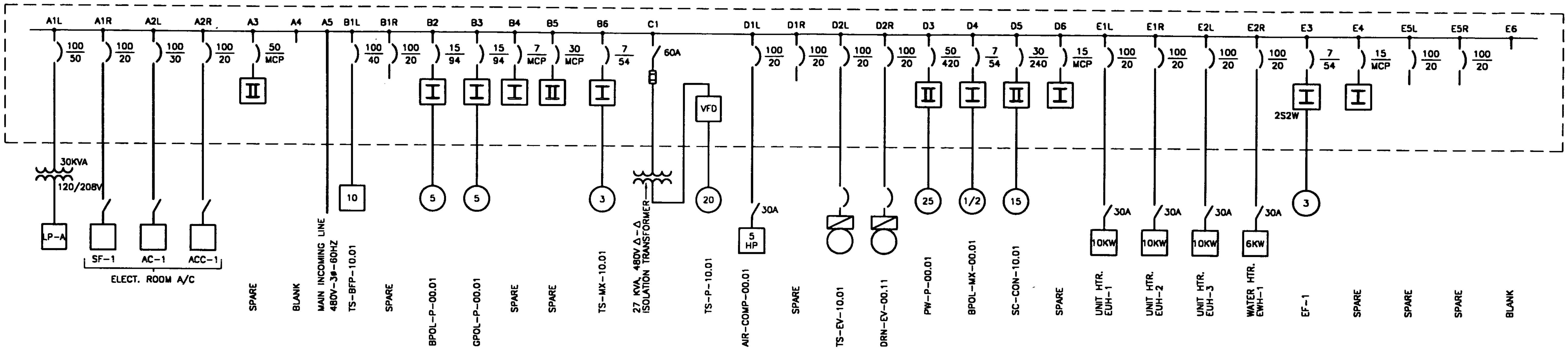
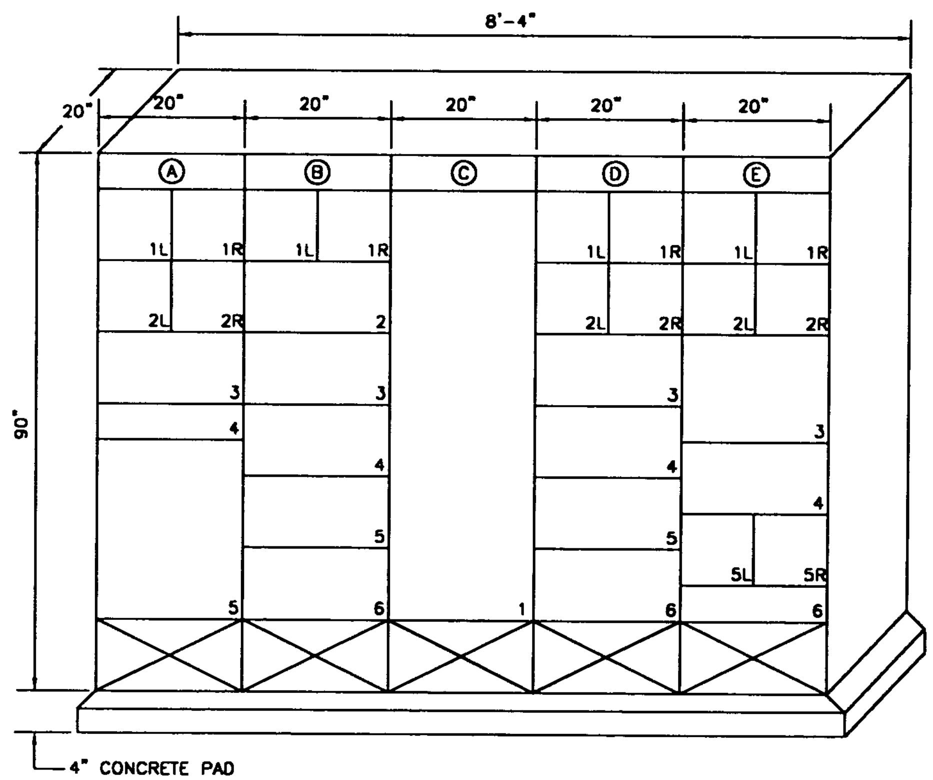
380-575-080



ONE-LINE- MCC-1

COMPARTMENT	DESCRIPTION
A1L	50A-3P-FCB, 30KVA TRANSFORMER AND LP- A
A1R	20A-3P-FCB, SUPPLY FAN SF-1
A2L	40A-3P-FCB, AIR CONDITIONER AC-1
A2R	20A-3P-FCB, CONDENSOR ACC-1
A3	COMB-CB-FVNR, NEMA SIZE 2 STARTER, SPARE
A4	BLANK
A5	400A MAIN LUGS
B1L	40A-3P-FCB, BELT FILTER PRESS TS-BFP-10.01, 10 HP
B1R	20A-3P-FCB, SPARE
B2	COMB CB FVNR NEMA SIZE 1 STARTER, TRANSFER PUMP BPOL-P-00.01, 5 HP
B3	COMB CB FVNR NEMA SIZE 1 STARTER, TRANSFER PUMP GPOL-P-00.01, 5 HP
B4	COMB CB FVNR NEMA SIZE 1 STARTER, SPARE
B5	COMB CB FVNR NEMA SIZE 2 STARTER, SPARE
B6	COMB CB FVNR NEMA SIZE 1 STARTER, BATCH TANK MIXER TS-MX-10.01, 3 HP
C1	VFD AND FUSED DISCONNECT, BELT FILTER PRESS FEED PUMP TS-P-10.01, 20 HP
D1L	20A-3P-FCB, AIR COMPRESSOR AIR-COMP-00.01, 5 HP
D1R	20A-3P-FCB, SPARE
D2L	20A-3P-FCB, BATCH TANK INLET VALVE TS-EV-10.01
D2R	20A-3P-FCB, SPARE
D3	COMB CB FVNR NEMA SIZE 2 STARTER, BOOSTER PUMP PW-P-00.01, 25 HP
D4	COMB CB FVNR NEMA SIZE 1 STARTER, DAY TANK MIXER BPOL-MX-00.01, .5 HP
D5	COMB CB FVNR NEMA SIZE 2 STARTER, BELT CONVEYOR SC-CON-10.01, 15 HP
D6	COMB CB FVNR NEMA SIZE 1 STARTER, SPARE
E1L	20A-3P-FCB, UNIT HEATER UH-1, 10 KW
E1R	20A-3P-FCB, UNIT HEATER UH-2, 10 KW
E2L	20A-3P-FCB, UNIT HEATER UH-3, 10 KW
E2R	20A-3P-FCB, WATER HEATER EWH-1, 6KW
E3	COMB CB 2S2W NEMA SIZE 1 STARTER, EXHAUST FAN EF-1, 3 HP
E4	COMB CB FVNR NEMA SIZE 1 STARTER, SPARE
E5L	20A-3P-FCB, SPARE
E5R	20A-3P-FCB, SPARE
E6	BLANK

SCHEDULE - MCC-1



LAYOUT - MCC-1

NOTES: 1. THE MCC MANUFACTURER MAY ADJUST THE LAYOUT TO ACCOMMODATE ITS STANDARD CIRCUIT BREAKER CONFIGURATION. THE OVERALL MCC DIMENSIONS HOWEVER SHALL REMAIN UNCHANGED.

DATE	REVISIONS

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
MCC-1 ONE-LINE,LAYOUT AND SCHEDULE

MONTGOMERY WATSON

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APPROVED: RS
DATE: JUNE 99
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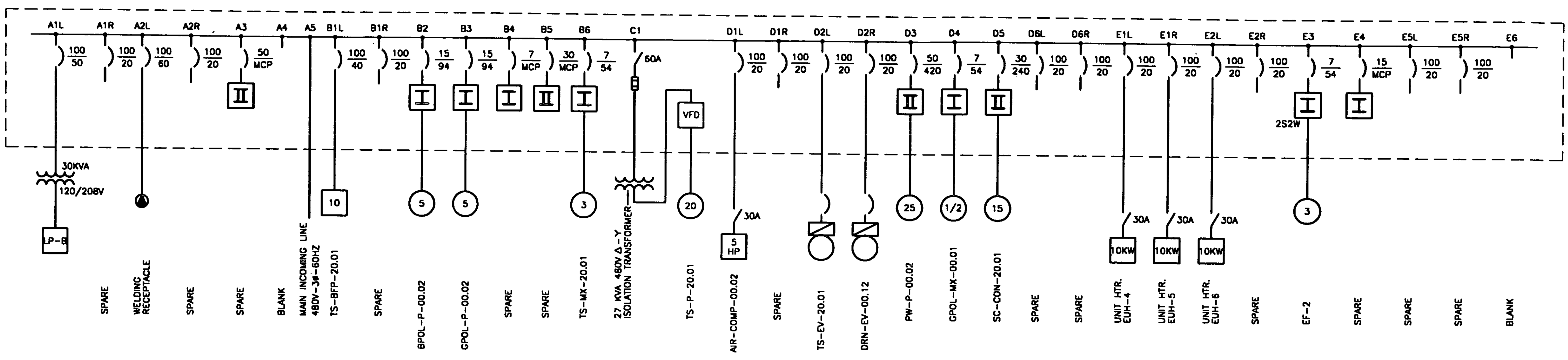
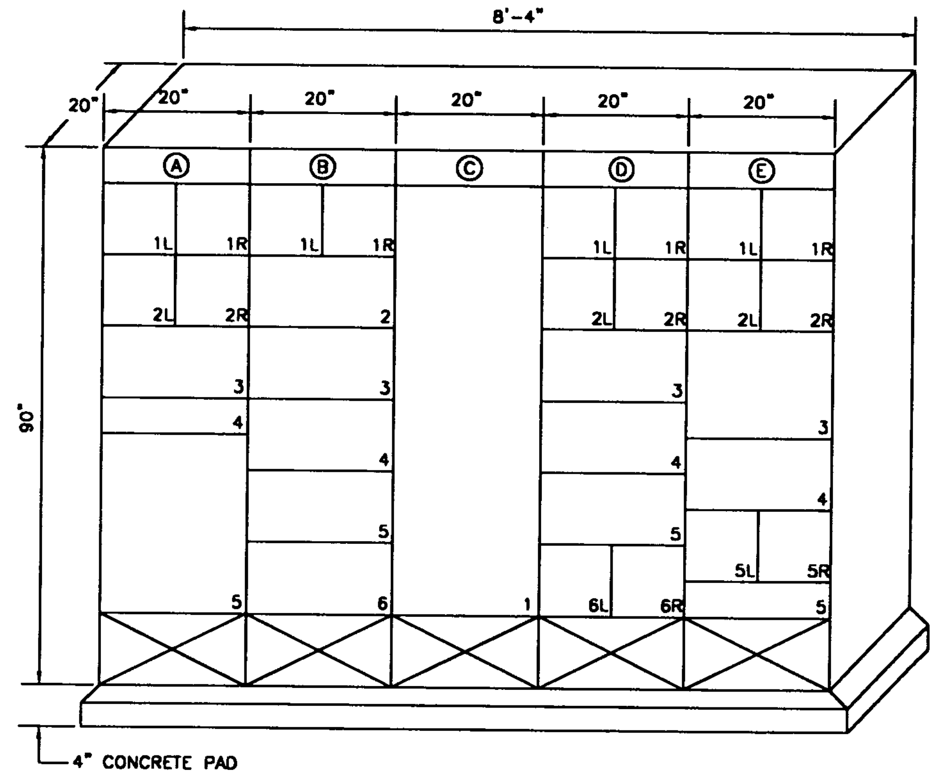
380-575-081



ONE-LINE- MCC-2

COMPARTMENT	DESCRIPTION
A1L	50A-3P-FCB, 30KVA TRANSFORMER AND LP- B
A1R	20A-3P-FCB, SPARE
A2L	60A-3P-FCB, WELDING RECEPTACLE
A2R	20A-3P-FCB, SPARE
A3	COMB-CB-FVNR, NEMA SIZE 2 STARTER, SPARE
A4	BLANK
A5	400A MAIN LUGS
B1L	40A-3P-FCB, BELT FILTER PRESS TS-BFP-20.01, 10 HP
B1R	20A-3P-FCB, SPARE
B2	COMB CB FVNR NEMA SIZE 1 STARTER, TRANSFER PUMP BPOL-P-00.02, 5 HP
B3	COMB CB FVNR NEMA SIZE 1 STARTER, TRANSFER PUMP GPOL-P-00.02, 5 HP
B4	COMB CB FVNR NEMA SIZE 1 STARTER, SPARE
B5	COMB CB FVNR NEMA SIZE 2 STARTER, SPARE
B6	COMB CB FVNR NEMA SIZE 1 STARTER, BATCH TANK MIXER TS-MX-20.01, 3 HP
C1	VFD AND FUSED DISCONNECT, BELT FILTER PRESS FEED PUMP TS-P-20.01, 20 HP
D1L	20A-3P-FCB, AIR COMPRESSOR AIR-COMP-00.02, 5 HP
D1R	20A-3P-FCB, SPARE
D2L	20A-3P-FCB, BATCH TANK INLET VALVE TS-EV-20.01
D2R	20A-3P-FCB, SPARE
D3	COMB CB FVNR NEMA SIZE 2 STARTER, BOOSTER PUMP PW-P-00.02, 25 HP
D4	COMB CB FVNR NEMA SIZE 1 STARTER, DAY TANK MIXER GPOL-MX-00.01, .5 HP
D5	COMB CB FVNR NEMA SIZE 2 STARTER, BELT CONVEYOR SC-CON-20.01, 15 HP
D6L	20A-3P-FCB, SPARE
D6R	20A-3P-FCB, SPARE
E1L	20A-3P-FCB, UNIT HEATER UH-4, 10 KW
E1R	20A-3P-FCB, UNIT HEATER UH-5, 10 KW
E2L	20A-3P-FCB, UNIT HEATER UH-6, 10 KW
E2R	20A-3P-FCB, SPARE
E3	COMB CB 2S2W NEMA SIZE 1 STARTER, EXHAUST FAN EF-2, 3 HP
E4	COMB CB FVNR NEMA SIZE 1 STARTER, SPARE
E5L	20A-3P-FCB, SPARE
E5R	20A-3P-FCB, SPARE
E6	BLANK

SCHEDULE - MCC-2



LAYOUT - MCC-2

NOTES: 1. THE MCC MANUFACTURER MAY ADJUST THE LAYOUT TO ACCOMMODATE ITS STANDARD CIRCUIT BREAKER CONFIGURATION. THE OVERALL MCC DIMENSIONS HOWEVER SHALL REMAIN UNCHANGED.

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
MCC-2 ONE-LINE, LAYOUT AND SCHEDULE

MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
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SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-082

120/208 VOLTS
100 A MAIN BREAKER
PH: 3
W: 4
A: 100
PANELBOARD: LP-A
LOCATION: ELECTRICAL ROOM
FEED: BOTTOM
MOUNTING: WALL

LOAD DESCRIPTION	KVA PH.A	KVA PH.B	KVA PH.C	LTG.	REC.	MIS.	CIR.	BKR.	BKR.	CIR.	MIS.	REC.	LTG.	KVA PH.A	KVA PH.B	KVA PH.C	LOAD DESCRIPTION
NORTHWEST RECEPTS.	0.72				X		1	20	20	2		X		0.54			NORTH RECEPTS.
SOUTH RECEPTS.		0.54			X		3	20	20	4		X			0.72		SOUTHEAST RECEPTS.
NORTH LIGHTING			1.1	X			5	20	20	6			X			1.1	SOUTH LIGHTING
CENTRAL LIGHTING	1.1			X			7	20	20	8			X	0.75			ELECTRICAL ROOM LTS.
OFFICE & CLOSET LIGHTING		0.25		X			9	20	20	10	X				0.15		FOR HVAC USE
CPF-2, CFP-3, CFP-5			0.9			X	11	20	20	12						0.0	SPARE
GPOL-LIT-00.01	0.15					X	13	20	20	14	X			0.15			TS-LIT-10.01
TS-FIT-10.01		0.15				X	15	20	20	16	X				0.2		BPOL-PBS-10.01
GPOL-PBS-00.01			0.2			X	17	20	20	18	X					0.2	WPOL-PBS-00.01
GPOL-WIT-00.01	0.15					X	19	20	20	20				0.3			SHOWER HEAT TRACE
DRN-TURT-10.01		0.15				X	21	20	20	22					1.0		TS-BFP-10.01 LCP
SPARE			0.0				23	20	20	24						0.0	POLY.CONT-LSH-00.01
SPARE	0.0						25	20	20	26				0.0			SPARE
SPARE		0.0					27	20	20	28					0.0		SPARE
SPARE			0.0				29	20	20	30						0.0	SPARE
SPARE	0.0						31	20		32				0.0			BLANK
SPARE		0.0					33	20		34					0.0		BLANK
SPARE			0.0				35	20		36						0.0	BLANK
	2.12	1.09	2.2				TOTAL		TOTAL					1.74	2.07	1.3	
	PHASE LOAD			TOTAL LOAD													
	3.86	3.16	3.5	10.52 KVA													

SCHEDULE – LP-A

120/208 VOLTS
100 A MAIN BREAKER
PH: 3
W: 4
A: 100
PANELBOARD: LP-B
LOCATION: ELECTRICAL ROOM
FEED: BOTTOM
MOUNTING: WALL

LOAD DESCRIPTION	KVA PH.A	KVA PH.B	KVA PH.C	LTG.	REC.	MIS.	CIR.	BKR.	BKR.	CIR.	MIS.	REC.	LTG.	KVA PH.A	KVA PH.B	KVA PH.C	LOAD DESCRIPTION
ELECTRICAL RM RECEPTS.	0.72				X		1	20	20	2			X	0.72			OFFICE & CLOSET RECEPTS.
CENTRAL RECEPTS.		0.54			X		3	20	20	4					0.0		SPARE
NORTH LIGHTING			1.1	X			5	20	20	6			X			1.1	SOUTH LIGHTING
OUTDOOR LTG. (N. AND E.)	1.1			X			7	20	20	8			X	1.1			OUTDOOR LTG. (S. & W.)
SPARE							9	20	20	10	X				0.15		FOR HVAC USE
CFP-1, CFP-7			0.6			X	11	20	20	12	X					0.9	CFP-4, CFP-6, CFP-8
BPOL-LIT-00.01	0.15					X	13	20	20	14	X			0.15			TS-LIT-10.01
TS-FIT-20.01		0.15				X	15	20	20	16	X				0.2		BPOL-PBS-20.01
GPOL-PBS-00.02			0.2			X	17	20	20	18	X					0.2	WPOL-PBS-00.02
BPOL-WIT-00.01	0.15					X	19	20	20	20				0.0			SPARE
DRN-TURT-20.01		0.15				X	21	20	20	22	X				1.0		TS-BFP-20.01 LCP
SPARE			0.0				23	20	20	24						0.0	SPARE
SPARE	0.0						25	20		26				0.0			BLANK
SPARE		0.0					27	20		28					0.0		BLANK
SPARE			0.0				29	20		30						0.0	BLANK
SPARE	0.0						31	20		32				0.0			BLANK
SPARE		0.0					33	20		34					0.0		BLANK
SPARE			0.0				35	20		36						0.0	BLANK
	2.12	0.84	1.9				TOTAL		TOTAL					1.97	1.35	2.2	
	PHASE LOAD			TOTAL LOAD													
	4.09	2.19	4.1	10.38 KVA													

SCHEDULE – LP-B

480 VOLTS
150 A MAIN BREAKER
PH: 3
W: 3
A: 225
PANELBOARD: PP-L
LOCATION: LAGOONS (WEST SIDE)
FEED: BOTTOM
MOUNTING: STRUT

LOAD DESCRIPTION	KVA PH.A	KVA PH.B	KVA PH.C	LTG.	REC.	MIS.	CIR.	BKR.	BKR.	CIR.	MIS.	REC.	LTG.	KVA PH.A	KVA PH.B	KVA PH.C	LOAD DESCRIPTION
	17.5						1			2				0.3			
SUPERNATANT PUMP CP		17.5				X	3	100	20	4	X				0.3		LS-EV-00.01, 00.02
			17.5				5			6						0.3	
	0.3						7			8				0.3			
DRN-P-00.01		0.3				X	9	20	20	10	X				0.3		LS-EV-00.03, 00.04
			0.3				11			12						0.3	
	5.0						13			14				0.0			
LP-L		5.0				X	15	40	20	16					0.0		SPARE
			5.0				17			18						0.0	
	0.0						19			20				0.0			
SPARE		0.0					21	20	20	22					0.0		SPARE
			0.0				23			24						0.0	
BLANK	0.0						25			26				0.0			BLANK
BLANK		0.0					27			28					0.0		BLANK
BLANK			0.0				29			30						0.0	BLANK
	22.8	22.8	22.8				TOTAL		TOTAL					0.6	0.6	0.6	
	PHASE LOAD			TOTAL LOAD													
	23.4	23.4	23.4	70.2 KVA													

SCHEDULE – PP-L

480 VOLTS
225 A MAIN BREAKER
PH: 3
W: 3
A: 225
PANELBOARD: PP-GT
LOCATION: GRAVITY THICKENERS
FEED: BOTTOM
MOUNTING: STRUT

LOAD DESCRIPTION	KVA PH.A	KVA PH.B	KVA PH.C	LTG.	REC.	MIS.	CIR.	BKR.	BKR.	CIR.	MIS.	REC.	LTG.	KVA PH.A	KVA PH.B	KVA PH.C	LOAD DESCRIPTION
	10.0						1			2				10.0			
TS-P-00.01, 00.02 PANEL		10.0					3	80	80	4					10.0		TS-P-00.03, 00.04 PANEL
			10.0				5			6						10.0	
	3.5						7			8				3.5			
TS-SC-00.01 PANEL		3.5					9	40	40	10					3.5		TS-SC-00.02 PANEL
			3.5				11			12						3.5	
	0.3						13			14				0.0			
SS-EV-00.21, 00.22		0.3					15	20	20	16					0.0		SPARE
			0.3				17			18						0.0	
	10.0						19			20				0.0			
LP-GT		10.0					21	60	20	22					0.0		SPARE
			10.0				23			24						0.0	
	0.0						25			26				0.0			
SPARE		0.0					27	20	20	28					0.0		SPARE
			0.0				29			30						0.0	
	0.0						31			32				0.0			
SPARE		0.0					33	20	20	34					0.0		SPARE
			0.0				35			36						0.0	
	0.0						37			38				0.0			
BLANK		0.0					39			40					0.0		BLANK
			0.0				41			42						0.0	
	23.8	23.8	23.8				TOTAL		TOTAL					13.5	13.5	13.5	
	PHASE LOAD			TOTAL LOAD													
	37.3	37.3	37.3	111.9 KVA													

