Chapter 9

WASTEWATER PUMP STATIONS AND FORCE MAINS

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9.01 General Provisions

The technical specifications contained in this Chapter, together with Oregon Department of Environmental Quality (DEQ) and U.S. Environmental Protection Agency standards and any other applicable requirements of federal, state and local law shall govern the character and quality of material, equipment, installation and construction procedures for wastewater pump stations, force main and other components of pressurized sanitary sewer work. In addition to the provisions within this Chapter, all applicable provisions of this Resolution and Order shall apply. Administrative provisions of Chapter 2 shall apply to the permit process.

9.01.1 Project Management

An Engineer approved by the District shall be retained to prepare the design, to manage all design and construction activities, to prepare the Operation and Maintenance manual, and to certify that construction was completed in accordance with the approved construction documents. The District maintains a list of pre-approved Engineers to provide these services. The Engineer must have current technical expertise and experience using the standards in this Chapter. In the event that the Engineer will not be involved in construction, the Engineer shall provide the District and the DEQ, as applicable, a written project management plan and the Owner shall notify the District in writing as to who will assume project management responsibilities. The District shall not manage construction activities or assume project management responsibilities. Construction shall not be undertaken by the Owner or the construction Contractor until the District has approved the project management plan.

9.01.2 Pump Station in lieu of Gravity Sanitary Sewer

A gravity sanitary sewer system shall be constructed to provide sanitary sewer service to all developments, unless otherwise approved by the District. Owner shall make a request, in writing, to the District for a pump station in lieu of a gravity sanitary sewer prior to submitting an application for a site development permit.

9.01.3 Layout and Sizing Requirements

The design shall provide for the complete construction of a wastewater pump station facility including site improvements; pumps; wetwell structure; valve vault(s); force main piping and appurtenances; gravity sewer piping and appurtenances; surge protection; odor control; plumbing; heating, ventilation,

and air conditioning (HVAC) system; electrical power; secondary emergency power connection to support full station loads and control systems; instrumentation and controls; and other associated work identified by the District as being necessary to make the facility fully functional.

The design shall adhere to and address the minimum layout and sizing requirements described below. Each of the layout and sizing requirements shall be specifically addressed in the pump station design report.

a. Pump Station Style/Configuration

Pump stations shall be of the duplex submersible type, unless otherwise approved in writing by the District.

b. Service Area and Population

Service area shall include all land that can be provided with gravity wastewater collection service, either currently or with future sanitary sewer extensions. Service area shall also include basin(s) which discharge via other wastewater pump stations into the subject basin either currently or in the future as identified through District planning or by District staff. The District shall make the final decision on the extent of the service area. Where applicable, service area shall be consistent with District master planning.

The preliminary design memorandum and final design report shall include a service area map that shows the following:

1. Topography of the pump station site at 1 ft. contours.
2. Topography of the service basin at 2-ft contours.
3. Property boundaries.
4. Existing and planned service areas.
5. District and City Boundaries.
6. Urban Growth Boundary, as applicable.
7. 100-year flood plain line, as applicable.
8. Property zoning.
9. Proposed pump station location and force main alignment.
10. Existing and proposed gravity collection system.

Service population shall be estimated for the entire service area at build-out and for a 25-year period if build-out is forecast to occur beyond 25 years. Initial service population shall also be estimated. Service population shall be calculated in accordance with and consistent with the District's master plan and other applicable jurisdiction's comprehensive plans, with additional input from District staff. For facilities being constructed as part of a new development, service population shall

incorporate actual planned densities.

c. Design Wastewater Flows

Wastewater flows shall be calculated for the following conditions:

1. Start-up, 1-year period, 5-year period, 25-year period, and service area build-out peak hourly flow (PHF).
2. Start-up, 1-year period, 5-year period, 25-year period, and service area build-out average dry weather flow (ADWF).