SCHEDULE – PP-GT

120/208 VOLTS
100 A MAIN BREAKER
PH: 3
W: 4
A: 100
PANELBOARD: LP-GT
LOCATION: GRAVITY THICKENERS
FEED: BOTTOM
MOUNTING: STRUT

LOAD DESCRIPTION	KVA PH.A	KVA PH.B	KVA PH.C	LTG.	REC.	MIS.	CIR.	BKR.	BKR.	CIR.	MIS.	REC.	LTG.	KVA PH.A	KVA PH.B	KVA PH.C	LOAD DESCRIPTION
GT 1 HEAT TRACE	3.0					X	1	40	20	2	X			0.15			TS-LIT-00.01
GT 2 HEAT TRACE		3.0				X	3	40	20	4	X				0.15		TS-LIT-00.02
RTU SPACE HEATER			1.0			X	5	20	20	6	X					0.5	RTU 8
WWW-EV-00.01	1.0					X	7	20	20	8				0.0			SPARE / REFEED EXISTING
WWW-EV-00.02		1.0				X	9	20	20	10					0.0		SPARE / REFEED EXISTING
WWW-EV-00.03			1.0			X	11	20	20	12						0.0	SPARE / REFEED EXISTING
SPARE / REFEED EXISTING	0.0						13	20	20	14				0.0			SPARE / REFEED EXISTING
SPARE / REFEED EXISTING		0.0					15	20	20	16					0.0		SPARE / REFEED EXISTING
SPARE / REFEED EXISTING			0.0				17	20	20	18						0.0	SPARE / REFEED EXISTING
SPARE / REFEED EXISTING	0.0						19	20		20				0.0			BLANK
SPARE / REFEED EXISTING		0.0					21	20		22					0.0		BLANK
SPARE / REFEED EXISTING			0.0				23	20		24						0.0	BLANK
	4.0	4.0	2.0				TOTAL		TOTAL					0.15	0.15	0.5	
	PHASE LOAD			TOTAL LOAD													
	4.15	4.15	2.5	10.8 KVA													

SCHEDULE – LP-GT

120/208 VOLTS
60 A MAIN BREAKER
PH: 3
W: 4
A: 100
PANELBOARD: LP-L
LOCATION: LAGOONS
FEED: BOTTOM
MOUNTING: STRUT

LOAD DESCRIPTION	KVA PH.A	KVA PH.B	KVA PH.C	LTG.	REC.	MIS.	CIR.	BKR.	BKR.	CIR.	MIS.	REC.	LTG.	KVA PH.A	KVA PH.B	KVA PH.C	LOAD DESCRIPTION
SUPERNATANT VAULT	0.46			X	X		1	20	20	2	X			0.2			LS-LIT-00.01
LSR-LIT-00.01		0.15				X	3	20	20	4	X				0.2		LS-LIT-00.02
SPARE			0.0				5	20	20	6	X					0.2	LS-LIT-00.03
SPARE	0.0						7	20	20	8	X			0.2			LS-LIT-00.04
SPARE		0.0					9	20	20	10					0.0		SPARE
SPARE			0.0				11	20	20	12						0.0	SPARE
BLANK	0.0						13			14				0.0			BLANK
BLANK		0.0					15			16					0.0		BLANK
BLANK			0.0				17			18						0.0	BLANK
	0.46	0.15	0.0				TOTAL		TOTAL					0.4	0.2	0.2	
	PHASE LOAD			TOTAL LOAD													
	0.88	0.35	0.2	1.41 KVA													

SCHEDULE – LP-L

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBERT
19941
REGISTERED
PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

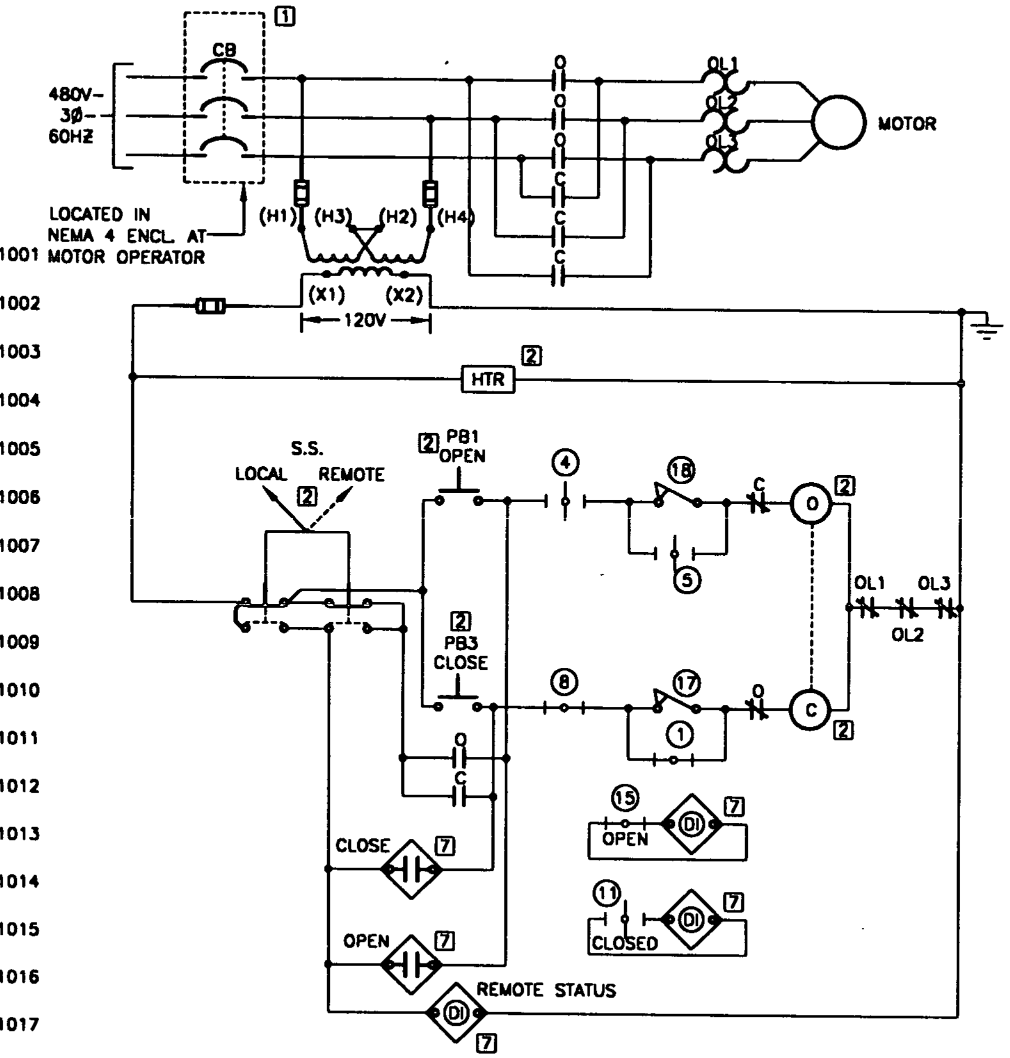
ELECTRICAL
LIGHTING & POWER PANEL SCHEDULES I

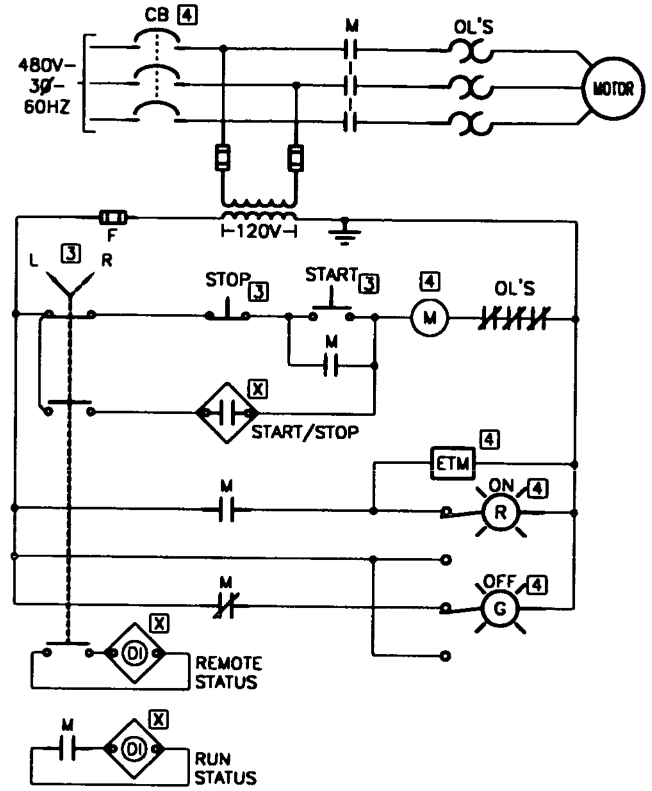
MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

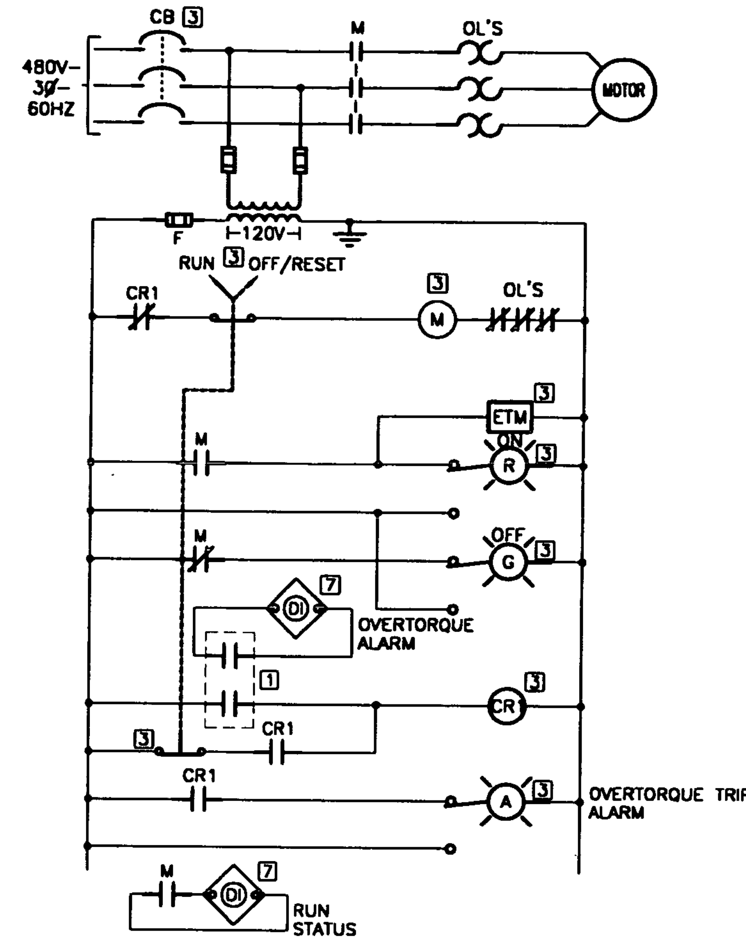
380-575-083



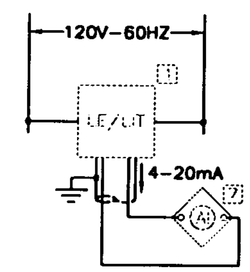


ELEMENTARY SCHEMATIC-BATCH FEED TANK MIXERS(TYP FOR 2)
TS-MX-10.01,TS-MX-20.01 (x=7)

ELEMENTARY SCHEMATIC-PLANT WATER BOOSTER PUMPS(TYP FOR 2)
PW-P-00.01,02 (x=6)



ELEMENTARY SCHEMATIC – GRAVITY THICKENER
MECHANICAL SLUDGE COLLECTOR(TYP. FOR 2)
TS-SC-00.01,02



ELEMENTARY SCHEMATIC – EXISTING
GRAVITY THICKENER LEVEL SENSOR(TYP. FOR 2)

GATE SHOWN IN FULL OPEN POSITION

ROTOR	CONTACT	LIMIT SWITCH CONTACT DEVELOPMENT – VALVE POSITION (FULL OPEN … FULL CLOSE)	FUNCTION
1	1		BY-PASS CIR
	2		SPARE
	3		SPARE
	4		OPEN LIMIT
2	5		BY-PASS CIR
	6		SPARE
	7		SPARE
	8		CLOSE LIMIT
3	9		SPARE
	10		SPARE
	11		REMOTE STATUS
	12		SPARE
4	13		SPARE
	14		SPARE
	15		REMOTE STATUS
	16		SPARE

2

LEGEND:

- O – OPEN CONTACT
- C – CLOSE CONTACT
- Ⓞ – OPENING COIL
- Ⓒ – CLOSING COIL
- OL – OVERLOAD RELAY
- + – MECHANICAL INTERLOCK
- CT – CONTROL TRANSFORMER
- (R) – RED INDICATING LIGHT
- (G) – GREEN INDICATING LIGHT
- PB1 – OPEN PUSHBUTTON
- PB2 – STOP PUSHBUTTON
- PB3 – CLOSE PUSHBUTTON
- HTR – SPACE HEATER (L.S. COMPT)

NOTES

1 ▬▬▬▬ CLOSE CONTACT

2 – – – – – OPEN CONTACT

(17) CLOSING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING CLOSING CYCLE

(18) OPENING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING OPENING CYCLE

ELEMENTARY SCHEMATIC – NON-MODULATED M.O. VALVE(TYP.)
GRAVITY THICKENER INLET VALVES(2),SS-EV-00.21,00.22
BATCH FEED TANK INLET VALVES(2),TS-EV-10.01,20.01
BATCH TANK DRAIN VALVES(2),DRN-EV-00.11,00.12

LOCATION LEGEND

1 FIELD MTD.
2 INCLUDED AS PART OF EQUIPMENT
3 LOCAL CONTROL STATION
4 MCC
5 BELT FILTER PRESS PANEL
6 BELT FILTER PRESS RTU
7 RTU

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

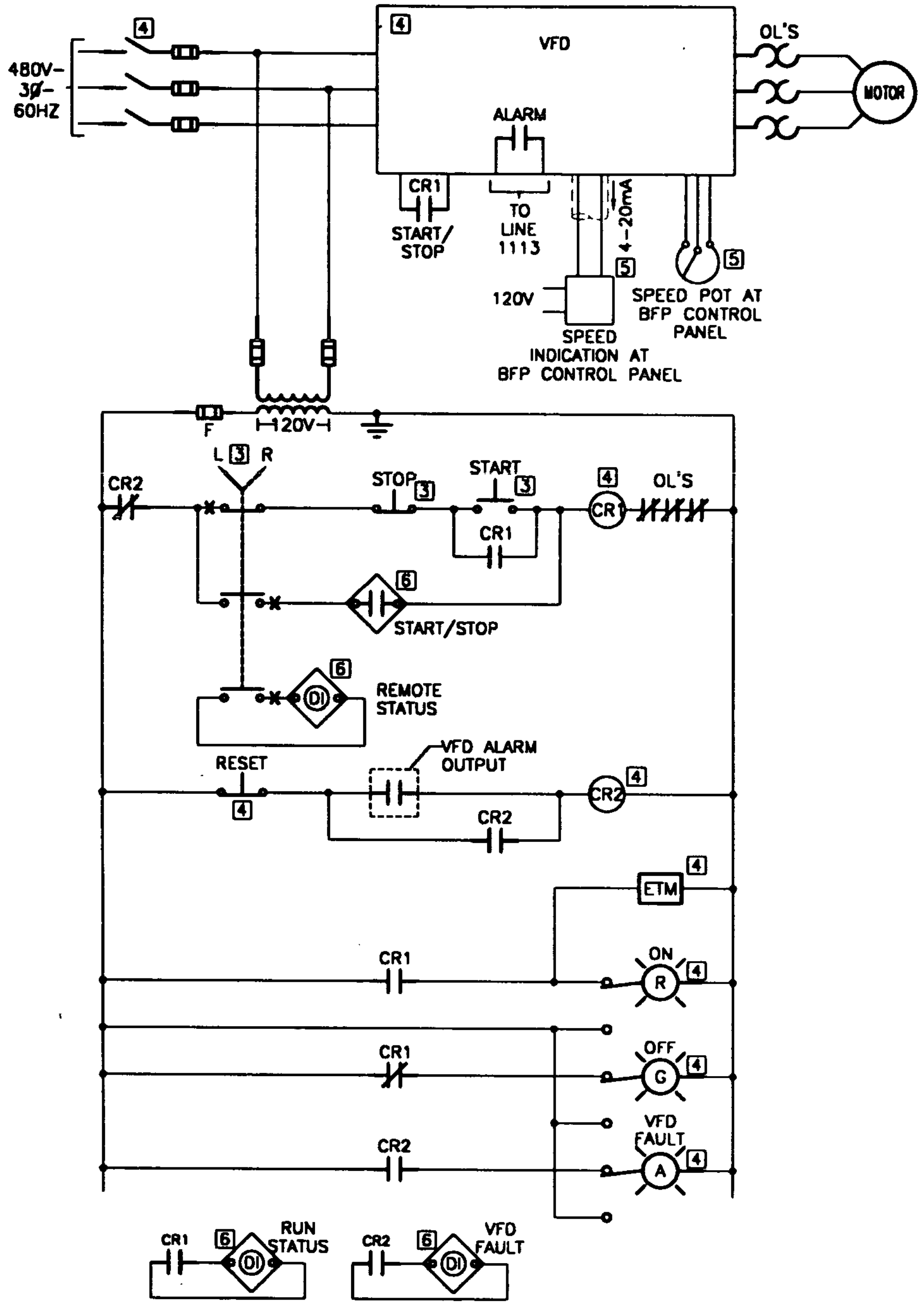
ELECTRICAL
ELEMENTARY SCHEMATICS I

MONTGOMERY WATSON

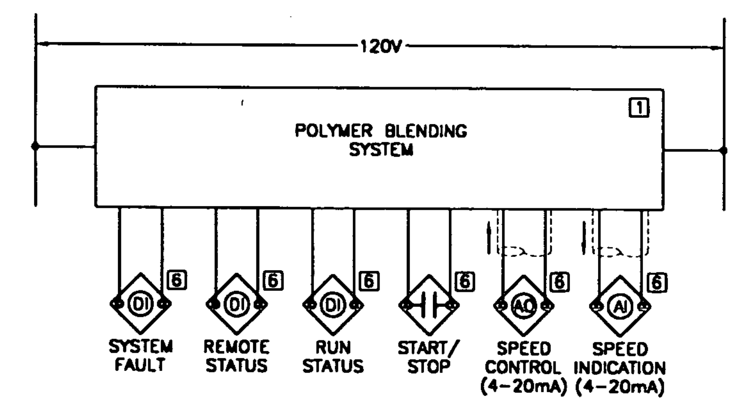
DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

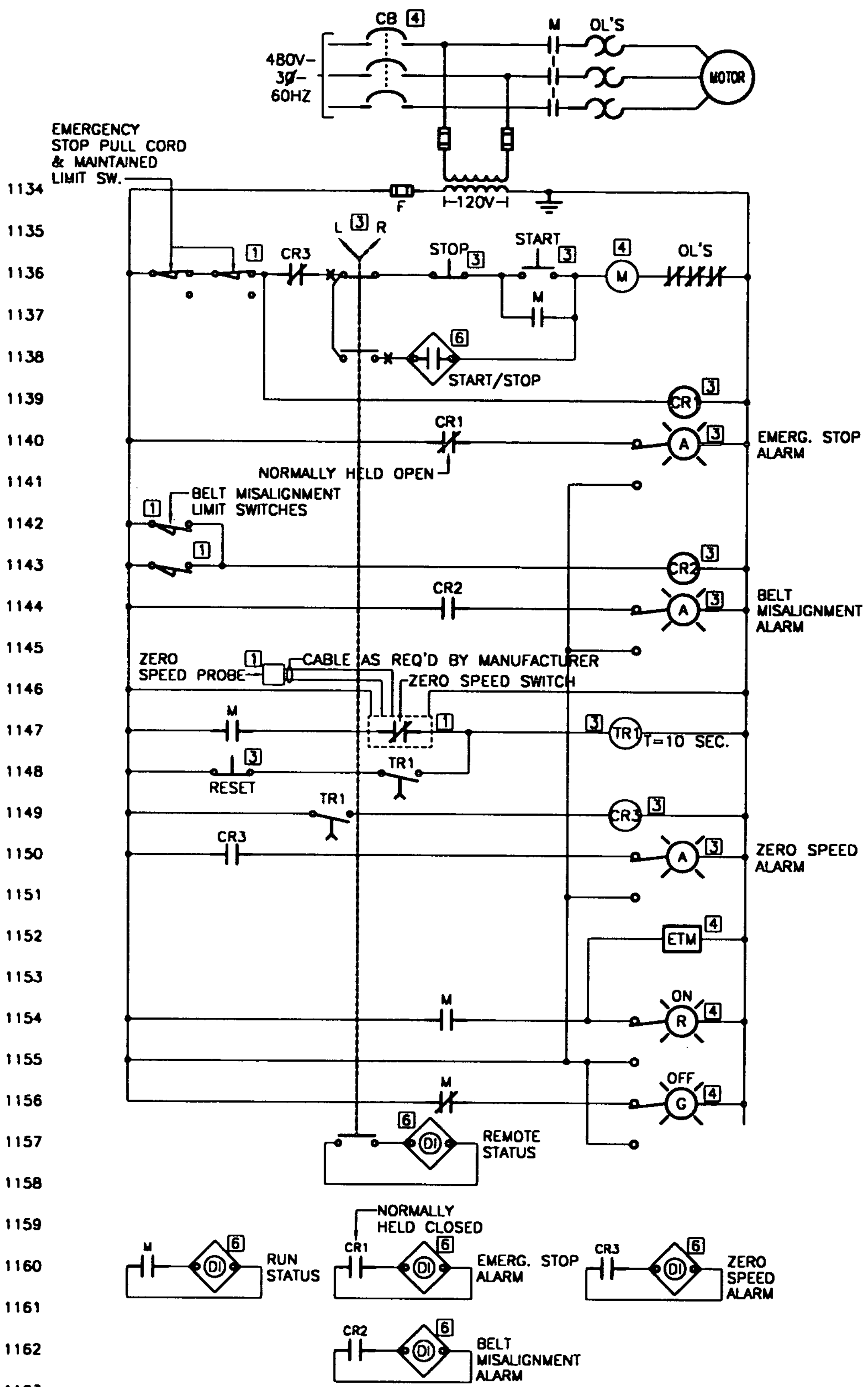
380-575-084



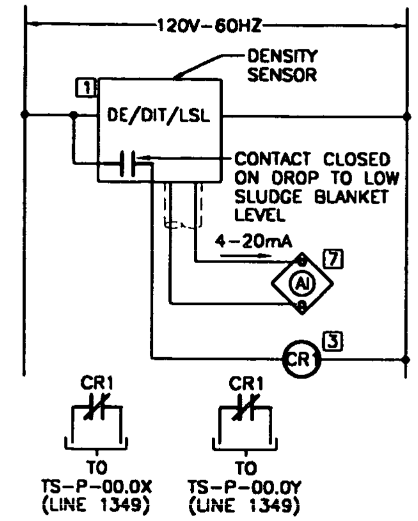
ELEMENTARY SCHEMATIC-BFP FEED PUMP(TYP. FOR 2)
TS-P-10.01,TS-P-20.01



ELEMENTARY SCHEMATIC-POLYMER BLENDING SYSTEM
(TYP. FOR 2) BPOL-PBS-10.01,20.01



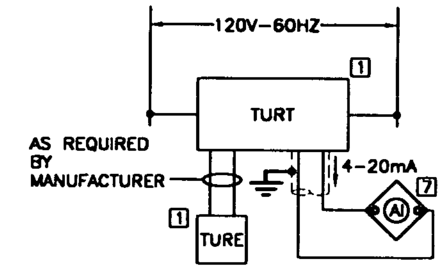
ELEMENTARY SCHEMATIC-BFP DISCHARGE BELT CONVEYOR
(TYP. FOR 2) SC-CON-10.01,20.01



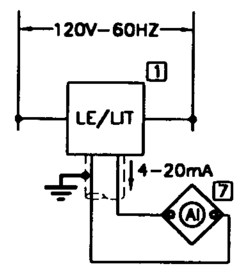
USAGE TABLE

EQUIPMENT TAG	X=	Y=
DIT-00.01	1	2
DIT-00.02	3	4

ELEMENTARY SCHEMATIC -
SLUDGE BLANKET LEVEL PROBE(TYP. FOR 2)



ELEMENTARY SCHEMATIC -
TURBIDITY SENSOR(TYP. FOR 2)
DRN-TURE-10.01,20.01



ELEMENTARY SCHEMATIC -
BATCH FEED TANK LEVEL SENSOR(TYP. FOR 2)

LOCATION LEGEND

1. FIELD MTD.
2. INCLUDED AS PART OF EQUIPMENT
3. LOCAL CONTROL STATION
4. MCC
5. BELT FILTER PRESS PANEL
6. BELT FILTER PRESS RTU
7. RTU

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED
PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

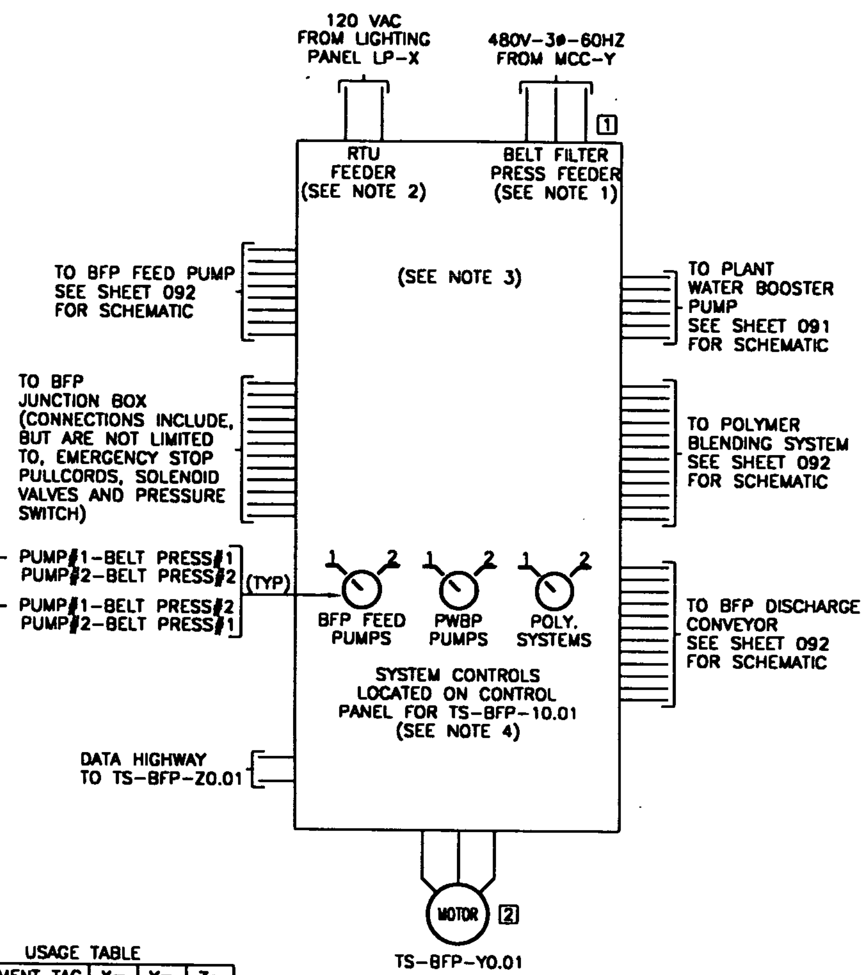
ELECTRICAL
ELEMENTARY SCHEMATICS II

MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-085



USAGE TABLE

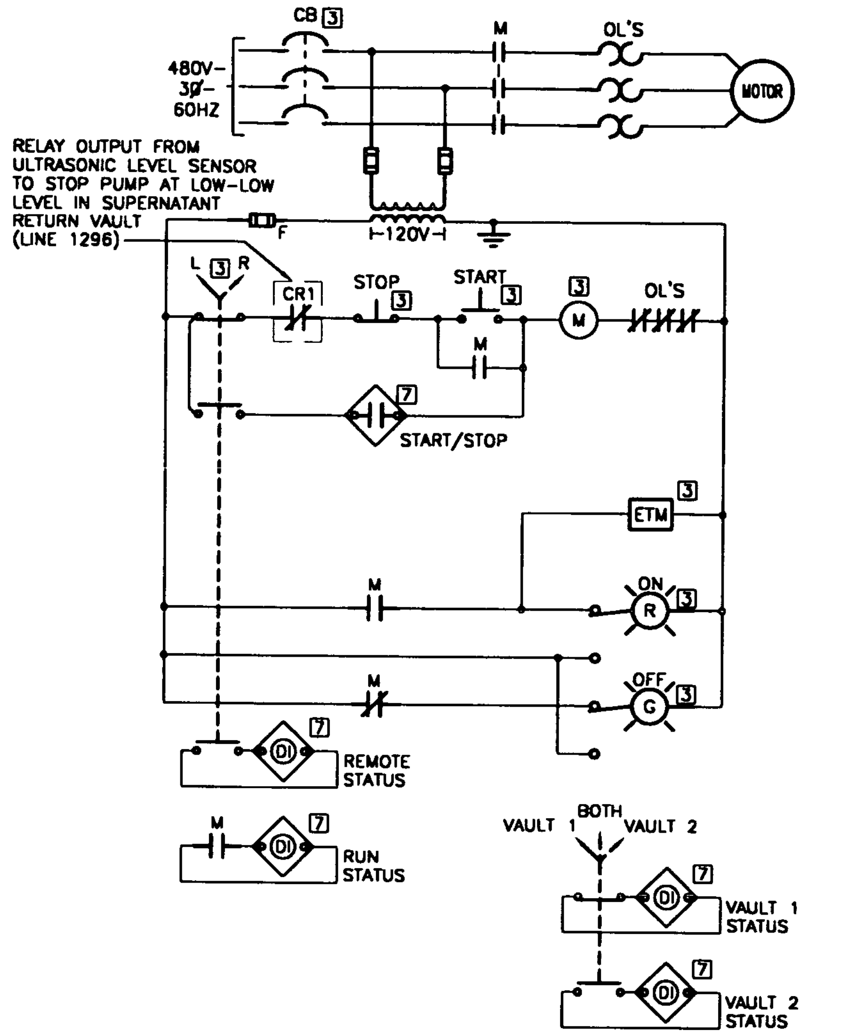
EQUIPMENT TAG	X=	Y=	Z=
TS-BFP-10.01	A	1	2
TS-BFP-20.01	B	2	1

BELT FILTER PRESS (TYP. FOR 2)
TS-BFP-10.01,TS-BFP-20.01

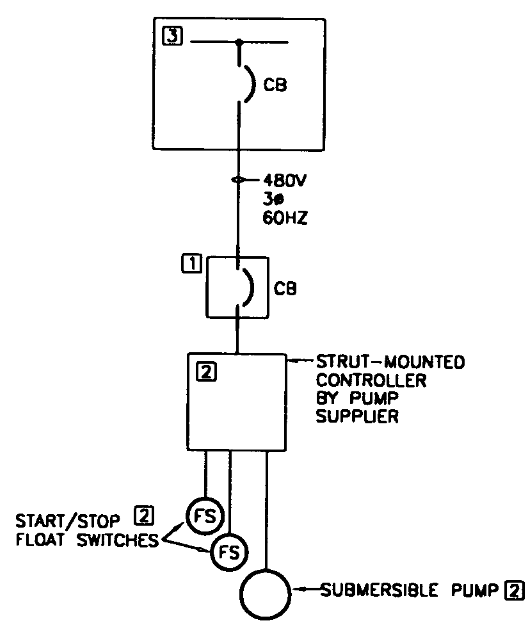
NOTES:
1. THE MAIN PANEL DISCONNECT SHALL DISCONNECT THE 480V FEED ONLY. PROVIDE A YELLOW NAMEPLATE NEAR THE DISCONNECT READING "CAUTION THE MAIN DISCONNECT DOES NOT DISCONNECT THE 120VAC FEEDING THE RTU."
2. PROVIDE AN INTERNALLY MOUNTED CIRCUIT BREAKER FOR THE RTU AND A YELLOW NAMEPLATE READING "RTU DISCONNECT".
3. REFER TO SECTION 11562 OF THE SPECIFICATIONS FOR PANEL DETAILS.
4. THE SYSTEM CONTROLS ARE COMMON CONTROLS FOR THE BELT FILTER PRESSES.

LOCATION LEGEND

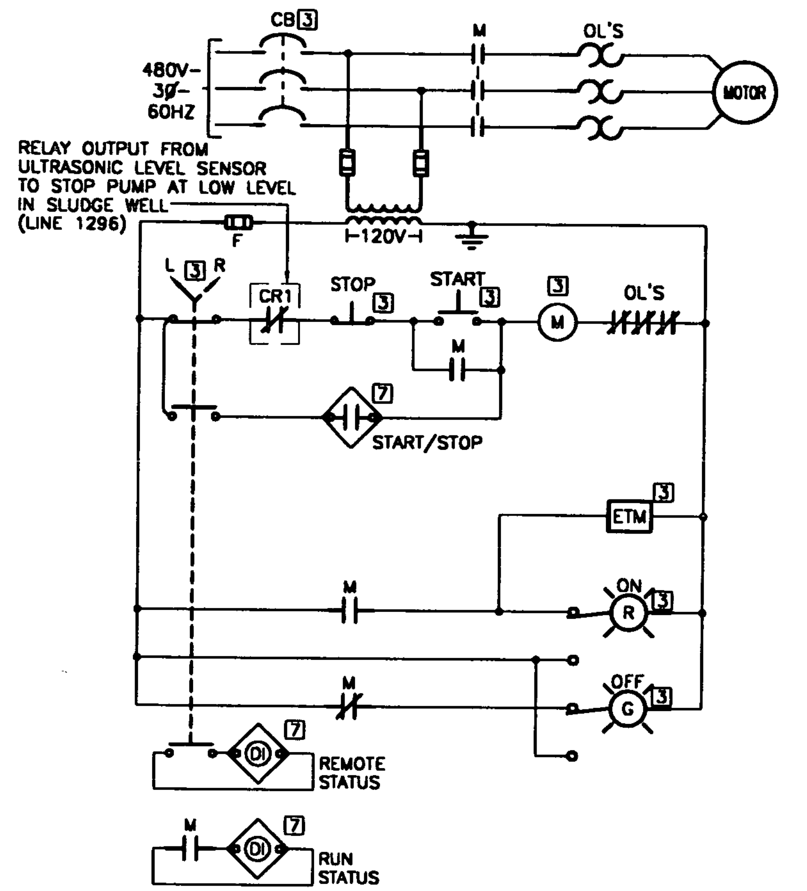
1 FIELD MTD.
2 INCLUDED AS PART OF EQUIPMENT
3 LOCAL CONTROL STATION
4 MCC
5 BELT FILTER PRESS PANEL
6 BELT FILTER PRESS RTU
7 RTU



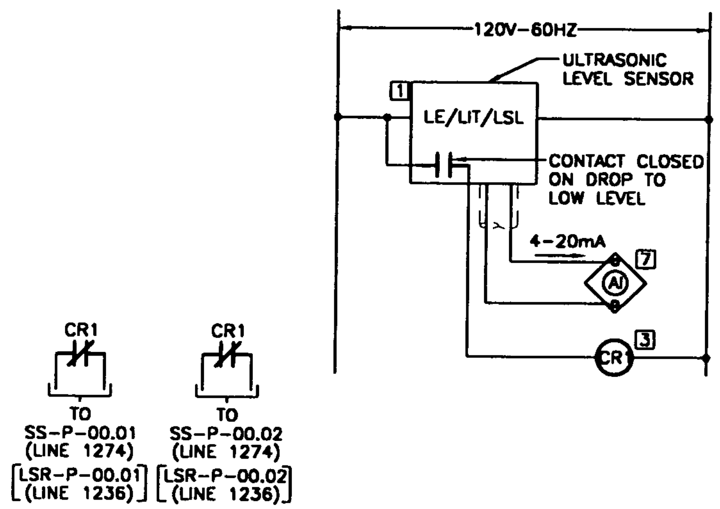
ELEMENTARY SCHEMATIC–SUPERNATANT RETURN PUMPS
LSR-P-00.01,LSR-P-00.02



LAGOON SUPERNATANT VAULT SUMP PUMP
DRN-P-00.01



ELEMENTARY SCHEMATIC–SETTLED SOLIDS PUMP
ELEMENTARY SCHEMATIC–SLUDGE WELL
SS-P-00.01,SS-P-00.02



ELEMENTARY SCHEMATIC–SLUDGE WELL(SS-LE-00.01)
AND SUPERNATANT RETURN VAULT(LSR-LE-00.01)LEVEL SENSORS

DATE	REVISIONS

STATE OF KENTUCKY REGISTERED PROFESSIONAL ENGINEER

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

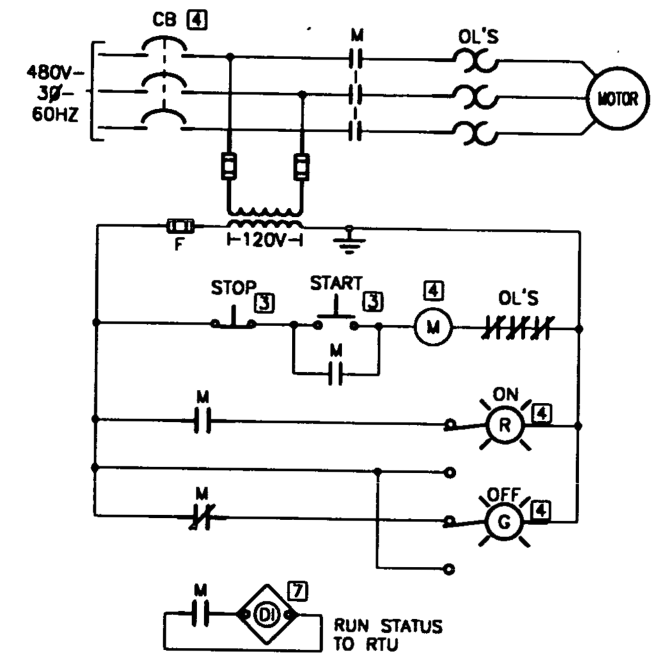
ELECTRICAL
ELEMENTARY SCHEMATICS III

MONTGOMERY WATSON

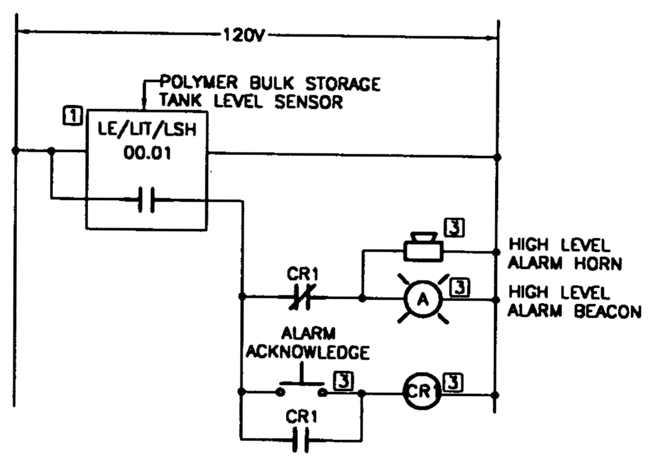
DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

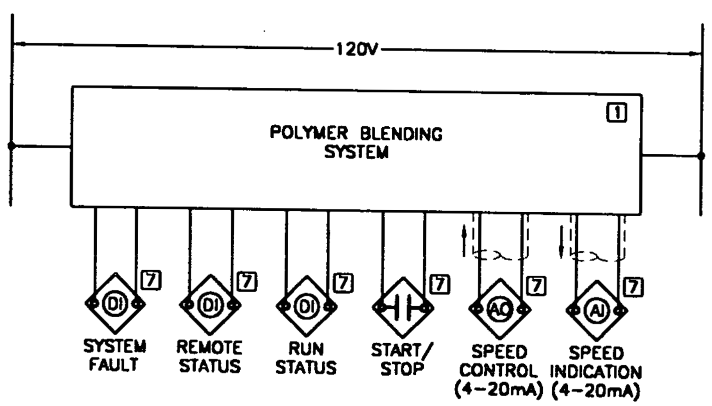
380-575-086



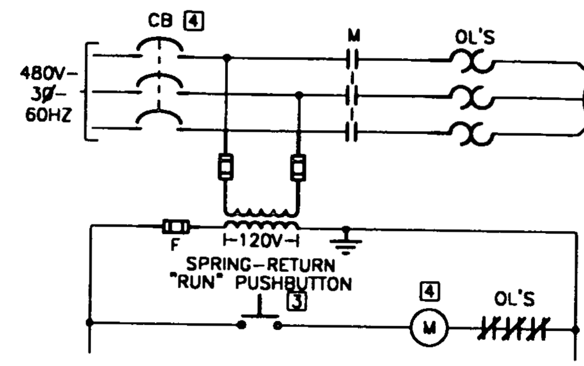
ELEMENTARY SCHEMATIC-POLYMER DAY TANK MIXER
BPOL-MX-00.01,GPOL-MX-00.01



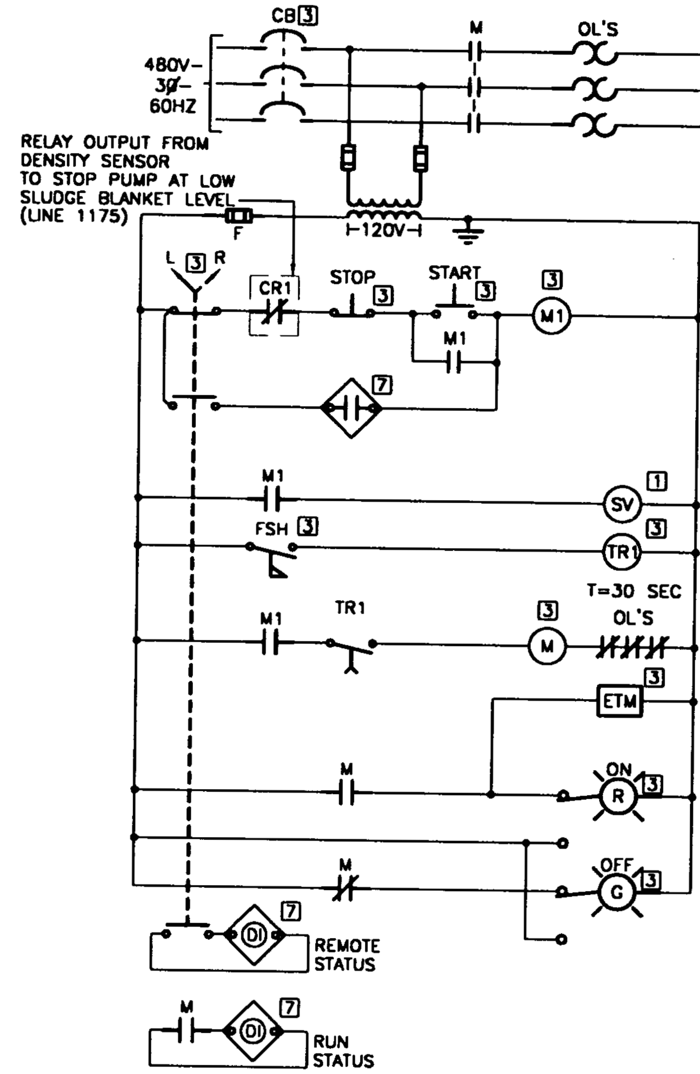
ELEMENTARY SCHEMATIC-POLYMER TRUCK FILL PANEL
(TYPICAL FOR 2, GPOL AND BPOL)