Flows shall be calculated in accordance with Chapter 5 of these Standards, and shall include domestic, industrial and infiltration and inflow. Final design flows shall be reviewed and approved by the District.

d. Design Period

Wetwell shall be sized to accommodate full build-out within the identified service area contributing to the pump station, unless otherwise approved by the District.

Pumps/motors, force main, and related equipment shall be sized based on the forecast 25-year PHF.

e. Service Life

Electrical/mechanical systems, including but not limited to pumps, motors, and electrical system, shall be designed and specified to provide for a minimum 25-year service life.

Structures and piping shall be designed and specified for a minimum 75-year service life.

The facility shall be capable of accommodating future components that may be needed for projected growth in the service area beyond the identified design period.

f. Hydraulic Analysis

The Engineer shall evaluate and design the pump/force main system and select pump(s) and force main(s) to provide the required capacity and pressure. The Engineer shall develop hydraulic system curves that indicate the required pump operating conditions. System curves shall be developed for pump suction and discharge piping, and shall include all valves, fittings and other items that may cause energy losses. Analysis shall be provided showing the effects of new and old pipe conditions, the

net positive suction head requirements, the hydraulic efficiency, the horsepower requirements, the revolutions per minute, and other operating conditions required for each pump and combination of pumps. Hydraulic system curves shall be developed using the Hazen-Williams equation for "C" factors of 100, 120 and 150, and under high and low wetwell conditions. Hydraulic system curves shall be overlain on the pump curves. Manufacturer pump curves shall be included in the design report. Computer generated curves may also be included.

The Engineer shall provide pump and system curves for the selected pump(s) to the District for review and approval.

g. Wetwell Size

Sufficient operating volume shall be provided in the wetwell to maintain individual pump starts per hour within the requirements stated herein under the "Pump and Motor" sub-section in Section 9.02. Gravity sewer piping entering the wetwell shall not be used to provide storage.

h. Receiving System

Engineer shall evaluate the existing downstream sanitary sewer system of the District or City to determine the impact of the increase in flow (e.g. peak pumping capacity) from the proposed pump station. Evaluation shall be performed under the design flow condition for all pumped and gravity connections to the receiving system. Sanitary sewer system shall be evaluated downstream to a point where no surcharging (caused by the increase in flow from the pump station) above the top of the pipe occurs. Hydraulic profile shall be provided in the design report. The District or City reserves the right to require upgrades to the downstream receiving system to mitigate the impact of the increased flow.

i. Hydrogen Sulfide

Engineer shall evaluate hydrogen sulfide potential in accordance with the following guidelines. Hydrogen sulfide controls shall be designed and constructed based on the following:

1. Detention Time less than 35 minutes: No hydrogen sulfide controls required.

2. Detention Time 35 to 90 minutes: Protect the force main discharge manhole with either a protective coating or with a chemical additive in the concrete. Products shall be approved by the District.

3. Detention Time greater than 90 minutes: Install an active hydrogen sulfide control system.

The detention time shall be calculated as the force main volume divided by the estimated ADWF at the 1-year period after pump station startup.

For pump stations discharging into existing force mains, evaluate existing force main discharge manhole for corrosion per the DEQ guidelines.

j. Reliability/Redundancy

Pumping facilities shall be designed and constructed to meet EPA Class I reliability requirements, which includes pump redundancy, standby power provisions, and a telemetry/SCADA system.

Firm pumping capacity shall be provided. Firm pumping capacity is defined as the ability to discharge the design PHF with the largest unit out of service.

Pumping facilities shall be equipped with a backup control system, which shall operate the entire pump station in the event the primary control system fails. Backup control system shall include water level monitoring device(s) and pump control system(s).

Standby power and telemetry/SCADA systems shall be provided per these Standards.

k. Parcel Size

A standard pump station site requires a minimum of approximately 2000 square feet of land area on a 50’ by 40’ lot. The minimum parcel size shall be based on the need to provide turn-around and parking for maintenance equipment; accommodate all the pump station structure(s), support enclosures, substructure(s), perimeter site buffer; and be in compliance with all development standards, building code requirements and local jurisdiction planning requirements. Turn-around shall be defined as providing sufficient room for the District's pump station O&M crew vehicle to maneuver within the fenced area. Turn-around shall be designed based on a minimum 46-foot vehicle turning radius, and with no more than two (2) turning maneuvers required to turn the vehicle 180 degrees. The entire pump station site shall be fenced as specified herein. A 15-foot wide buffer shall be provided around the pump station fenced area. Parcel size shall also be large enough to provide for future pump station expansion, within the Design Period/Service Life. See Section 9.02.

l. Parcel Zoning and Other Land Use Requirements

Land use designation for the pump station site shall be consistent with the local jurisdiction's requirements for this type of facility. Site and design shall comply with this Resolution and Order, all relevant land use requirements, and all other applicable local/State/Federal rules and regulations.

m. Parcel Ownership

Pump station site and access road shall be dedicated to the District in the form of a permanent easement, as approved, or transferred into direct ownership. All easements or parcel ownership transfers shall be finalized prior to pump station start-up and acceptance by the District.

n. Storm and Surface Water Management

Storm and surface water runoff from the pump station site, including the access road, shall be managed in accordance with District and all other applicable standards.

9.01.4 Design Procedures

a. General

The Engineer shall provide the following minimum scope of work for wastewater pump station and force main designs. The District may modify and supplement this scope of work to more specifically fit the project.

For projects that involve both a new pump station and force main, they shall be designed together and included in the same construction documents. Construction shall also occur concurrently.

The Engineer shall manage all aspects of the project design and construction process, including all plan review and permitting processes. For any plan review processes beyond the District's including, but not limited to, the DEQ plan review process, the Engineer shall provide the District with resulting review comments, and shall be responsible for facilitating resolution of any conflicts. The District's final plan approval shall not occur until final approval has been received by the Engineer from all other applicable jurisdictions or regulatory agencies.

b. Project Design Submittals

Project design submittals, including the design report, construction plans,

and technical specifications, shall be made to the District at the following intervals:

1. 35% completion
2. 60% completion
3. 90% completion
4. 100% completion

c. Project Review Meetings

1. Kick-off Meeting: Prior to the commencement of design and/or construction of any wastewater pump station and/or force main, the Engineer shall contact the District's Wastewater Treatment Department (WTD) to arrange a project kick-off meeting to discuss and review design and equipment requirements. A District project coordinator will be assigned as staff liaison to the Engineer. The District may also form a staff committee to work closely with the Engineer and District project coordinator during the life of the project. The Engineer, after completing the project kick-off, may proceed with the design of the project.

2. Project Review Meetings: Following the project kick-off meeting, the Engineer shall, at a minimum, meet with the District to review the documents and receive comments following District review of each submittal.

3. O&M Staff Meeting: Following the 35% design submittal, the Engineer shall also meet with District pump station operations and maintenance staff to tour and inspect applicable existing pump stations to become familiar with District requirements and to clarify and confirm specific pump station requirements.

Agendas and meeting minutes shall be prepared by the Engineer for all project-related meetings. Meetings shall be scheduled at least ten business days in advance. Agendas and supporting information shall be distributed by the Engineer to all invited attendees at least two business days in advance of any meeting. Meeting minutes shall be distributed to meeting attendees and other interested parties within five business days of the meeting date.

d. Design

The Engineer shall perform the following minimum preliminary design tasks:

1. Review applicable District master plans and design reports.

2. Coordinate with District to finalize the site selection.
3. Coordinate with District to finalize the service area, design population, and design flows.
4. Coordinate with District to confirm downstream receiving system capacity, and to address any hydrogen sulfide control requirements.
5. Perform design surveys.
6. Perform geotechnical investigation work. Develop at least two bore holes where the proposed pump station wetwell will be located, and determine appropriate soil design requirements. Also identify any potential landslide conditions.