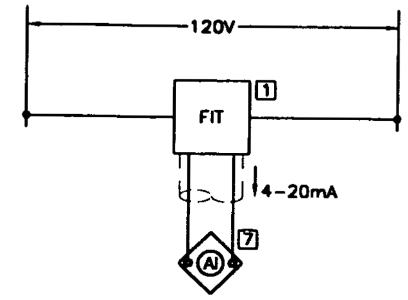
ELEMENTARY SCHEMATIC-POLYMER BLENDING SYSTEM
(TYP. FOR 4) GPOL-PBS-00.01,00.02
WPOL-PBS-00.01,00.02



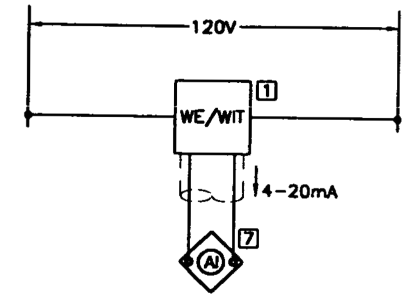
ELEMENTARY SCHEMATIC-BFP POLYMER TRANSFER SYSTEM
BPOL-P-00.01,BPOL-P-00.02
(SIMILAR FOR GT POLYMER TRANSFER SYSTEM)
GPOL-P-00.01,GPOL-P-00.02



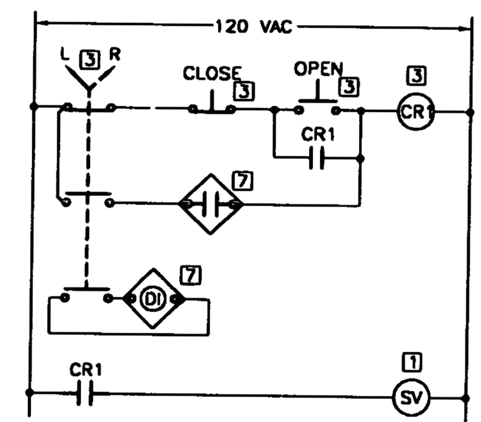
ELEMENTARY SCHEMATIC-THICKENED SOLIDS PUMPS(TYP. FOR 4)
TS-P-00.01,02,03,04



ELEMENTARY SCHEMATIC-THICKENED SLUDGE MAGNETIC FLOWMETER
TS-FM-10.01,TS-FM-20.01



ELEMENTARY SCHEMATIC-POLYMER DAY TANK WEIGH SCALE
BPOL-WSC-00.01,GPOL-WSC-00.01

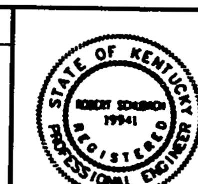


ELEMENTARY SCHEMATIC-FLUSHING WATER
SOLENOID VALVES
PW-SV-00.01 THRU 00.10

LOCATION LEGEND

1 FIELD MTD.
2 INCLUDED AS PART OF EQUIPMENT
3 LOCAL CONTROL STATION
4 MCC
5 BELT FILTER PRESS PANEL
6 BELT FILTER PRESS RTU
7 RTU

DATE	REVISIONS



WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

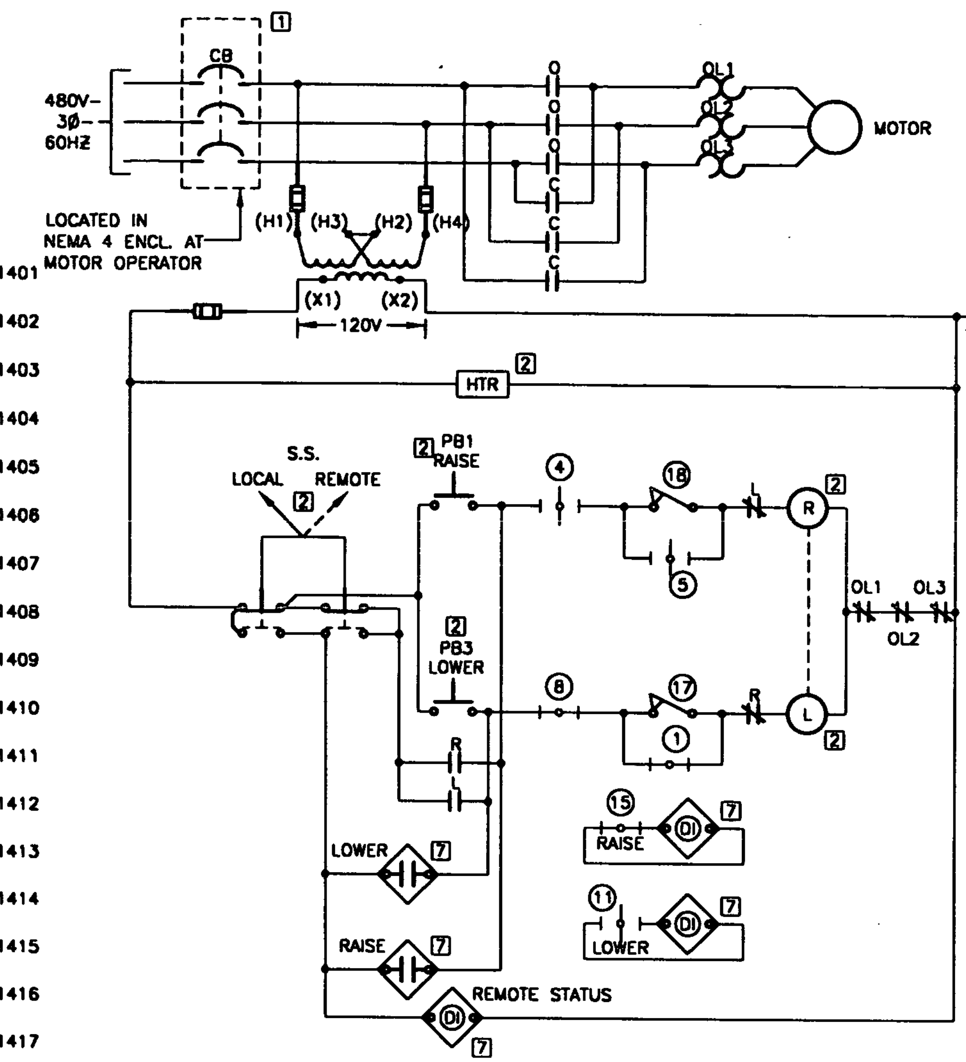
ELECTRICAL
ELEMENTARY SCHEMATICS IV

MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-087



GATE SHOWN IN FULL OPEN POSITION

2

ROTOR	CONTACT	LIMIT SWITCH CONTACT DEVELOPMENT — VALVE POSITION: FULL RAISE … FULL LOWER	FUNCTION
1	1		BY-PASS CIR
	2		SPARE
	3		SPARE
	4		RAISE LIMIT
2	5		BY-PASS CIR
	6		SPARE
	7		SPARE
	8		LOWER LIMIT
3	9		SPARE
	10		SPARE
	11		REMOTE STATUS
	12		SPARE
4	13		SPARE
	14		SPARE
	15		REMOTE STATUS
	16		SPARE

LEGEND:

R – RAISE CONTACT
L – LOWER CONTACT
Ⓡ – RAISING COIL
Ⓛ – LOWERING COIL
OL – OVERLOAD RELAY
\+ – MECHANICAL INTERLOCK
CT – CONTROL TRANSFORMER
R – RED INDICATING LIGHT
G – GREEN INDICATING LIGHT
PB1– RAISE PUSHBUTTON
PB2– STOP PUSHBUTTON
PB3– LOWER PUSHBUTTON
HTR– SPACE HEATER (L.S. COMPT)

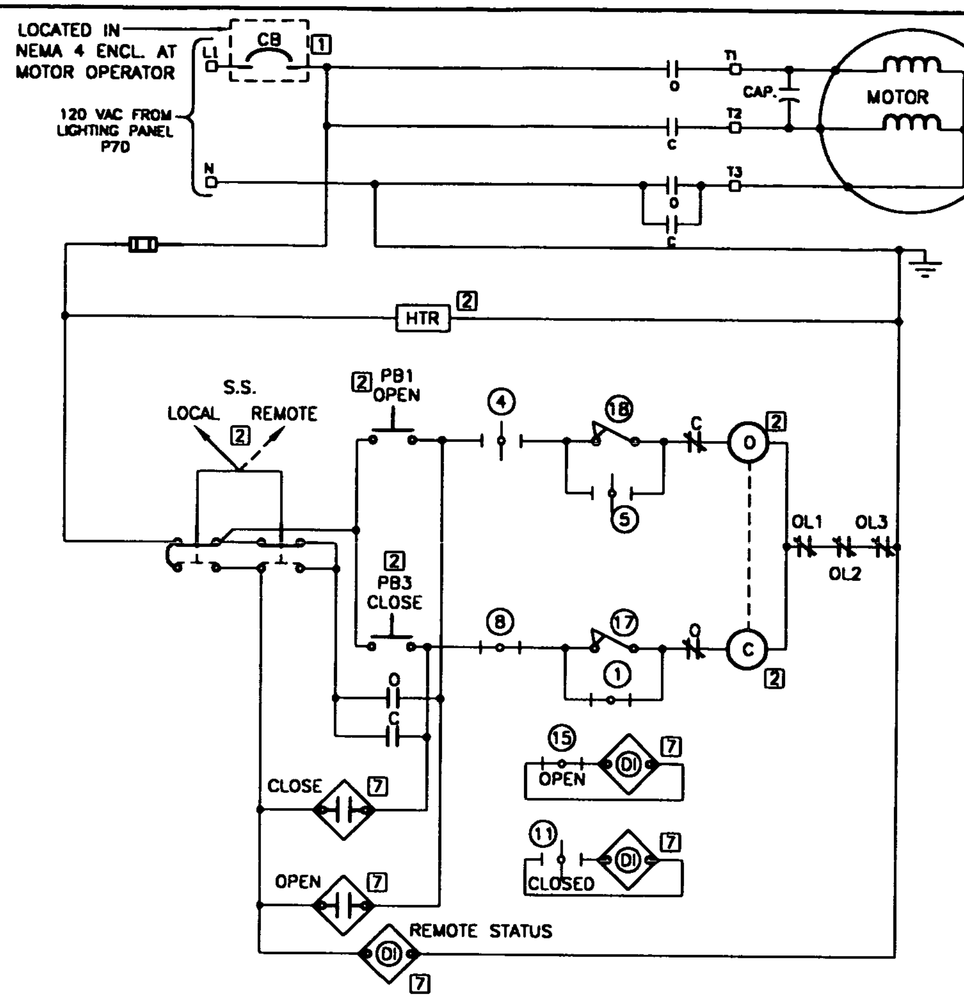
NOTES

1 ▬▬▬ LOWER CONTACT
2 — — — RAISE CONTACT

(17) LOWERING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING LOWERING CYCLE

(18) RAISING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING RAISING CYCLE

ELEMENTARY SCHEMATIC – NON-MODULATED M.O. VALVE(TYP.) LAGOON SUPERNATANT TELESCOPING VALVES(4),LS-EV-00.01 THRU -00.04



GATE SHOWN IN FULL OPEN POSITION

2

ROTOR	CONTACT	LIMIT SWITCH CONTACT DEVELOPMENT — VALVE POSITION: FULL OPEN … FULL CLOSE	FUNCTION
1	1		BY-PASS CIR
	2		SPARE
	3		SPARE
	4		OPEN LIMIT
2	5		BY-PASS CIR
	6		SPARE
	7		SPARE
	8		CLOSE LIMIT
3	9		SPARE
	10		SPARE
	11		REMOTE STATUS
	12		SPARE
4	13		SPARE
	14		SPARE
	15		REMOTE STATUS
	16		SPARE

LEGEND:

O – OPEN CONTACT
C – CLOSE CONTACT
Ⓞ – OPENING COIL
Ⓒ – CLOSING COIL
OL – OVERLOAD RELAY
\+ – MECHANICAL INTERLOCK
CT – CONTROL TRANSFORMER
R – RED INDICATING LIGHT
G – GREEN INDICATING LIGHT
PB1– OPEN PUSHBUTTON
PB2– STOP PUSHBUTTON
PB3– CLOSE PUSHBUTTON
HTR– SPACE HEATER (L.S. COMPT)

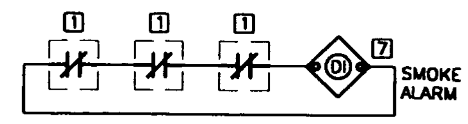
NOTES

1 ▬▬▬ CLOSE CONTACT
2 — — — OPEN CONTACT

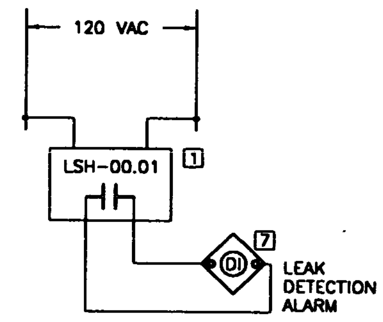
(17) CLOSING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING CLOSING CYCLE

(18) OPENING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING OPENING CYCLE

ELEMENTARY SCHEMATIC – NON-MODULATED M.O. VALVE(TYP.) SETTLED SOLIDS VALVES(10),SS-EV-00.0X(X=2,4,6,8,10,12,14,16,18,20) LAGOON INLET VALVES(3),WWW-EV-00.01,00.02,00.03 PURIFICATION UNIT DRAIN VALVES(10),DRN-EV-00.XX (XX=01 THRU 10)



ELEMENTARY SCHEMATIC – SMOKE DETECTORS



ELEMENTARY SCHEMATIC – POLYMER CONTAINMENT LEAK DETECTION

LOCATION LEGEND

1 FIELD MTD.
2 INCLUDED AS PART OF EQUIPMENT
3 LOCAL CONTROL STATION
4 MCC
5 BELT FILTER PRESS PANEL
6 BELT FILTER PRESS RTU
7 RTU

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED
PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

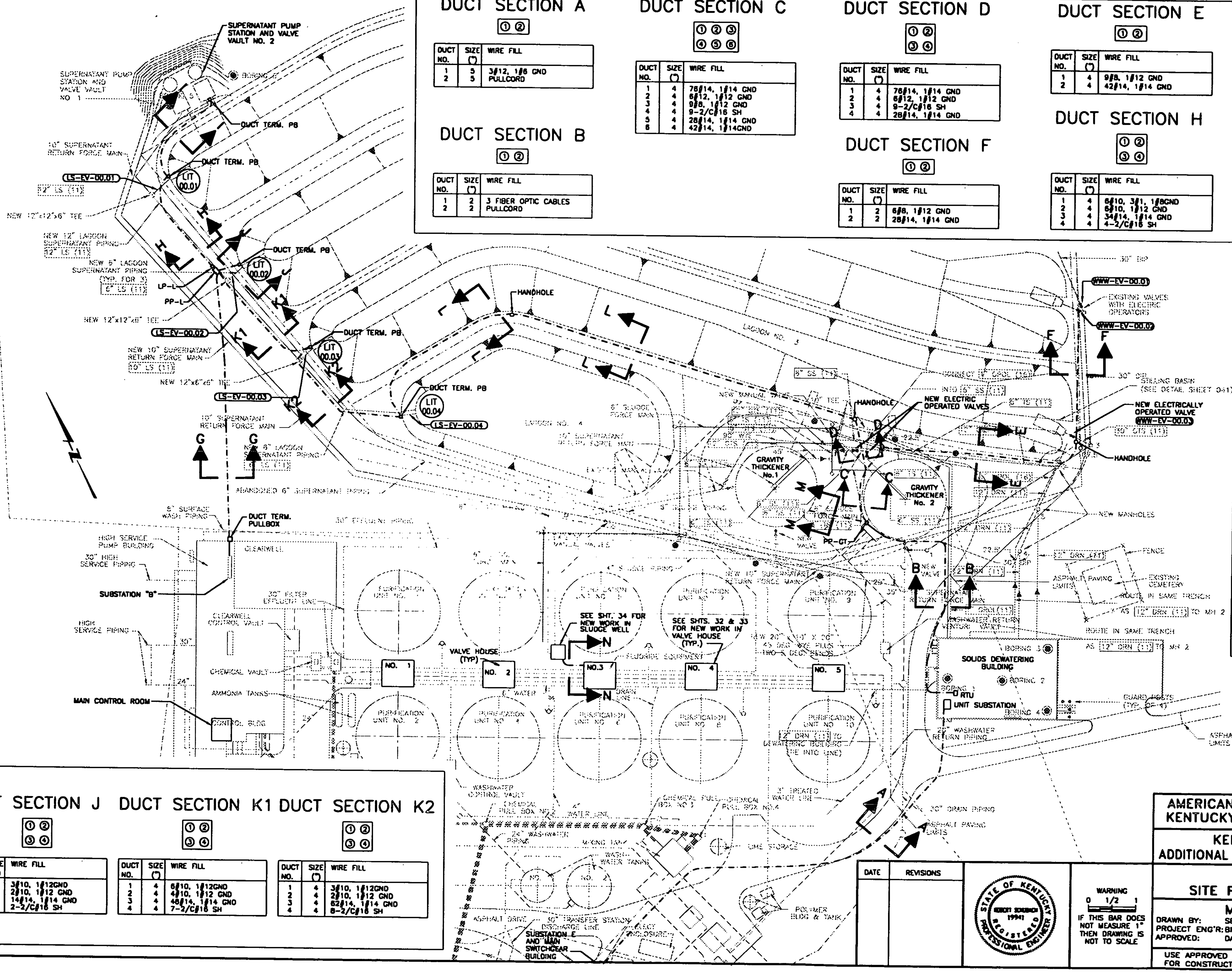
ELECTRICAL
ELEMENTARY SCHEMATICS V

MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-088



NOTES:

1. DRAWING BASED ON RECORD DRAWINGS BY OTHERS. CONTRACTOR SHALL FIELD VERIFY LOCATIONS OF ALL STRUCTURES, UTILITIES, AND PIPING PRIOR TO COMMENCING ANY WORK.

DUCT SECTION A

①②

DUCT NO.	SIZE (")	WIRE FILL
1	5	3#12, 1#6 GND
2	5	PULLCORD

DUCT SECTION B

①②

DUCT NO.	SIZE (")	WIRE FILL
1	2	3 FIBER OPTIC CABLES
2	2	PULLCORD

DUCT SECTION C

①②③
④⑤⑥

DUCT NO.	SIZE (")	WIRE FILL
1	4	78#14, 1#14 GND
2	4	6#12, 1#12 GND
3	4	9#8, 1#12 GND
4	4	9-2/C#16 SH
5	4	28#14, 1#14 GND
6	4	42#14, 1#14GND