The Engineer shall, at a minimum, include the following items with the 35% review submittal:

1. Schematic site design, gravity sanitary sewer connection(s), and force main layout.
2. Preliminary wetwell buoyancy calculations.
3. Preliminary design report. Report shall address how the project responds to the Layout and Sizing requirements specified herein. Report shall also identify all permitting requirements.

Following District review and concurrence with the 35% submittal, the Engineer shall proceed with the design. The Engineer shall perform the following minimum design tasks:

1. Prepare a Final Design Report, consistent with the District and DEQ guidelines.
2. Prepare final construction contract documents, including but not limited to construction drawings and technical specifications.
3. Prepare estimates of construction cost.
4. Submit documents and cost estimate at the scheduled milestones to the District.
5. Meet with District O&M staff as provided in 9.01.4.c.3.

e. Project Construction Documents

Construction drawings shall include, but not be limited to, the following as deemed applicable by the District and the Engineer:

1. Cover sheet
2. Legend, Symbols and Abbreviations
3. Location and Vicinity Map
4. Pump Station Design Data (see sample table in Appendix)
5. Demolition Plan
6. Site Layout, Grading, Drainage, and Paving Plan

7. Site Utilities, Plans, Profiles, and Details
8. Landscaping
9. Exterior Elevations, Sections, and Details
10. Foundation Plans, Sections, and Details
11. Structure(s) Floor Plans, Sections, and Details
12. Architectural/Civil Framing and Roof Plans, Sections, and Details
13. Door and Window Schedules
14. Mechanical Pump and Piping Plans, Sections, and Details
15. Temporary Pumping Plan
16. Piping Schematics
17. HVAC
18. Electrical Site Plan and Power Plan
19. Power Distribution One-Line Diagram(s)
20. Lighting Plan(s)
21. Electrical Enclosures - One-Line Diagram(s) and Elevation Layouts
22. Miscellaneous Devices/Panels One-Line Diagram(s)
23. Panel Schedule(s) and Layout(s); Circuit Schedule(s)
24. Instrumentation Plan
25. Process and Instrumentation Diagram

Technical specifications shall be prepared to supplement and clarify the construction drawings and these Standards.

9.01.5 Approval of Alternative Methods or Materials

See Approval of Alternative Methods or Materials in Section 1.06 of this Resolution and Order.

9.01.6 Construction Management/Facility Testing Procedures

a. General Roles and Responsibilities

General roles and responsibilities during construction shall be as follows:

1. Contractor shall coordinate directly with the Engineer on all construction issues, including interpretation of contract documents.

2. Engineer shall contact the District regarding any interpretation of Standards and other related District requirements.

3. Engineer shall contact and review with the District any proposed changes to the approved documents. For any change to the approved documents, Engineer shall submit a "Field Revision Form" to the District for approval.

4. District will perform periodic construction observation to verify that work is being performed in accordance with the approved documents. District inspector will not have the authority to approve any aspects of construction activities, nor authorize any changes or modifications.

5. Contractor shall attend a District-led tour of pump stations similar in construction and design to the proposed pump station.

b. Submittal Reviews

Engineer shall be responsible for obtaining and reviewing Contractor submittals to verify that proposed materials and equipment meet the specifications. Engineer shall be responsible for obtaining and reviewing Contractor submittals to verify that proposed materials and equipment meet the specifications. Furthermore, Engineer shall forward all submittals associated with the pump station performance and materials to the District for review. Required submittals include but are not limited to:

1. Pumps and motors
2. Valves
3. Flow meter
4. Pipe supports
5. Control panel layout
6. Control logic diagrams
7. Generator and automatic transfer switch
8. Deferred submittals
9. Level control measurement
10. Power panel board
11. Main breaker
12. Transformer

Engineer shall also forward to the District all requested substitutions to the approved documents, for review.

c. Pre-Construction Conference

Engineer shall facilitate and attend a pre-construction conference meeting with the District, the Contractor, the Owner, and other interested parties to review roles and responsibilities and to answer questions about the plans and specifications. Engineer shall prepare meeting agenda and provide the District with meeting minutes. The meeting shall be scheduled at least ten business days in advance.