DUCT SECTION D

①②
③④

DUCT NO.	SIZE (")	WIRE FILL
1	4	76#14, 1#14 GND
2	4	6#12, 1#12 GND
3	4	9-2/C#16 SH
4	4	28#14, 1#14 GND

DUCT SECTION F

①②

DUCT NO.	SIZE (")	WIRE FILL
1	2	6#8, 1#12 GND
2	2	28#14, 1#14 GND

DUCT SECTION E

①②

DUCT NO.	SIZE (")	WIRE FILL
1	4	9#8, 1#12 GND
2	4	42#14, 1#14 GND

DUCT SECTION H

①②
③④

DUCT NO.	SIZE (")	WIRE FILL
1	4	6#10, 3#1, 1#8GND
2	4	6#10, 1#12 GND
3	4	34#14, 1#14 GND
4	4	4-2/C#16 SH

DUCT SECTION G

①②

DUCT NO.	SIZE (")	WIRE FILL
1	4	3#1/0, 1#6 GND
2	4	PULLCORD

DUCT SECTION I

①②
③④

DUCT NO.	SIZE (")	WIRE FILL
1	4	3#10, 3#1, 1#8GND
2	4	4#10, 1#12 GND
3	4	20#14, 1#14 GND
4	4	2-2/C#16 SH

DUCT SECTION L

①②

DUCT NO.	SIZE (")	WIRE FILL
1	4	76#14, 1#14 GND
2	4	9-2/C#16 SH

DUCT SECTION M

①②
③④

DUCT NO.	SIZE (")	WIRE FILL
1	4	3#8, 3#2, 1#8GND
2	4	6#10, 1#12 GND
3	4	24#14, 1#14 GND
4	4	3-2/C#16 SH

DUCT SECTION N

①②③

DUCT NO.	SIZE (")	WIRE FILL
1	2	2#12, 1#12 GND
2	2	16#14, 1#14 GND
3	2	2-2/C#16 SH

DUCT SECTION J

①②
③④

DUCT NO.	SIZE (")	WIRE FILL
1	2	3#10, 1#12GND
2	2	2#10, 1#12 GND
3	2	14#14, 1#14 GND
4	2	2-2/C#16 SH

DUCT SECTION K1

①②
③④

DUCT NO.	SIZE (")	WIRE FILL
1	4	6#10, 1#12GND
2	4	4#10, 1#12 GND
3	4	46#14, 1#14 GND
4	4	7-2/C#16 SH

DUCT SECTION K2

①②
③④

DUCT NO.	SIZE (")	WIRE FILL
1	4	3#10, 1#12GND
2	4	2#10, 1#12 GND
3	4	62#14, 1#14 GND
4	4	8-2/C#16 SH

DATE	REVISIONS

STATE OF KENTUCKY — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
SITE PLAN AND DUCT SECTIONS

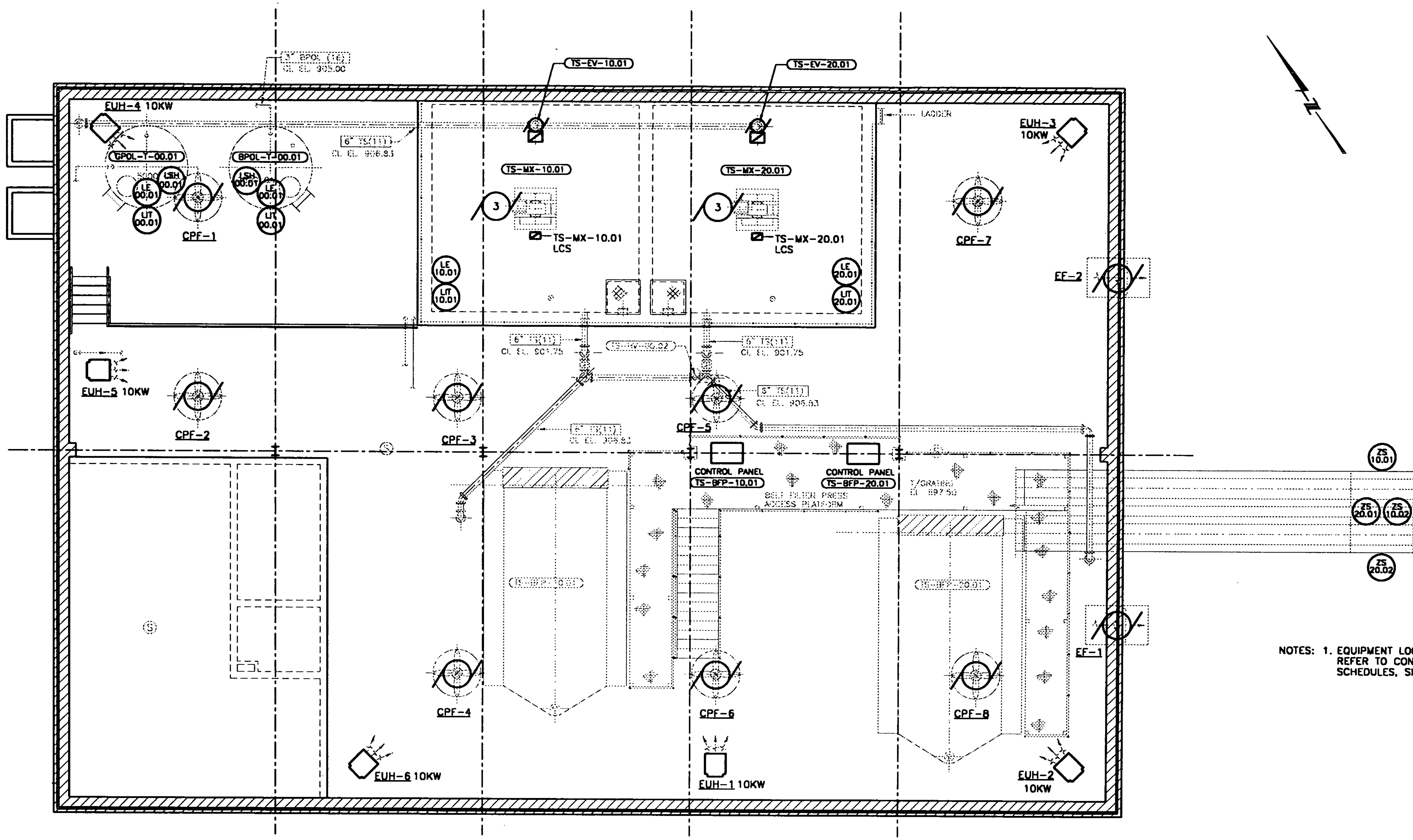
MONTGOMERY WATSON

DRAWN BY: SB
PROJECT ENG'R: BMS
APPROVED: DAR

DATE: JUNE 1999 USE DIMENSIONS ONLY
SCALE 1" = 40'

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-089



NOTES: 1. EQUIPMENT LOCATIONS ONLY ARE SHOWN. REFER TO CONDUIT DEVELOPMENTS AND SCHEDULES, SHEETS 095 THROUGH 103.

PLAN AT EL. 907.83

SCALE: 3/16" = 1'-0"

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

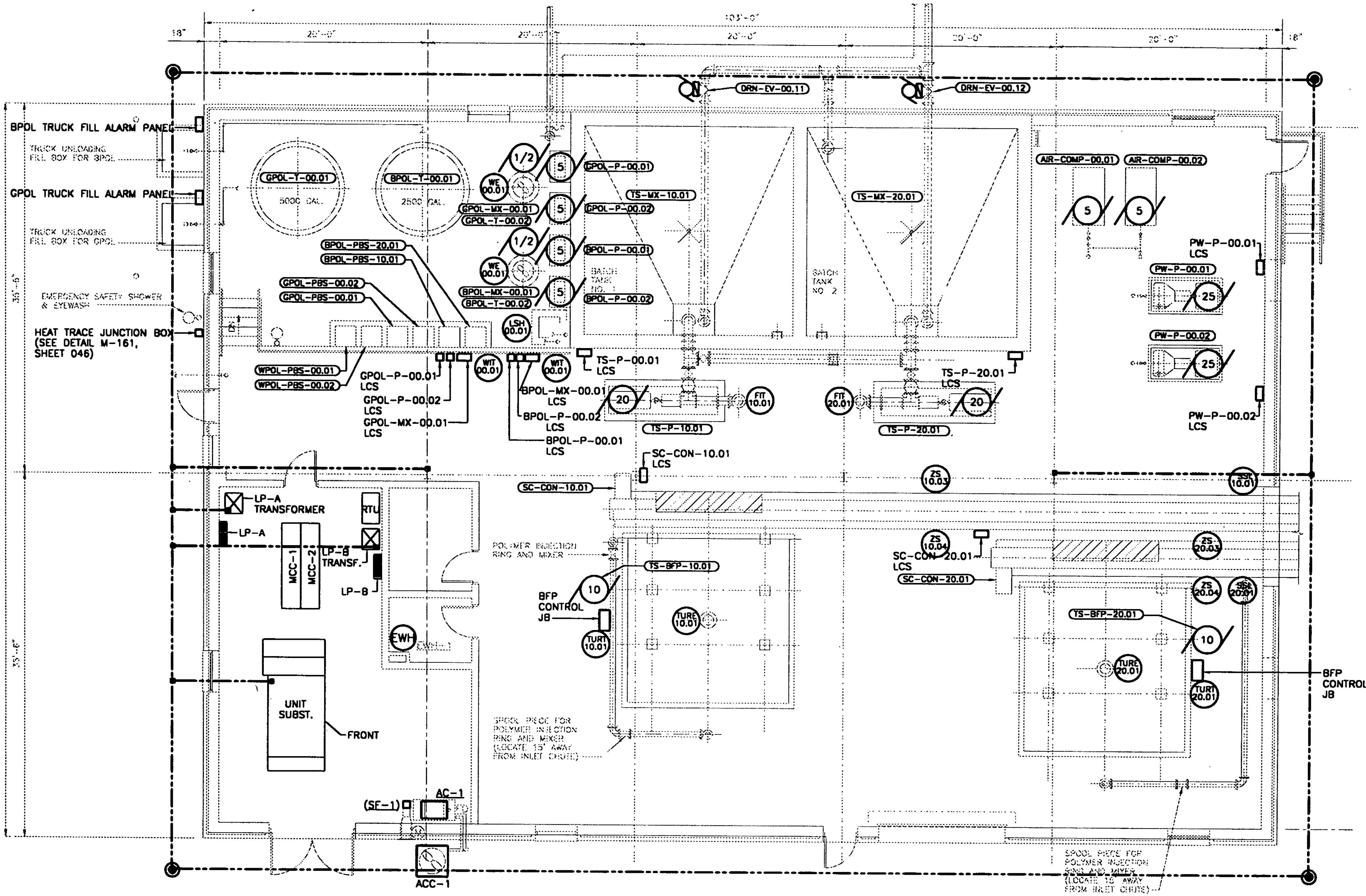
ELECTRICAL
DEWATERING BUILDING PLANT AT EL. 907.83

MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-090



PLAN AT EL. 888.50

SCALE: 3/16" = 1'-0"

NOTES:

1. EQUIPMENT LOCATIONS ONLY ARE SHOWN. REFER TO CONDUIT DEVELOPMENTS AND SCHEDULES, SHEETS 095 THROUGH 103.
2. REFER TO SECTION 16450 OF THE SPECIFICATIONS FOR GROUNDING REQUIREMENTS.

DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
DEWATERING BUILDING PLAN AT EL. 888.50

MONTGOMERY WATSON

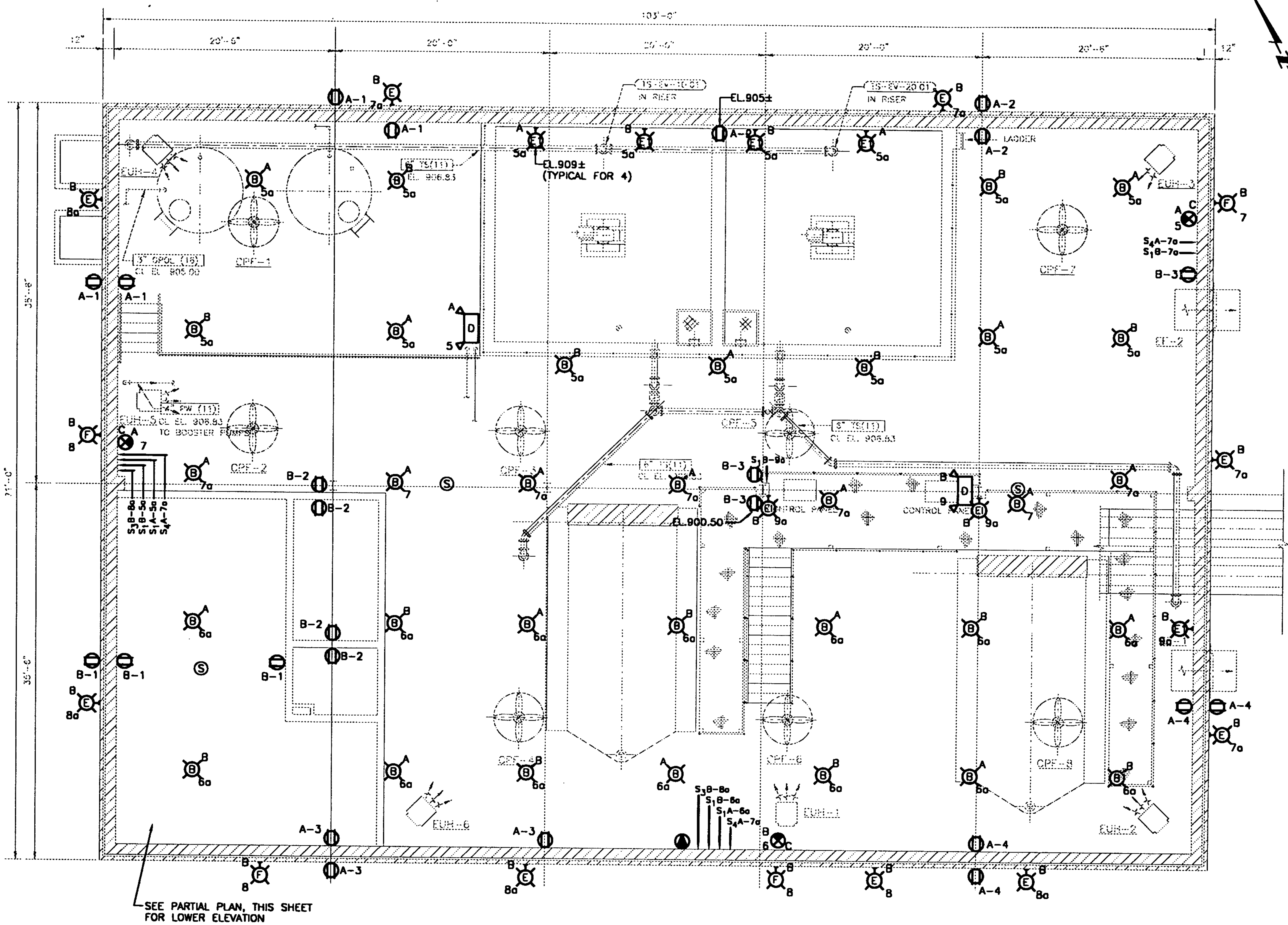
DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS

DATE: JUNE 1999

USE DIMENSIONS ONLY
SCALE AS SHOWN

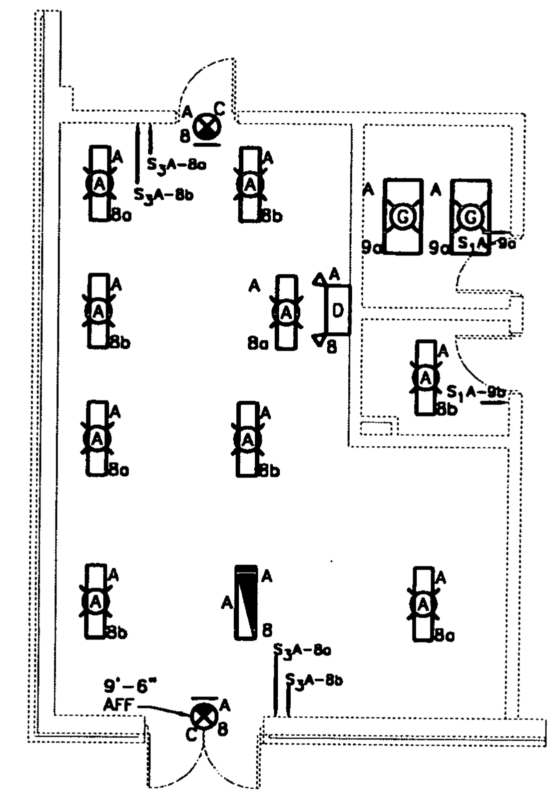
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-091



PLAN AT EL. 907.83

SCALE: 3/16" = 1'-0"



PARTIAL PLAN AT EL. 888.50

SCALE: 3/16" = 1'-0"

NOTES:

1. MOUNT TYPE A AND D FIXTURES 9'-6" A.F.F. UNLESS OTHERWISE NOTED.
2. MOUNT TYPE B FIXTURES 19'-0" A.F.F. UNLESS OTHERWISE NOTED.
3. MOUNT TYPE E FIXTURES 13'-4" ABOVE GRADE UNLESS OTHERWISE NOTED.
4. MOUNT TYPE E1 FIXTURES 7'-6" A.F.F. UNLESS OTHERWISE NOTED.
5. MOUNT TYPE F FIXTURES 10'-0" A.F.F. UNLESS OTHERWISE NOTED.
6. SEE GENERAL NOTE 15.
7. REFER ALSO TO ARCHITECTURAL DEWATERING BUILDING ELEVATIONS SHEETS 026 AND 027. FOR OUTDOOR LIGHTING.
8. CONDUIT AND WIRE FOR LIGHTING AND RECEPTACLES SHALL BE 3/4" CONDUIT WITH 2#12, 1#12 GND MINIMUM. ADD ADDITIONAL CONDUCTORS AS REQUIRED. DERATE CONDUCTOR SIZE WHERE REQUIRED BY THE N.E.C.
9. REFER TO SECTION 16500 OF THE SPECIFICATIONS FOR LIGHTING FIXTURE SCHEDULE.

DATE	REVISIONS

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
DEWATERING BUILDING LIGHTING PLAN

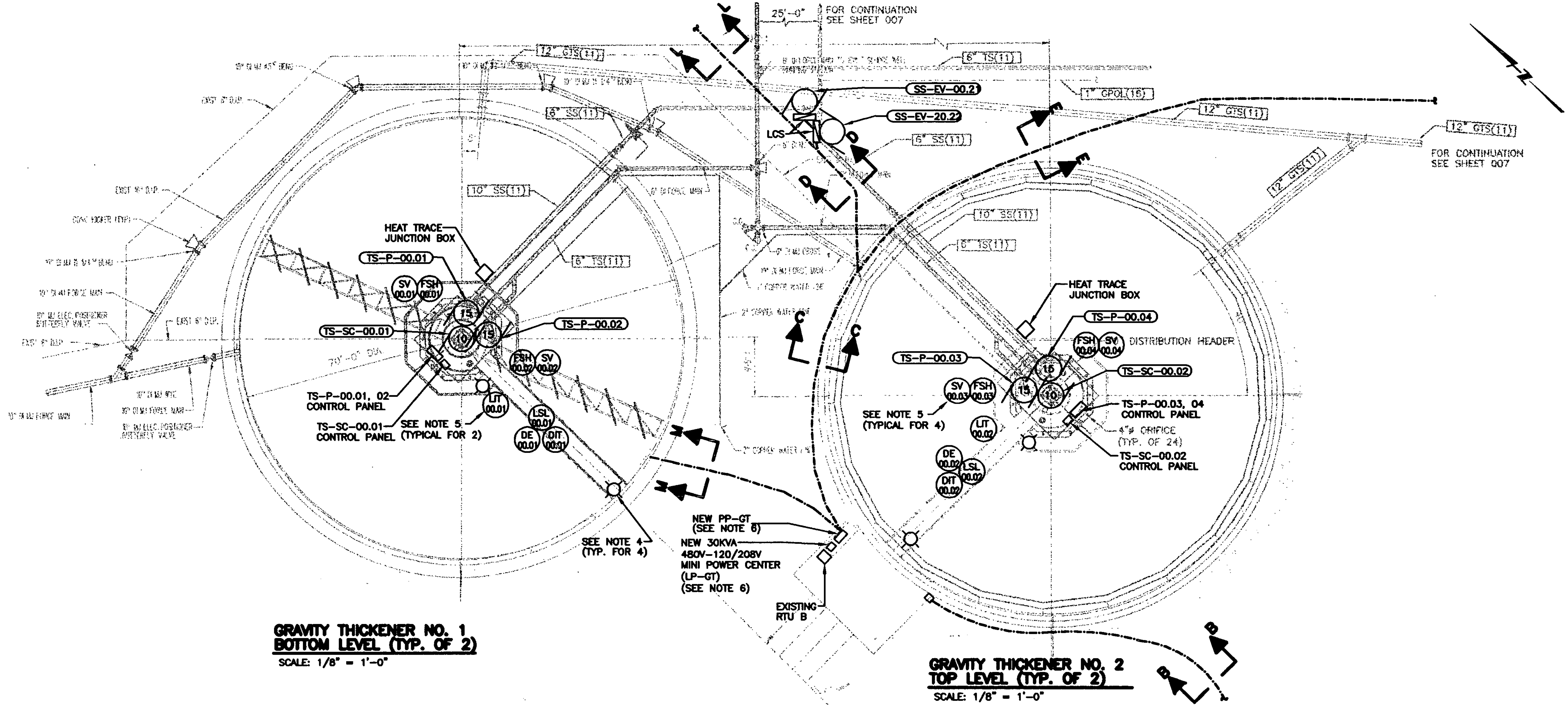
MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS

DATE: JUNE 1999 USE DIMENSIONS ONLY SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-092



GRAVITY THICKENER NO. 1 BOTTOM LEVEL (TYP. OF 2)

SCALE: 1/8" = 1'-0"

GRAVITY THICKENER NO. 2 TOP LEVEL (TYP. OF 2)

SCALE: 1/8" = 1'-0"

NOTES:
1. REFER TO SHEETS 010 AND 011 FOR DEMOLITION WORK IN THIS AREA.
2. REMOVE EXISTING CONDUIT AND WIRE ASSOCIATED WITH THE EXISTING PUMPS, PUMP PANELS AND ASSOCIATED DEVICES. SEE NOTE 1.
3. REFER TO SHEETS 078 AND 079 FOR DEMOLITION AND REPLACEMENT OF THE POWER DISTRIBUTION IN THIS AREA.
4. REMOVE EXISTING CONDUIT AND WIRE ASSOCIATED WITH THE EXISTING WALKWAY LIGHTING. SEE NOTE 1. FEED THE REINSTALLED LIGHTING FIXTURES FROM LP-GT USING 2#12, 1#12G AND 3/4" CONDUIT MINIMUM.
5. REINSTALL EXISTING LEVEL TRANSMITTERS, SOLENOID VALVES, AND FLOW SWITCHES.
6. STRUT MOUNT NEW PP-GT AND LP-GT ON EXISTING MCC-WH EQUIPMENT PAD.