Engineer shall facilitate an electrical, instrumentation and controls pre-submittal meeting. The contractor, associated electrical subcontractor, and

equipment manufacturer representatives shall attend this meeting. Equipment manufacturer representatives shall bring sample submittals for applicable equipment for review and discussion.

d. Construction Inspection and Meetings

Engineer shall weekly inspect the construction to confirm that the work is being performed in accordance with the approved plans, and to remedy any problems. Engineer shall also meet bi-weekly with the District on site to review construction progress.

e. Construction Check Points

At a minimum, the District will inspect the following items prior to Contractor proceeding with work. Engineer shall provide the District a minimum of two business days notice that the subject work will be completed and ready for inspection. Engineer shall be on site to participate in these inspections. Contractor shall not cover or otherwise obscure these work items until inspected by the District.

1. Wetwell Excavation/Base Rock - inspect prior to setting structure; verify compaction.
2. Vault Excavation/Base Rock - inspect prior to setting structure; verify compaction.
3. Piping connections between all structures and the force main - inspect prior to backfilling.
4. Base slabs for generator, electrical and other enclosures - inspect base rock, and verify compaction.
5. Pump base elbow anchor bolts - concurrent with structural testing as specified in Section 9.02.6(e).
6. Factory test of the pump station control panel.
7. Generator test.
8. Conduit installation.
9. Electrical wiring.

District inspection of these and any other items does not relieve the Contractor or Owner of responsibility for a complete and operating system.

Copies of compaction test results shall also be provided to the District.

f. Start-up

Engineer shall coordinate with Contractor to prepare a start-up plan to submit to the District for review and approval a minimum of 30 days prior to start-up. Engineer shall coordinate with Contractor and District to

schedule a start-up plan review meeting a minimum of 14 days prior to witness testing. Engineer shall coordinate with Contractor and District to schedule witnessing of facility readiness testing at the pump station prior to commissioning and start-up. Prior to facility readiness testing, Engineer shall coordinate with Contractor to provide all proper installation certifications and factory, field and readiness testing reports a minimum of 7 days prior to start-up. Engineer shall notify the District in writing that the pump station has been tested and operates in accordance with the construction document requirements, and provide a performance log which identifies any issues during performance testing. Engineer shall be on site to witness and oversee the formal pump station start-up testing. Prior to start-up, Engineer shall coordinate with Contractor for the equipment manufacturer's field service representative to be on site during all inspection and testing as detailed in an approved start-up plan schedule. District representatives shall inspect the installation and witness the start-up activities. District staff shall not perform any work during facility start-up.

All equipment shall be tested in accordance with the manufacturer's recommendations and as specified or required herein.

g. Warranties

The Engineer shall obtain and provide to the District a copy of the manufacturers' warranties for all equipment. These shall be included in the O&M manual.

h. Training

After field and readiness testing and prior to facility commissioning, the Engineer and manufacturer's representative shall train the District's personnel in the proper operation and maintenance of the pump station and all equipment. As part of the start-up plan mentioned in 9.01.6.f. a training plan shall be developed that includes the items covered during training and the day/time each of the items will be trained upon. The District may videotape the training.

i. Punch List

Following construction and start-up testing, Engineer and District shall develop a punch list of items to be completed or repaired. Contractor shall be responsible for correcting all identified punch list items. Engineer shall provide written confirmation that the work is completed.

j. Project Completion

The Engineer shall obtain and provide to the District a copy of the start-up report as prepared by the manufacturer's representative. The Engineer shall provide certification to the DEQ that all construction was completed per the approved plans and specifications.

9.01.7 Operation and Maintenance Manual

The Engineer shall prepare an Operation and Maintenance manual in accordance with District requirements. The manual shall constitute no less than two separate volumes. Volume 1 shall address the fundamental O&M procedures specific to the new pump station. Volume 2 shall provide the equipment manufacturer's O&M literature specific to the pump station. The District will provide an electronic copy (Microsoft Word format or searchable PDF) of the District's standard format for Volume 1. Engineer shall supplement with project specific information.