DATE	REVISIONS

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

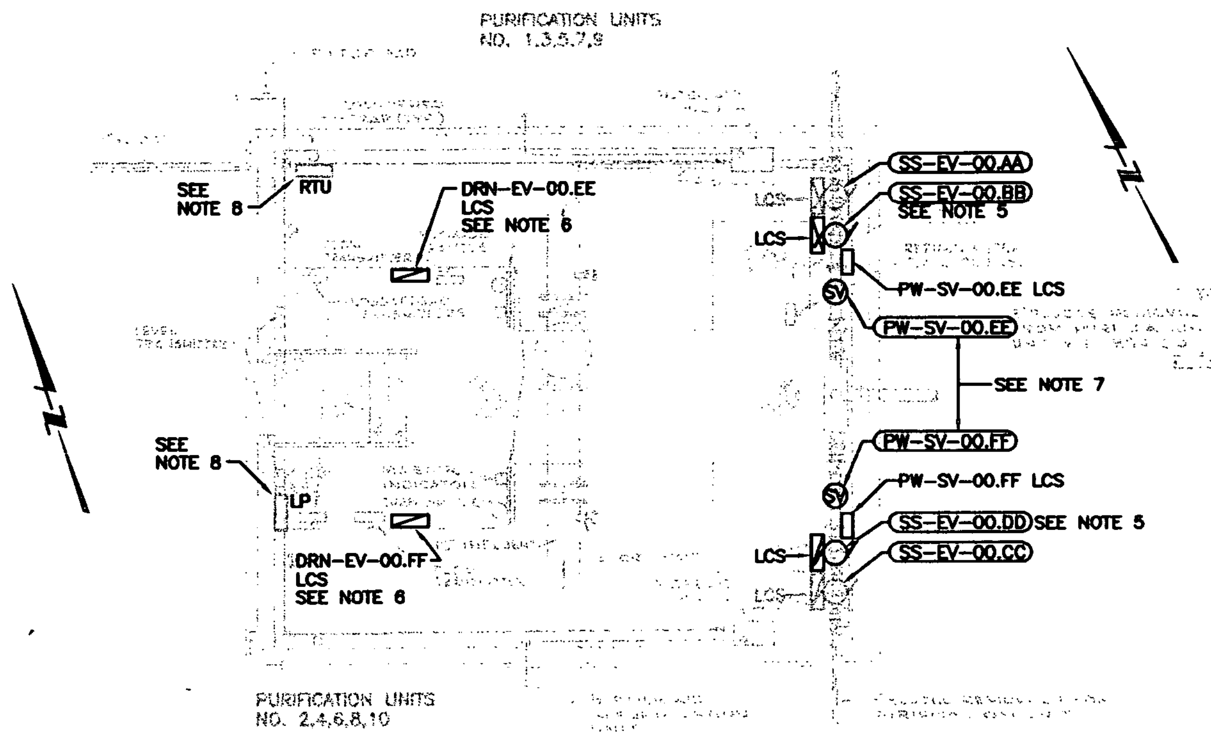
ELECTRICAL
GRAVITY THICKENERS PLAN

MONTGOMERY WATSON

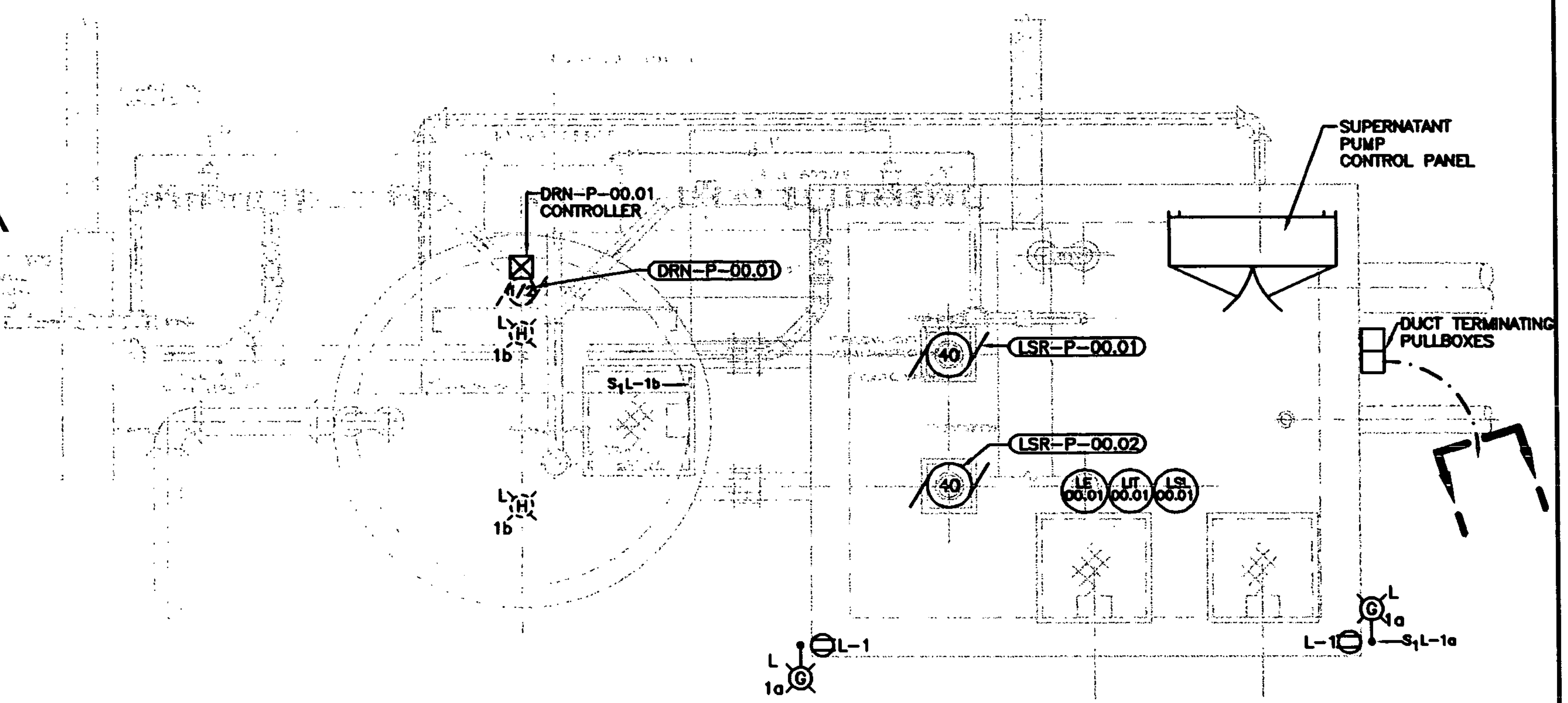
DRAWN BY: SB
PROJECT ENG'R: BMS
APPROVED: DAR
DATE: JUNE 1999
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

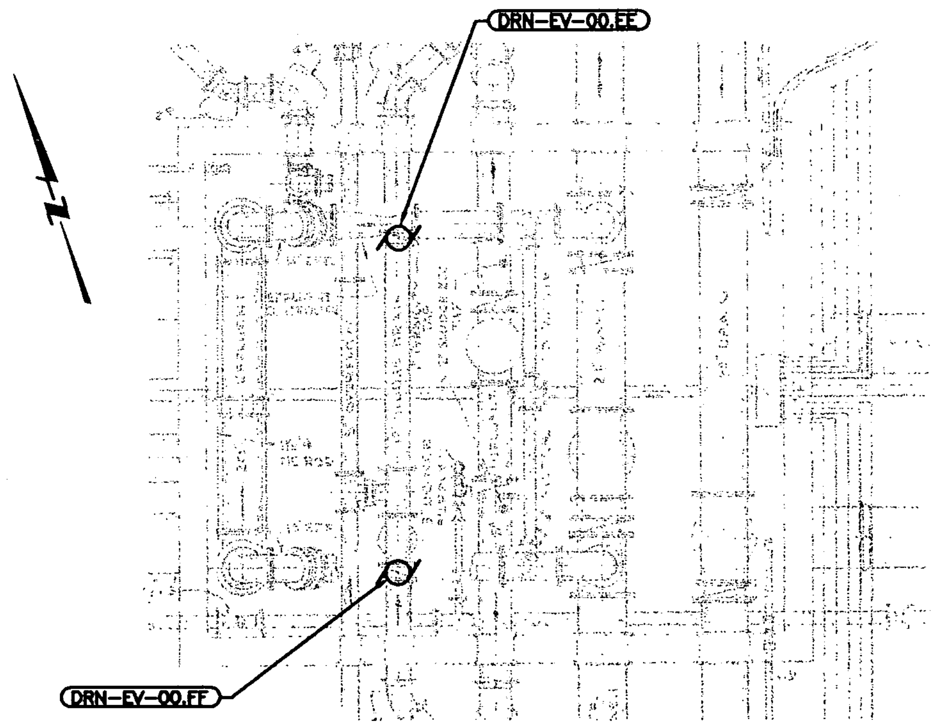
380-575-093



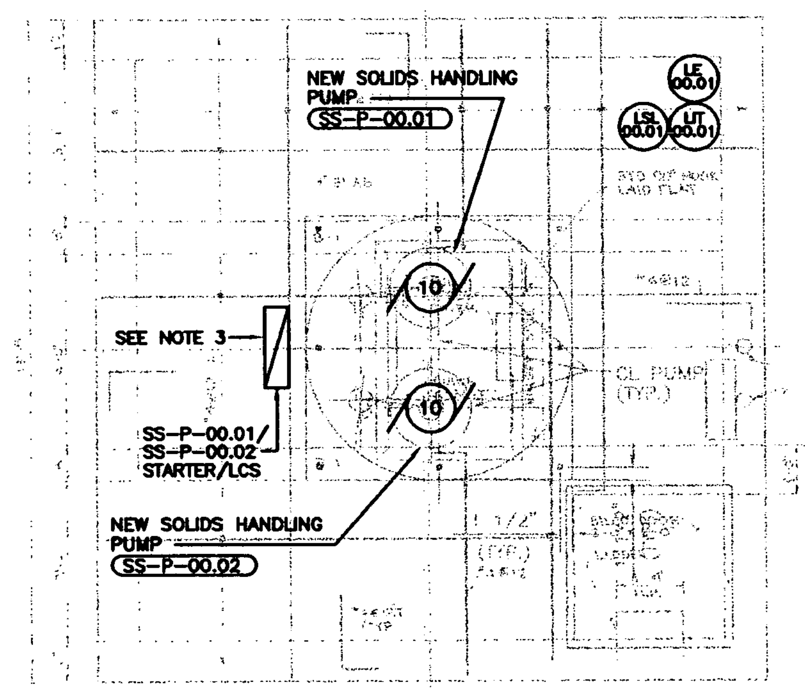
TYPICAL VALVE HOUSE UPPER PLAN (TYPICAL OF 5) SEE NOTE 1
SCALE: 1/4" = 1'-0"



LAGOON SUPERNATANT VAULT NO.2 PLAN SEE NOTE 4
SCALE: 3/8" = 1'-0"



TYPICAL VALVE HOUSE LOWER PLAN (TYPICAL OF 5) SEE NOTE 1
SCALE: 1/4" = 1'-0"



SLUDGE WELL PLAN SEE NOTE 2
SCALE: 1/2" = 1'-0"

NOTES:
1. REFER TO SHEETS 032 AND 033 FOR TYPICAL VALVE HOUSE SECTIONS.
2. REFER TO SHEETS 034 FOR SLUDGE WELL SECTIONS.
3. FURNISH AND INSTALL NEW 60A DISCONNECT AND COMB. CB FVNR NEMA SIZE 1 STARTERS. TERMINATE EXISTING POWER FEED AND EXTEND NEW CONDUIT AND WIRE TO THE NEW SOLIDS HANDLING PUMPS.
4. REFER TO SHEET 042 FOR LAGOON SUPERNATANT VAULT NO.2 SECTIONS.
5. PROVIDE 120 VAC TO VALVES SS-EV-00.BB AND SS-EV-00.DD FROM EXISTING LIGHTING PANEL.
6. PROVIDE 120 VAC TO VALVES DRN-EV-00.EE AND DRN-EV-00.FF FROM EXISTING LIGHTING PANEL.
7. PROVIDE 120V POWER TO THE FLUSHING WATER SOLENOID VALVES FROM EXISTING LIGHTING PANEL.
8. FIELD VERIFY LOCATIONS OF EXISTING LIGHTING PANELS AND RTU'S.
9. REMOVE CONDUIT AND WIRE ASSOCIATED WITH ELECTRICAL EQUIPMENT REMOVED ON SHEET 037.

VALVE HOUSE USAGE TABLE

VALVE HOUSE	AA=	BB=	CC=	DD=	EE=	FF=	X=
1	01	02	03	04	01	02	1
2	05	06	07	08	03	04	2
3	09	10	11	12	05	06	3
4	13	14	15	16	07	08	4
5	17	18	19	20	09	10	5

DATE	REVISIONS

WARNING
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KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
VAULT PLANS

MONTGOMERY WATSON

DRAWN BY: LW
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
USE DIMENSIONS ONLY SCALE AS SHOWN

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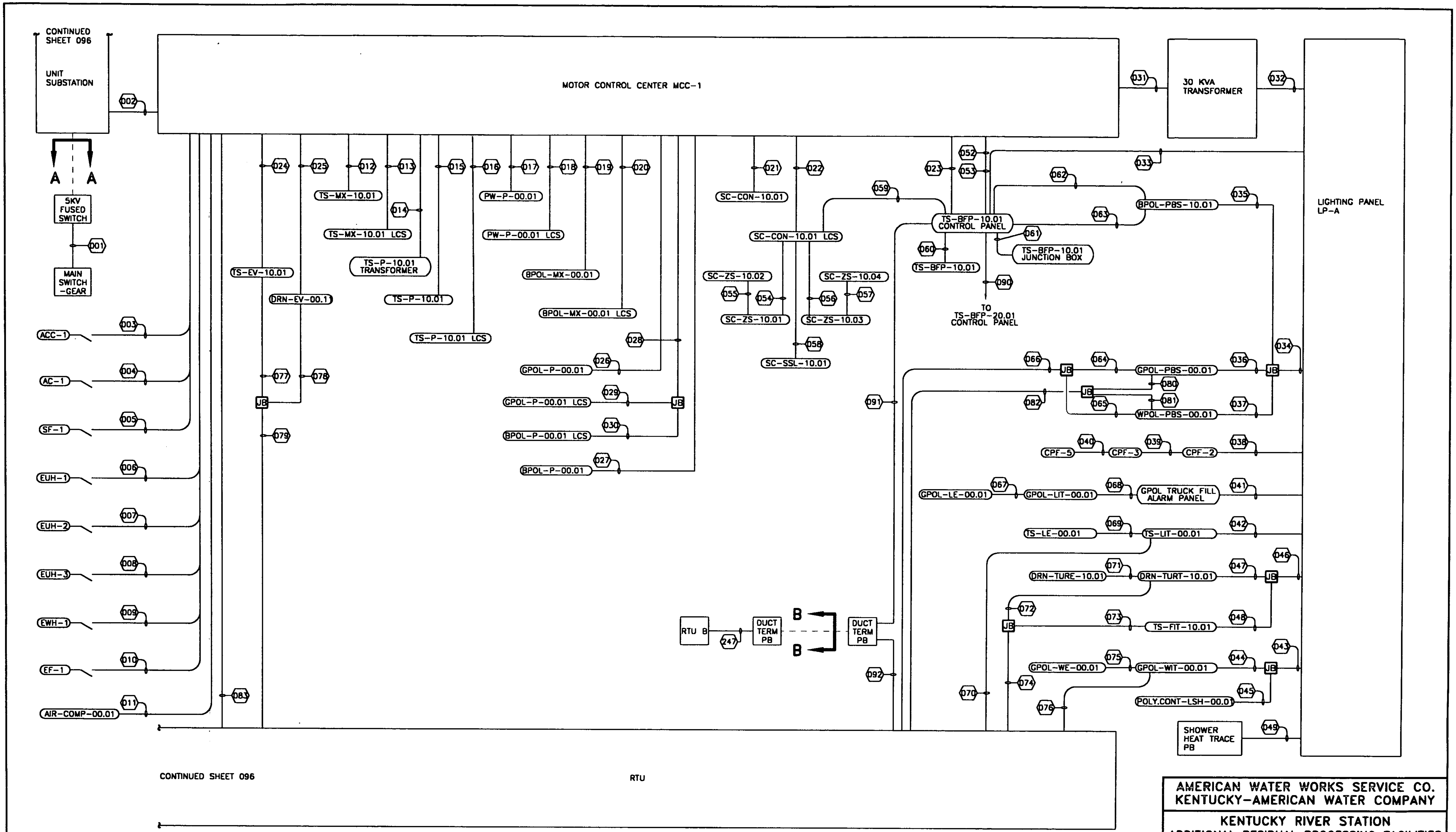
380-575-094



DATE	REVISIONS

STATE OF KENTUCKY
ROBERT SCHUBACH
19941
REGISTERED
PROFESSIONAL ENGINEER

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KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
CONDUIT DEVELOPMENT I

MONTGOMERY WATSON

DRAWN BY: CJP
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

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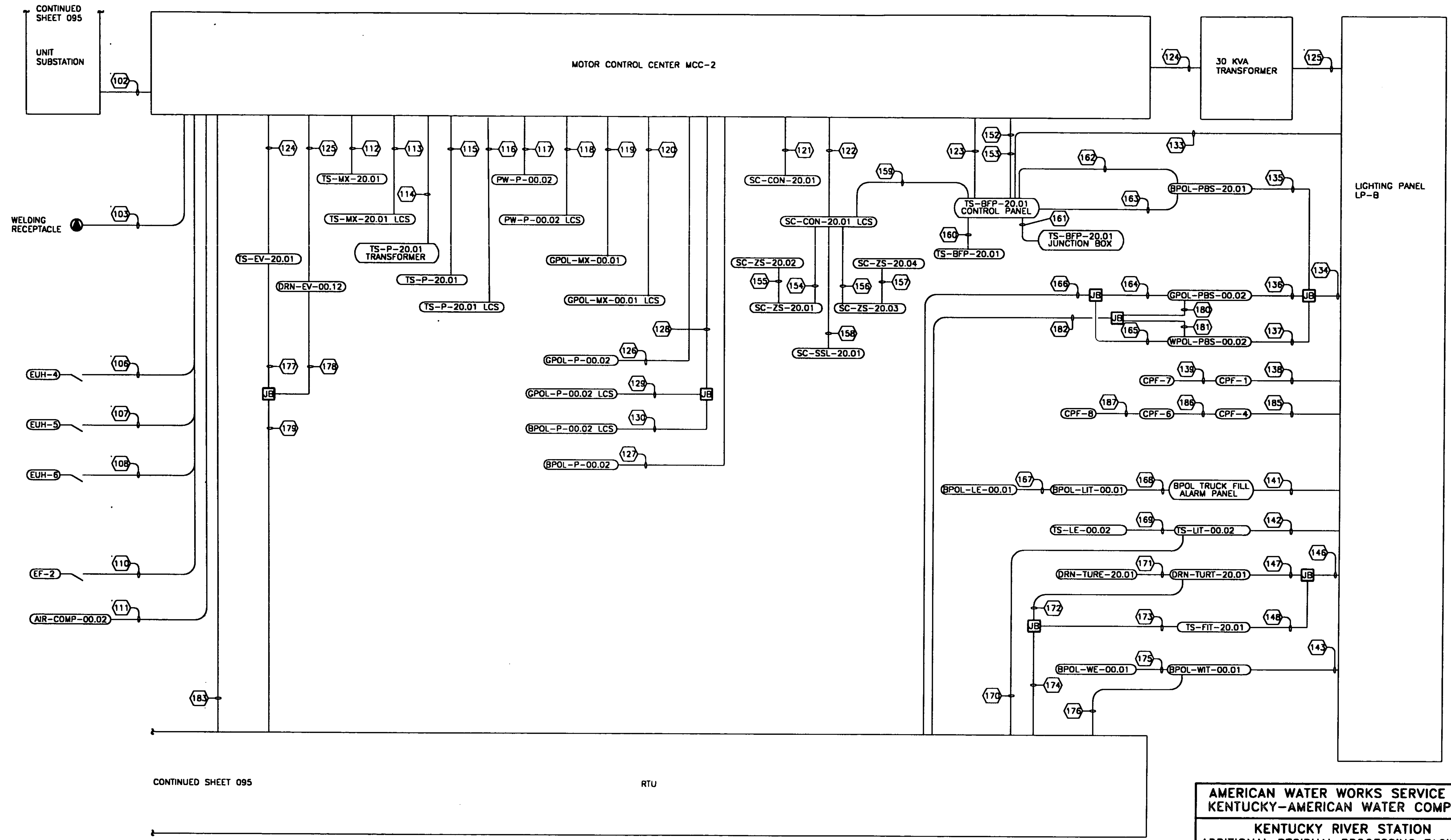
380-575-095



DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

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KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

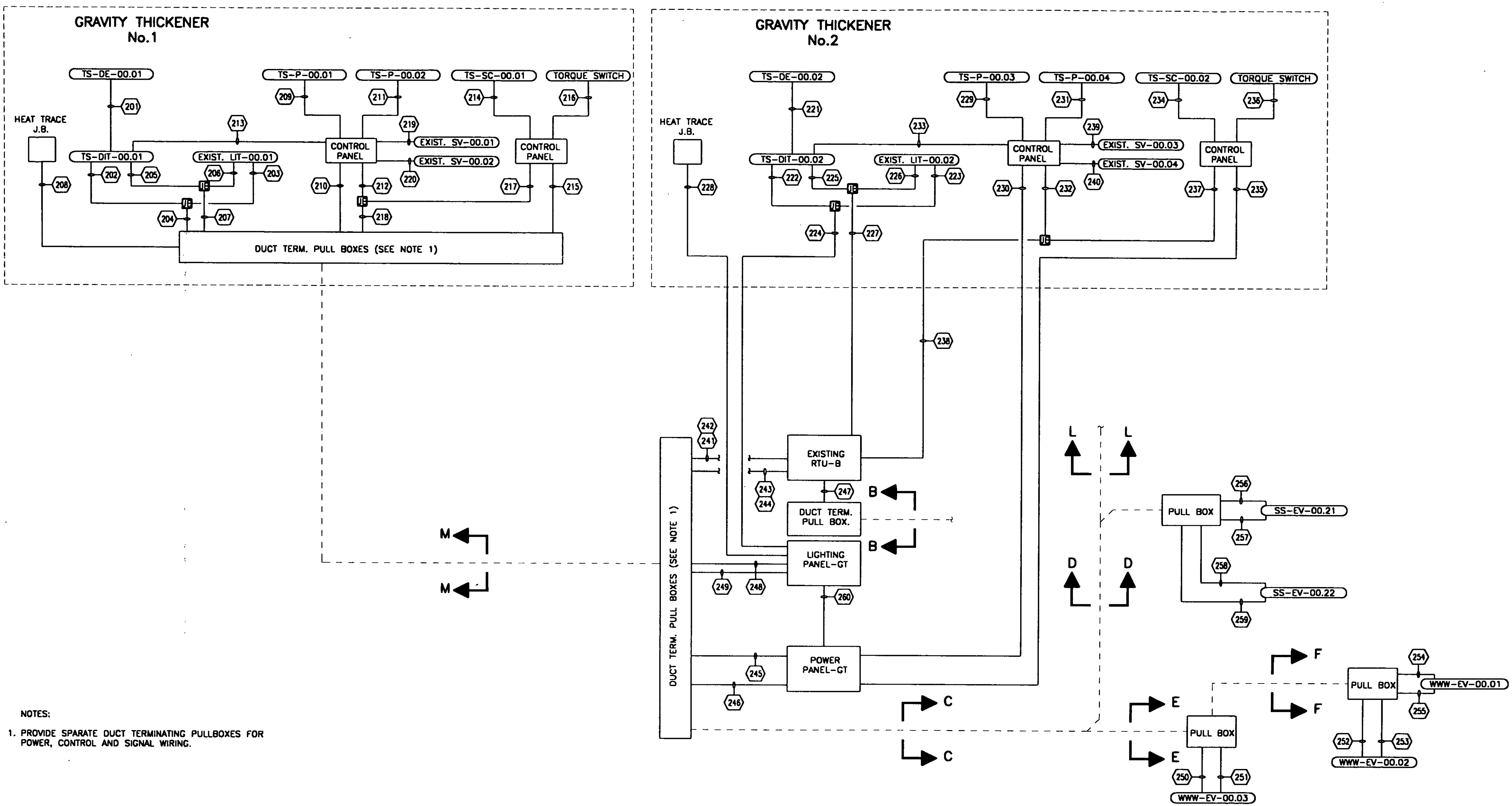
ELECTRICAL
CONDUIT DEVELOPMENT II

MONTGOMERY WATSON

DRAWN BY: CJP
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-096



NOTES:

1. PROVIDE SPARATE DUCT TERMINATING PULLBOXES FOR POWER, CONTROL AND SIGNAL WIRING.

CONDUIT DEVELOPMENT AND GRAVITY THICKENERS

DATE	REVISIONS

STATE OF KENTUCKY ROBERT SCHUBACH 19941 REGISTERED PROFESSIONAL ENGINEER

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KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

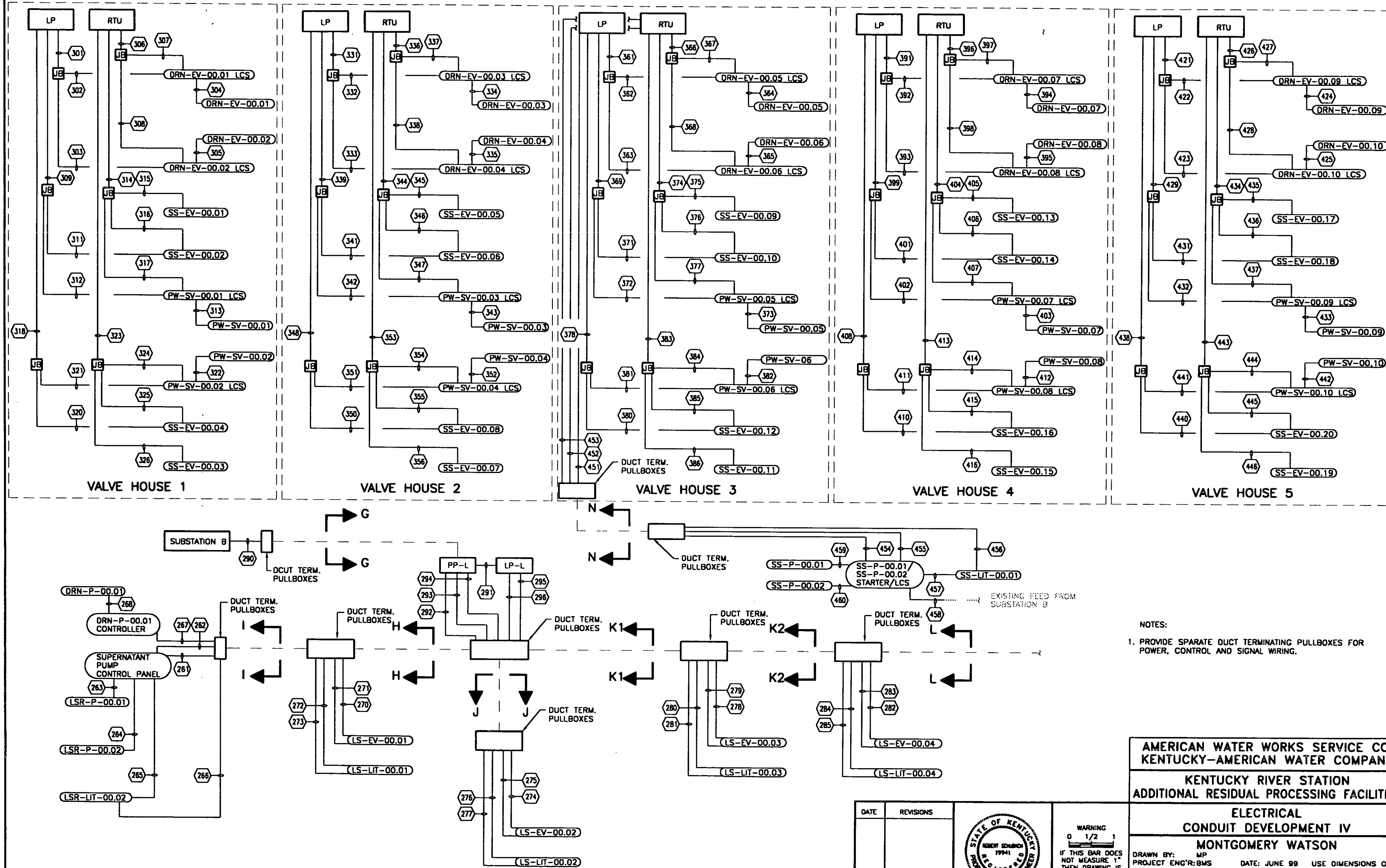
ELECTRICAL
ELECTRICAL CONDUIT DEVELOPMENTS III

MONTGOMERY WATSON

DRAWN BY: MP
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-097



NOTES:

1. PROVIDE SPARATE DUCT TERMINATING PULLBOXES FOR POWER, CONTROL AND SIGNAL WIRING.

DATE	REVISIONS

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ROBERT SCHUBACH
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KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
CONDUIT DEVELOPMENT IV

MONTGOMERY WATSON

DRAWN BY: MP
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 99
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380-575-098

CONDUIT NO.	CONDUIT SIZE	POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
001	4	3-500 KCML, 1#2 GND				MAIN SWITCHGEAR	5KV FUSED SWITCH	5 KV CABLE	
002	4	3-500 KCML, 1#2 GND				UNIT SUBSTATION	MCC-1		
003	3/4	3#12, 1#12 GND				ACC-1	MCC-1		
004	3/4	3#10, 1#10 GND				AC-1	MCC-1		
005	3/4	3#12, 1#12 GND				SF-1	MCC-1		
006	3/4	3#12, 1#12 GND				EUH-1	MCC-1		
007	3/4	3#12, 1#12 GND				EUH-2	MCC-1		
008	3/4	3#12, 1#12 GND				EUH-3	MCC-1		
009	3/4	3#12, 1#12 GND				EWH-1	MCC-1		
010	3/4	6#12, 1#12 GND				EF-1	MCC-1		
011	3/4	3#12, 1#12 GND				AIR-COMP-00.01	MCC-1		
012	3/4	3#12, 1#12 GND				TS-MX-10.01	MCC-1		
013	3/4		10#14, 1#14 GND		4#14	TS-MX-10.01 LCS	MCC-1		
014	1 1/2	6#6, 1#10 GND				TS-P-10.01 TRANSFORM.	MCC-1		
015	3/4	3#8, 1#10 GND				TS-P-10.01	MCC-1		
016	3/4		10#14, 1#14 GND		4#14	TS-P-=10.01 LCS	MCC-1		
017	3/4	3#8, 1#10 GND				PW-P-00.01	MCC-1		
018	3/4		10#14, 1#14 GND		4#14	PW-P-00.01 LCS	MCC-1		
019	3/4	3#12, 1#12 GND				BPOL-MX-00.01	MCC-1		
020	3/4		8#14, 1#14 GND		2#14	BPOL-MX-00.01 LCS	MCC-1		
021	3/4	3#10, 1#10 GND				SC-CON-10.01	MCC-1		
022	3/4		10#14, 1#14 GND		4#14	SC-CON-10.01 LCS	MCC-1		
023	3/4	3#8, 1#10 GND				TS-BFP-10.01 PANEL	MCC-1		
024	3/4	3#12, 1#12 GND				TS-EV-10.01	MCC-1		
025	3/4	3#12, 1#12 GND				DRN-EV-00.01	MCC-1		
026	3/4	3#12, 1#12 GND				GPOL-P-00.01	MCC-1		
027	3/4	3#12, 1#12 GND				BPOL-P-00.01	MCC-1		
028	3/4		8#14, 1#14 GND		4#14	JB	MCC-1		
029	3/4		4#14, 1#14 GND		2#14	GPOL-P-00.01 LCS	JB		
030	3/4		4#14, 1#14 GND		2#14	BPOL-P-00.01 LCS	JB		
031	3/4	3#8, 1#10 GND				MCC-1	30 KVA TRANSFORMER		
032	1 1/2	3#2, 1#8 GND				30 KVA TRANSFORMER	LIGHTING PANEL LP-A		
033	3/4	2#12, 1#12 GND				TS-BFP-10.01 PANEL	LIGHTING PANEL LP-A		
034	3/4	6#12, 1#12 GND				JB	LIGHTING PANEL LP-A		
035	3/4	2#12, 1#12 GND				BPOL-PBS-10.01	LIGHTING PANEL LP-A		
036	3/4	2#12, 1#12 GND				GPOL-PBS-00.01	JB		
037	3/4	2#12, 1#12 GND				WPOL-PBS-00.01	JB		
038	3/4	2#12, 1#12 GND				CPF-2	LIGHTING PANEL LP-A		
039	3/4	2#12, 1#12 GND				CPF-3	CPF-2		
040	3/4	2#12, 1#12 GND				CPF-5	CPF-3		
041	3/4	2#12, 1#12 GND				GPOL TRUCK FILL PANEL	LIGHTING PANEL LP-A		
042	3/4	2#12, 1#12 GND				TS-LIT-00.01	LIGHTING PANEL LP-A		
043	3/4	4#12, 1#12 GND				JB	LIGHTING PANEL LP-A		
044	3/4	2#12, 1#12 GND				GPOL-WIT-00.01	JB		
045	3/4	2#12, 1#12 GND				POLY.CONT-LSH-00.01	JB		
046	3/4	4#12, 1#12 GND				JB	LIGHTING PANEL LP-A		
047	3/4	2#12, 1#12 GND				DRN-TURT-10.01	JB		
048	3/4	2#12, 1#12 GND				TS-FIT-10.01	JB		
049	3/4	2#12, 1#12 GND				SHOW. HEAT TRACE PB	LIGHTING PANEL LP-A		
050								NOT USED	
051								NOT USED	
052	1 1/2		24#14, 1#14 GND		6#14	TS-BFP-10.01 PANEL	MCC-1		
053	1			2-2/C,1-3/C#16	1-2/C #16(SH)	TS-BFP-10.01 PANEL	MCC-1	(SH)	
054	3/4		2#14, 1#14 GND			SC-ZS-10.01	SC-CON-10.01 LCS		
055	3/4		4#14, 1#14 GND		2#14	SC-ZS-10.01	SC-ZS-10.02		

CONDUIT NO.	CONDUIT SIZE	POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
056	3/4		4#14, 1#14 GND		2#14	SC-ZS-10.03	SC-CON-10.01 LCS		
057	3/4		8#14, 1#14 GND		4#14	SC-ZS-10.03	SC-ZS-10.04		
058	3/4		6#14, 1#14 GND		2#14	SC-SSL-10.01	SC-CON-10.01 LCS		
059	3/4		10#14, 1#14 GND		4#14	SC-CON-10.01 LCS	TS-BFP-10.01 PANEL		
060	3/4	3#10, 1#10 GND				TS-BFP-10.01	TS-BFP-10.01 PANEL		
061	1		16#14, 1#14 GND		4#14	TS-BFP-10.01 JUNC. BOX	TS-BFP-10.01 PANEL		
062	3/4			2-2/C #16(SH)		TS-BFP-10.01 PANEL	BPOL-PBS-10.01		
063	3/4		10#14, 1#14 GND		2#14	TS-BFP-10.01 PANEL	BPOL-PBS-10.01		
064	3/4		10#14, 1#14 GND		2#14	JB	GPOL-PBS-00.01		
065	3/4		10#14, 1#14 GND		2#14	JB	WPOL-PBS-00.01		
066	1		20#14, 1#14 GND		4#14	RTU	JB		
067	1			AS REQUIRED		GPOL-LE-00.01	GPOL-LIT-00.01		
068	3/4		6#14, 1#14 GND		2#14	GPOL-LIT-00.01	GPOL TRUCK FILL PANEL		
069	1			AS REQUIRED		TS-LE-00.01	TS-LIT-00.01		
070	3/4			1-2/C #16(SH)		RTU	TS-LIT-00.01		
071	1			AS REQUIRED		DRN-TURE-10.01	DRN-TURT-10.01		
072	3/4			1-2/C #16(SH)		JB	DRN-TURT-10.01		
073	3/4			1-2/C #16(SH)		JB	TS-FIT-10.01		
074	3/4			2-2/C #16(SH)		RTU	JB		
075	1			AS REQUIRED		GPOL-WE-00.01	GPOL-WIT-00.01		
076	3/4			1-2/C #16(SH)		RTU	GPOL-WIT-00.01		
077	1		14#14, 1#14 GND		4#14	JB	TS-EV-10.01		
078	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.11		
079	1 1/2		28#14, 1#14 GND		8#14	RTU	JB		
080	3/4			2-2/C #16(SH)		JB	GPOL-PBS-00.01		
081	3/4			2-2/C #16(SH)		JB	WPOL-PBS-00.01		
082	1 1/2			4-2/C #16(SH)		RTU	JB		
083	1		16#14, 1#14 GND		8#14	RTU	MCC-1		
084								NOT USED	
085								NOT USED	
086								NOT USED	
087								NOT USED	
088								NOT USED	
089								NOT USED	
090	1			F. O. CABLE		TS-BFP-10.01 PANEL	TS-BFP-20.01 PANEL		
091	1			F. O. CABLE		DUCT TERM PB	TS-BFP-10.01 PANEL		
092	1			F. O. CABLE		DUCT TERM PB	RTU		
093								NOT USED	
094								NOT USED	
095								NOT USED	
096								NOT USED	
097								NOT USED	
098								NOT USED	
099								NOT USED	
100								NOT USED	

* THE NUMBER IN THE SPARES WIRE FILL COLUMN INDICATES THE NUMBER OF SPARES INCLUDED IN THE CONTROL OR SIGNAL WIRE FILL COLUMN.

** THE CONDUIT LENGTH COLUMN IS LEFT BLANK INTENTIONALLY FOR THE CONTRACTOR'S USE.

DATE	REVISIONS

STATE OF KENTUCKY — ROBERT SCHUBACH — 19941 — REGISTERED PROFESSIONAL ENGINEER

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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
ELECTRICAL CONDUIT SCHEDULE I

MONTGOMERY WATSON

DRAWN BY: BMS
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

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380-575-099

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CONDUIT NO.	SIZE	CONDUCTORS POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
101								NOT USED	
102	3	3-500 KCMIL, 1#2 GND				UNIT SUBSTATION	MCC-2		
103	1	3#6, 1#10 GND				WELDING RECEPT.	MCC-2		
104								NOT USED	
105								NOT USED	
106	3/4	3#12, 1#12 GND				EUH-4	MCC-2		
107	3/4	3#12, 1#12 GND				EUH-5	MCC-2		
108	3/4	3#12, 1#12 GND				EUH-6	MCC-2		
109								NOT USED	
110	3/4	6#12, 1#12 GND				EF-2	MCC-2		
111	3/4	3#12, 1#12 GND				AIR-COMP-00.02	MCC-2		
112	3/4	3#12, 1#12 GND				TS-MX-20.01	MCC-2		
113	3/4		10#14, 1#14 GND		4#14	TS-MX-20.01 LCS	MCC-2		
114	1 1/2	6#6, 1#10 GND				TS-P-20.01 TRANSFORM.	MCC-2		
115	3/4	3#8, 1#10 GND				TS-P-20.01	MCC-2		
116	3/4		10#14, 1#14 GND		4#14	TS-P-=20.01 LCS	MCC-2		
117	3/4	3#8, 1#10 GND				PW-P-00.02	MCC-2		
118	3/4		10#14, 1#14 GND		4#14	PW-P-00.02 LCS	MCC-2		
119	3/4	3#12, 1#12 GND				BPOL-MX-00.02	MCC-2		
120	3/4		6#14, 1#14 GND		2#14	BPOL-MX-00.02 LCS	MCC-2		
121	3/4	3#10, 1#10 GND				SC-CON-20.01	MCC-2		
122	3/4		10#14, 1#14 GND		4#14	SC-CON-20.01 LCS	MCC-2		
123	3/4	3#8, 1#10 GND				TS-BFP-20.01 PANEL	MCC-2		
124	3/4	3#12, 1#12 GND				TS-EV-20.01	MCC-2		
125	3/4	3#12, 1#12 GND				DRN-EV-00.02	MCC-2		
126	3/4	3#12, 1#12 GND				GPOL-P-00.02	MCC-2		
127	3/4	3#12, 1#12 GND				BPOL-P-00.02	MCC-2		
128	3/4		8#14, 1#14 GND		4#14	JB	MCC-2		
129	3/4		4#14, 1#14 GND		2#14	GPOL-P-00.02 LCS	JB		
130	3/4		4#14, 1#14 GND		2#14	BPOL-P-00.02 LCS	JB		
131	3/4	3#8, 1#10 GND				MCC-2	30 KVA TRANSFORMER		
132	1 1/2	3#2, 1#8 GND				30 KVA TRANSFORMER	LIGHTING PANEL LP-B		
133	3/4	2#12, 1#12 GND				TS-BFP-20.01 PANEL	LIGHTING PANEL LP-B		
134	3/4	6#12, 1#12 GND				JB	LIGHTING PANEL LP-B		
135	3/4	2#12, 1#12 GND				BPOL-PBS-20.01	LIGHTING PANEL LP-B		
136	3/4	2#12, 1#12 GND				GPOL-PBS-00.02	JB		
137	3/4	2#12, 1#12 GND				WPOL-PBS-00.02	JB		
138	3/4	2#12, 1#12 GND				CPF-1	LIGHTING PANEL LP-B		
139	3/4	2#12, 1#12 GND				CPF-7	CPF-1		
140								NOT USED	
141	3/4	2#12, 1#12 GND				BPOL TRUCK FILL PANEL	LIGHTING PANEL LP-B		
142	3/4	2#12, 1#12 GND				TS-LIT-00.01	LIGHTING PANEL LP-B		
143	3/4	2#12, 1#12 GND				BPOL-WIT-00.01	LIGHTING PANEL LP-B		
144								NOT USED	
145								NOT USED	
146	3/4	4#12, 1#12 GND				JB	LIGHTING PANEL LP-B		
147	3/4	2#12, 1#12 GND				DRN-TURT-20.01	JB		
148	3/4	2#12, 1#12 GND				TS-FIT-20.01	JB		
149								NOT USED	
150								NOT USED	
151								NOT USED	
152	1 1/2		24#14, 1#14 GND		6#14	TS-BFP-20.01 PANEL	MCC-2		
153	1			2-2/C,1-3/C#16	1-2/C #16(SH)	TS-BFP-20.01 PANEL	MCC-2		
154	3/4		2#14, 1#14 GND			SC-ZS-20.01	SC-CON-20.01 LCS		
155	3/4		4#14, 1#14 GND		2#14	SC-ZS-20.01	SC-ZS-20.02		

CONDUIT NO.	SIZE	CONDUCTORS POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
156	3/4		4#14, 1#14 GND		2#14	SC-ZS-20.03	SC-CON-20.01 LCS		
157	3/4		8#14, 1#14 GND		4#14	SC-ZS-20.03	SC-ZS-20.04		
158	3/4		6#14, 1#14 GND		2#14	SC-SSL-20.01	SC-CON-20.01 LCS		
159	3/4		10#14, 1#14 GND		4#14	SC-CON-20.01 LCS	TS-BFP-20.01 PANEL		
160	3/4	3#10, 1#10 GND				TS-BFP-20.01	TS-BFP-20.01 PANEL		
161	1		16#14, 1#14 GND		4#14	TS-BFP-20.01 JUNC. BOX	TS-BFP-20.01 PANEL		
162	3/4			2-2/C #16(SH)		TS-BFP-20.01 PANEL	BPOL-PBS-20.01		
163	3/4		10#14, 1#14 GND		2#14	TS-BFP-20.01 PANEL	BPOL-PBS-20.01		
164	3/4		10#14, 1#14 GND		2#14	JB	GPOL-PBS-00.02		
165	3/4		10#14, 1#14 GND		2#14	JB	WPOL-PBS-00.02		
166	1		20#14, 1#14 GND		4#14	RTU	JB		
167	1			3-2/C #16(SH)		BPOL-LE-00.01	BPOL-LIT-00.01		
168	3/4		6#14, 1#14 GND		2#14	BPOL-LIT-00.01	BPOL TRUCK FILL PANEL		
169	1			3-2/C #16(SH)		TS-LE-00.02	TS-LIT-00.02		
170	3/4			1-2/C #16(SH)		RTU	TS-LIT-00.02		
171	1			3-2/C #16(SH)		DRN-TURE-20.01	DRN-TURT-20.01		
172	3/4			1-2/C #16(SH)		JB	DRN-TURT-20.01		
173	3/4			1-2/C #16(SH)		JB	TS-FIT-20.01		
174	3/4			2-2/C #16(SH)		RTU	JB		
175	1			3-2/C #16(SH)		BPOL-WE-00.01	BPOL-WIT-00.01		
176	3/4			1-2/C #16(SH)		RTU	BPOL-WIT-00.01		
177	1		14#14, 1#14 GND		4#14	JB	TS-EV-20.01		
178	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.12		
179	1 1/2		28#14, 1#14 GND		8#14	RTU	JB		
180	3/4			2-2/C #16(SH)		JB	GPOL-PBS-00.02		
181	3/4			2-2/C #16(SH)		JB	WPOL-PBS-00.02		
182	1 1/2			4-2/C #16(SH)		RTU	JB		
183	1		16#14, 1#14 GND		8#14	RTU	MCC-2		
184								NOT USED	
185	3/4	2#12, 1#12 GND				CPF-4	LIGHTING PANEL LP-B		
186	3/4	2#12, 1#12 GND				CPF-6	CPF-4		
187	3/4	2#12, 1#12 GND				CPF-8	CPF-6		
188								NOT USED	
189								NOT USED	
190								NOT USED	
191								NOT USED	
192								NOT USED	
193								NOT USED	
194								NOT USED	
195								NOT USED	
196								NOT USED	
197								NOT USED	
198								NOT USED	
199								NOT USED	
200								NOT USED	

* THE NUMBER IN THE SPARES WIRE FILL COLUMN INDICATES THE NUMBER OF SPARES INCLUDED IN THE CONTROL OR SIGNAL WIRE FILL COLUMN.

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ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
ELECTRICAL CONDUIT SCHEDULE II

MONTGOMERY WATSON

DRAWN BY: BMS
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-100

CONDUIT NO.	SIZE	CONDUCTORS POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
201	1			AS REQUIRED		TS-DE-00.01	TS-DIT-00.01		
202	3/4	2#12, 1#12 GND				TS-DIT-00.01	JB		
203	3/4	2#12, 1#12 GND				EXIST LIT-00.01	JB		
204	3/4	4#10, 1#12 GND				JB	DUCT TERM PB		
205	3/4			1-2/C #16(SH)		TS-DIT-00.01	JB		
206	3/4			1-2/C #16(SH)		EXIST LIT-00.01	JB		
207	1			3-2/C #16(SH)	1-2/C #16(SH)	JB	DUCT TERM PB		
208	3/4	2#10, 1#12 GND				HEAT TRACE J.B.	DUCT TERM PB		
209	3/4	3#10, 1#10 GND				TS-P-00.01	CONTROL PANEL		
210	1 1/2	3#2, 1#8 GND				CONTROL PANEL	DUCT TERM PB		
211	3/4	3#10, 1#10 GND				TS-P-00.02	CONTROL PANEL		
212	1		16#14, 1#14 GND		4#14	CONTROL PANEL	JB		
213	3/4		4#14, 1#14 GND		2#14	CONTROL PANEL	TS-DIT-00.01		
214	3/4	3#12, 1#12 GND				TS-SC-00.01	CONTROL PANEL		
215	1	3#6, 1#10 GND				CONTROL PANEL	DUCT TERM PB		
216	3/4		4#14, 1#14 GND			TORQUE SWITCH	CONTROL PANEL		
217	3/4		8#14, 1#14 GND		4#14	CONTROL PANEL	JB		
218	1 1/2		24#14, 1#14 GND		8#14	JB	DUCT TERM PB		
219	3/4		4#14, 1#14 GND			EXIST SV-00.01	CONTROL PANEL		
220	3/4		4#14, 1#14 GND			EXIST SV-00.02	CONTROL PANEL		
221	1			3-2/C #16(SH)		TS-DE-00.02	TS-DIT-00.02		
222	3/4	2#12, 1#12 GND				DIT-00.02	JB		
223	3/4	2#12, 1#12 GND				EXIST LIT-00.02	JB		
224	3/4	4#12, 1#12 GND				JB	LIGHTING PANEL-GT		
225	3/4			1-2/C #16(SH)		TS-DIT-00.02	JB		
226	3/4			1-2/C #16(SH)		EXIST LIT-00.02	JB		
227	1			3-2/C #16(SH)	1-2/C #16(SH)	JB	EXISTING RTU-B		
228	3/4	2#12, 1#12 GND				HEAT TRACE J.B.	LIGHTING PANEL-GT		
229	3/4	3#10, 1#10 GND				TS-P-00.03	CONTROL PANEL		
230	1	3#4, 1#8 GND				CONTROL PANEL	POWER PANEL-GT		
231	3/4	3#10, 1#10 GND				TS-P-00.04	CONTROL PANEL		
232	1		16#14, 1#14 GND		4#14	CONTROL PANEL	JB		
233	3/4		4#14, 1#14 GND		2#14	CONTROL PANEL	TS-DIT-00.02		
234	3/4	3#12, 1#12 GND				TS-SC-00.02	CONTROL PANEL		
235	3/4	3#8, 1#10 GND				CONTROL PANEL	POWER PANEL-GT		
236	3/4		4#14, 1#14 GND			TORQUE SWITCH	CONTROL PANEL		
237	3/4		8#14, 1#14 GND		4#14	CONTROL PANEL	JB		
238	1 1/2		24#14, 1#14 GND		8#14	JB	EXISTING RTU-B		
239	3/4		4#14, 1#14 GND			EXIST SV-00.03	CONTROL PANEL		
240	3/4		4#14, 1#14 GND			EXIST SV-00.04	CONTROL PANEL		
241	1 1/2			6-2/C #16(SH)		EXISTING RTU-B	DUCT TERM PB		
242	1 1/2			6-2/C #16(SH)		EXISTING RTU-B	DUCT TERM PB		
243	2		85#14, 1#14 GND			EXISTING RTU-B	DUCT TERM PB		
244	2		85#14, 1#14 GND			EXISTING RTU-B	DUCT TERM PB		
245	3/4	6#12, 1#12 GND				POWER PANEL-GT	DUCT TERM PB		
246	1 1/2	3#6, 3#2, 1#8 GND				POWER PANEL-GT	DUCT TERM PB		
247	1			F. O. CABLE		EXISTING RTU-B	DUCT TERM PB		
248	1 1/2	9#8, 1#12 GND				LIGHTING PANEL-GT	DUCT TERM PB		
249	3/4	6#10, 1#12 GND				LIGHTING PANEL-GT	DUCT TERM PB		
250	3/4	3#8, 1#12 GND				WWW-EV-00.03	PULL BOX		
251	1		14#14, 1#14 GND		4#14	WWW-EV-00.03	PULL BOX		
252	3/4	3#8, 1#12 GND				WWW-EV-00.02	PULL BOX		
253	1		14#14, 1#14 GND		4#14	WWW-EV-00.02	PULL BOX		
254	3/4	3#8, 1#12 GND				WWW-EV-00.01	PULL BOX		
255	1		14#14, 1#14 GND		4#14	WWW-EV-00.01	PULL BOX		

CONDUIT NO.	SIZE	CONDUCTORS POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
256	3/4	3#12, 1#12 GND				SS-EV-00.21	PULL BOX		
257	1		14#14, 1#14 GND		4#14	SS-EV-00.21	PULL BOX		
258	3/4	3#12, 1#12 GND				SS-EV-00.22	PULL BOX		
259	1		14#14, 1#14 GND		4#14	SS-EV-00.22	PULL BOX		
260	1	3#6, 1#10 GND				LIGHTING PANEL-GT	POWER PANEL-GT		
261	1 1/2	3#1, 1#8 GND				SUPERNAT. PUMP CP	DUCT TERM PB		
262	3/4	2#10, 1#12 GND				SUPERNAT. PUMP CP	DUCT TERM PB		
263	1	3#6, 1#10 GND				LSR-P-00.01	SUPERNAT. PUMP CP		
264	1	3#6, 1#10 GND				LSR-P-00.02	SUPERNAT. PUMP CP		
265	3/4		6#14, 1#14 GND		2#14	LSR-LIT-00.02	SUPERNAT. PUMP CP		
266	3/4			1-2/C #16(SH)		LSR-LIT-00.02	DUCT TERM PB		
267	3/4	3#10, 1#12 GND				DRN-P-00.01 CONTROL	DUCT TERM PB		
268		AS REQUIRED	AS REQUIRED			DPN-P-00.01	DRN-P-00.01 CONTROL		
269								NOT USED	
270	3/4	3#10, 1#12 GND				LS-EV-00.01	DUCT TERM PB		
271	1		14#14, 1#14 GND		4#14	LS-EV-00.01	DUCT TERM PB		
272	3/4	2#10, 1#12 GND				LS-LIT-00.01	DUCT TERM PB		
273	3/4			1-2/C #16(SH)		LS-LIT-00.01	DUCT TERM PB		
274	3/4	3#10, 1#12 GND				LS-EV-00.02	DUCT TERM PB		
275	1		14#14, 1#14 GND		4#14	LS-EV-00.02	DUCT TERM PB		
276	3/4	2#10, 1#12 GND				LS-LIT-00.02	DUCT TERM PB		
277	3/4			1-2/C #16(SH)		LS-LIT-00.02	DUCT TERM PB		
278	3/4	3#10, 1#12 GND				LS-EV-00.03	DUCT TERM PB		
279	1		14#14, 1#14 GND		4#14	LS-EV-00.03	DUCT TERM PB		
280	3/4	2#10, 1#12 GND				LS-LIT-00.03	DUCT TERM PB		
281	3/4			1-2/C #16(SH)		LS-LIT-00.03	DUCT TERM PB		
282	3/4	3#10, 1#12 GND				LS-EV-00.04	DUCT TERM PB		
283	1		14#14, 1#14 GND		4#14	LS-EV-00.04	DUCT TERM PB		
284	3/4	2#10, 1#12 GND				LS-LIT-00.04	DUCT TERM PB		
285	3/4			1-2/C #16(SH)		LS-LIT-00.04	DUCT TERM PB		
286								NOT USED	
287								NOT USED	
288								NOT USED	
289								NOT USED	
290	1 1/2	3#1/0, 1#6 GND				SUBSTATION B	DUCT TERM PB		
291	3/4	3#8, 1#10 GND				PP-L	LP-L		
292	2	3#10, 3#1, 1#8 GND				PP-L	DUCT TERM PB		
293	3/4	6#10, 1#12 GND				PP-L	DUCT TERM PB		
294	3/4	6#10, 1#12 GND				PP-L	DUCT TERM PB		
295	3/4	6#10, 1#12 GND				LP-L	DUCT TERM PB		
296	3/4	6#10, 1#12 GND				LP-L	DUCT TERM PB		
297								NOT USED	
298								NOT USED	
299								NOT USED	
300								NOT USED	

* THE NUMBER IN THE SPARES WIRE FILL COLUMN INDICATES THE NUMBER OF SPARES INCLUDED IN THE CONTROL OR SIGNAL WIRE FILL COLUMN.

** THE CONDUIT LENGTH COLUMN IS LEFT BLANK INTENTIONALLY FOR THE CONTRACTOR'S USE.

DATE	REVISIONS

STATE OF KENTUCKY · REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
ELECTRICAL CONDUIT SCHEDULE III

MONTGOMERY WATSON

DRAWN BY: BMS
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-101

CONDUIT NO.	SIZE	CONDUCTORS POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
301	3/4	4#12, 1#12 GND				LP	JB		
302	3/4	2#12, 1#12 GND				JB	DRN-EV-00.01 LCS		
303	3/4	2#12, 1#12 GND				JB	DRN-EV.00.02 LCS		
304	3/4	3#12, 1#12 GND				DRN-EV-00.01 LCS	DRN-EV-00.01		
305	3/4	3#12, 1#12 GND				DRN-EV.00.02 LCS	DRN-EV-00.02		
306	1 1/2		28#14, 1#14 GND		8#14	RTU	JB		
307	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.01 LCS		
308	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.02		
309	3/4	4#12, 1#12 GND				LP	JB		
310								NOT USED	
311	3/4	2#12, 1#12 GND				JB	SS-EV-00.02		
312	3/4	2#12, 1#12 GND				JB	PW-SV-00.01 LCS		
313	3/4		2#14, 1#14 GND			PW-SV-00.01 LCS	PW-SV-00.01		
314	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
315	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.01		
316	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.02		
317	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.01 LCS		
318	3/4	4#12, 1#12 GND				LP	JB		
319								NOT USED	
320	3/4	2#12, 1#12 GND				JB	PW-SV-00.02 LCS		
321	3/4	2#12, 1#12 GND				JB	SS-EV-00.04		
322	3/4		2#14, 1#14 GND			PW-SV-00.02 LCS	PW-SV-00.02		
323	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
324	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.02 LCS		
325	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.04		
326	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.03		
327								NOT USED	
328								NOT USED	
329								NOT USED	
330								NOT USED	
331	3/4	4#12, 1#12 GND				LP	JB		
332	3/4	2#12, 1#12 GND				JB	DRN-EV-00.03 LCS		
333	3/4	2#12, 1#12 GND				JB	DRN-EV.00.04 LCS		
334	3/4	3#12, 1#12 GND				DRN-EV-00.03 LCS	DRN-EV-00.03		
335	3/4	3#12, 1#12 GND				DRN-EV.00.04 LCS	DRN-EV-00.04		
336	1 1/2		28#14, 1#14 GND		8#14	RTU	JB		
337	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.03 LCS		
338	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.04		
339	3/4	4#12, 1#12 GND				LP	JB		
340								NOT USED	
341	3/4	2#12, 1#12 GND				JB	SS-EV-00.06		
342	3/4	2#12, 1#12 GND				JB	PW-SV-00.03 LCS		
343	3/4		2#14, 1#14 GND			PW-SV-00.03 LCS	PW-SV-00.03		
344	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
345	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.05		
346	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.06		
347	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.03 LCS		
348	3/4	4#12, 1#12 GND				LP	JB		
349								NOT USED	
350	3/4	2#12, 1#12 GND				JB	PW-SV-00.04 LCS		
351	3/4	2#12, 1#12 GND				JB	SS-EV-00.08		
352	3/4		2#14, 1#14 GND			PW-SV-00.04 LCS	PW-SV-00.04		
353	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
354	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.04 LCS		
355	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.08		
356	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.08		
357								NOT USED	
358								NOT USED	
359								NOT USED	
360								NOT USED	
361	3/4	4#12, 1#12 GND				LP	JB		
362	3/4	2#12, 1#12 GND				JB	DRN-EV-00.05 LCS		
363	3/4	2#12, 1#12 GND				JB	DRN-EV.00.06 LCS		
364	3/4	3#12, 1#12 GND				DRN-EV-00.05 LCS	DRN-EV-00.05		
365	3/4	3#12, 1#12 GND				DRN-EV.00.06 LCS	DRN-EV-00.06		
366	1 1/2		28#14, 1#14 GND		8#14	RTU	JB		
367	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.05 LCS		
368	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.06		
369	3/4	4#12, 1#12 GND				LP	JB		
370								NOT USED	
371	3/4	2#12, 1#12 GND				JB	SS-EV-00.10		
372	3/4	2#12, 1#12 GND				JB	PW-SV-00.05 LCS		
373	3/4		2#14, 1#14 GND			PW-SV-00.05 LCS	PW-SV-00.05		
374	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
375	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.09		
376	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.10		
377	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.05 LCS		
378	3/4	4#12, 1#12 GND				LP	JB		
379								NOT USED	
380	3/4	2#12, 1#12 GND				JB	PW-SV-00.06 LCS		
381	3/4	2#12, 1#12 GND				JB	SS-EV-00.12		
382	3/4		2#14, 1#14 GND			PW-SV-00.06 LCS	PW-SV-00.06		
383	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
384	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.06 LCS		
385	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.12		
386	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.11		
387								NOT USED	
388								NOT USED	
389								NOT USED	
390								NOT USED	
391	3/4	4#12, 1#12 GND				LP	JB		
392	3/4	2#12, 1#12 GND				JB	DRN-EV-00.07 LCS		
393	3/4	2#12, 1#12 GND				JB	DRN-EV.00.08 LCS		
394	3/4	3#12, 1#12 GND				DRN-EV-00.07 LCS	DRN-EV-00.07		
395	3/4	3#12, 1#12 GND				DRN-EV.00.08 LCS	DRN-EV-00.08		
396	1 1/2		28#14, 1#14 GND		8#14	RTU	JB		
397	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.07 LCS		
398	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.08		
399	3/4	4#12, 1#12 GND				LP	JB		
400								NOT USED	

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DATE	REVISIONS

STATE OF KENTUCKY — ROBERT SCHUBACH 19941 — REGISTERED PROFESSIONAL ENGINEER

WARNING
0 1/2 1
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AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
ELECTRICAL CONDUIT SCHEDULE IV

MONTGOMERY WATSON

DRAWN BY: BMS
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

380-575-102

CONDUIT NO.	SIZE	CONDUCTORS POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
401	3/4	2#12, 1#12 GND				JB	SS-EV-00.14		
402	3/4	2#12, 1#12 GND				JB	PW-SV-00.07 LCS		
403	3/4		2#14, 1#14 GND			PW-SV-00.07 LCS	PW-SV-00.07		
404	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
405	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.13		
406	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.14		
407	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.07 LCS		
408	3/4	4#12, 1#12 GND				LP	JB		
409								NOT USED	
410	3/4	2#12, 1#12 GND				JB	PW-SV-00.08 LCS		
411	3/4	2#12, 1#12 GND				JB	SS-EV-00.16		
412	3/4		2#14, 1#14 GND			PW-SV-00.08 LCS	PW-SV-00.08		
413	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
414	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.08 LCS		
415	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.16		
416	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.15		
417								NOT USED	
418								NOT USED	
419								NOT USED	
420								NOT USED	
421	3/4	4#12, 1#12 GND				LP	JB		
422	3/4	2#12, 1#12 GND				JB	DRN-EV-00.09 LCS		
423	3/4	2#12, 1#12 GND				JB	DRN-EV.00.10 LCS		
424	3/4	3#12, 1#12 GND				DRN-EV-00.09 LCS	DRN-EV-00.09		
425	3/4	3#12, 1#12 GND				DRN-EV.00.10 LCS	DRN-EV-00.10		
426	1 1/2		28#14, 1#14 GND		8#14	RTU	JB		
427	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.09 LCS		
428	1		14#14, 1#14 GND		4#14	JB	DRN-EV-00.10		
429	3/4	4#12, 1#12 GND				LP	JB		
430								NOT USED	
431	3/4	2#12, 1#12 GND				JB	SS-EV-00.18		
432	3/4	2#12, 1#12 GND				JB	PW-SV-00.09 LCS		
433	3/4		2#14, 1#14 GND			PW-SV-00.09 LCS	PW-SV-00.09		
434	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
435	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.17		
436	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.18		
437	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.09 LCS		
438	3/4	4#12, 1#12 GND				LP	JB		
439								NOT USED	
440	3/4	2#12, 1#12 GND				JB	PW-SV-00.10 LCS		
441	3/4	2#12, 1#12 GND				JB	SS-EV-00.20		
442	3/4		2#14, 1#14 GND			PW-SV-00.10 LCS	PW-SV-00.10		
443	1 1/2		34#14, 1#14 GND		10#14	RTU	JB		
444	3/4		6#14, 1#14 GND		2#14	JB	PW-SV-00.10 LCS		
445	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.20		
446	1		14#14, 1#14 GND		4#14	JB	SS-EV-00.19		
447								NOT USED	
448								NOT USED	
449								NOT USED	
450								NOT USED	
451	3/4	2#12, 1#12 GND				DUCT TERM PB	LP		
452	1		16#14, 1#14 GND		4#14	RTU	LP		
453	3/4			2-2/C #16(SH)	1-2/C #16(SH)	RTU	LP		
454	3/4	2#12, 1#12 GND				SS-P-00.01/02 START/LCS	DUCT TERM PB		
455	1		16#14, 1#14 GND		4#14	SS-P-00.01/02 START/LCS	DUCT TERM PB		

CONDUIT NO.	SIZE	CONDUCTORS POWER	CONTROL	SIGNAL	SPARES*	FROM	TO	REMARKS	CONDUIT LENGTH**
456	3/4			2-2/C #16(SH)	1-2/C #16(SH)	SS-LIT-00.01	DUCT TERM PB		
457	3/4		6#14, 1#14 GND		2#14	SS-LIT-00.01	DUCT TERM PB		
458	1							EXIST. WIRING	
459	3/4	3#12, 1#12 GND				SS-P-00.01	SS-P-00.01/02 START/LCS		
460	3/4	3#12, 1#12 GND				SS-P-00.02	SS-P-00.01/02 START/LCS		
461								NOT USED	
462								NOT USED	
463								NOT USED	
464								NOT USED	
465								NOT USED	
466								NOT USED	
467								NOT USED	
468								NOT USED	
469								NOT USED	
470								NOT USED	
471								NOT USED	
472								NOT USED	
473								NOT USED	
474								NOT USED	
475								NOT USED	
476								NOT USED	
477								NOT USED	
478								NOT USED	
479								NOT USED	
480								NOT USED	
481								NOT USED	
482								NOT USED	
483								NOT USED	
484								NOT USED	
485								NOT USED	
486								NOT USED	
487								NOT USED	
488								NOT USED	
489								NOT USED	
490								NOT USED	
491								NOT USED	
492								NOT USED	
493								NOT USED	
494								NOT USED	
495								NOT USED	
496								NOT USED	
497								NOT USED	
498								NOT USED	
499								NOT USED	
500								NOT USED	

* THE NUMBER IN THE SPARES WIRE FILL COLUMN INDICATES THE NUMBER OF SPARES INCLUDED IN THE CONTROL OR SIGNAL WIRE FILL COLUMN.

** THE CONDUIT LENGTH COLUMN IS LEFT BLANK INTENTIONALLY FOR THE CONTRACTOR'S USE.

DATE	REVISIONS

STATE OF KENTUCKY REGISTERED PROFESSIONAL ENGINEER 19941

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

AMERICAN WATER WORKS SERVICE CO.
KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER STATION
ADDITIONAL RESIDUAL PROCESSING FACILITIES

ELECTRICAL
ELECTRICAL CONDUIT SCHEDULE V

MONTGOMERY WATSON

DRAWN BY: BMS
PROJECT ENG'R: BMS
APPROVED: RS
DATE: JUNE 1999
SCALE NONE

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

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