Specific information that shall be provided in the O&M manual shall include, but not be limited to, the following:

a. Electrical and control diagrams based on as-constructed conditions. Diagrams shall show the wire colors and numbers, coordinated with the field installation.
b. Calibration sheets for all calibrated equipment, including model number and serial number of the equipment.
c. Hard copy of all programming, including (as applicable) Missions , soft start/VFD, flow meter, and pump station level controller.
d. Hard copy of the generator test results.
e. Vendor list and contact information for all supplied equipment.
f. Complete set of reduced size record drawings 11x17.

The Engineer shall adhere to the following O&M Manual submittal process:

a. Draft O&M Manual - A draft O&M manual, Volume 1, shall be submitted to the District and the DEQ for review no later than eight (8) weeks prior to pump station start-up. Formatting and attachments shall meet District and DEQ requirements. A 90% version, including both Volumes 1 and 2, shall be submitted to the District for review two (2) weeks prior to pump station start-up.
b. Final O&M Manual - The final Volume 2 O&M manual, incorporating all District review comments, shall be submitted to the District prior to pump station start-up. Pump station start-up testing shall not proceed without the Volume 2 manual being complete. The final Volume 1 O&M manual shall be updated to address District review comments and to incorporate start-up records, and shall be submitted no later than two (2) weeks following pump station start-up.

9.01.8 As-Built Drawings

For the purposes of this section, as-built drawings will also mean drawings of record, record drawings, or terms indicative of an attempt to record the as-constructed state of the facility.

Following completion of construction, the Engineer shall submit as-built drawings. As-built drawings shall describe any and all revisions to the previously approved construction plans, and shall be accompanied by a certification letter from the Engineer, indicating that the as-built drawings have been reviewed and revised as necessary, to accurately show all known as constructed details, and that the improvements have been completed in accordance with the District Standards to the best of his/her knowledge. The words "As-Built Drawing" or "Record Drawing" shall appear as the last entry in the revision block along with the month, day, and year the as-built drawing was prepared.

One complete full-size draft set on paper shall be submitted first for checking by District staff. Submission of as-built drawings shall be made within two (2) weeks of acceptance of facilities by the District.

After making changes prompted by District review of the draft paper copy, final As-Built Drawings shall be submitted. All plans shall be prepared using Computer Aided Drafting (CAD), and the final submittal shall include the following:

a. An AutoCAD compatible digital form (DWG Format) of the as-built drawings (version per District requirements).
b. Basic layering scheme.
c. Standard symbols for appurtenances.

9.01.9 Project Review and Acceptance Process

Key aspects of the Project Review and Acceptance Process are as follows:

a. Request for Pump Station Installation

   Owner shall first submit a written request to District for permission to install a wastewater pump station in lieu of a gravity sewer.

b. Gain Approval to Construct Pump Station

   District will determine the need for a pump station. If District determines that a proposed pump station is an acceptable alternative to a gravity sewer, District will grant permission to proceed with pump station design.

c. Number of Copies

Unless otherwise noted, for all project submittals, submit six (6) copies to the District.

d. Wastewater Treatment Department (WTD) Design Review

Pump station/force main design and construction documents shall first be reviewed and approved by WTD. All submittals shall be delivered to WTD. Upon approval by WTD, the approved construction documents shall be submitted to Development Services. Development Services will perform a final review of the documents and issue the required construction permits.

e. Coordination with Development Services Reviews

Engineer shall coordinate with Development Services reviews to satisfy requirements associated with the gravity sanitary sewer and additional site layout requirements.

f. DEQ Plan Review

Concurrent with final Development Services review, the Owner shall submit final WTD approved plans and specifications to DEQ for review. A copy of the DEQ approval shall be submitted to the District before final design approval is issued.

g. Final Design Approval

Upon final District and DEQ reviews and approvals and receipt of appropriate review fees (including separate payment to DEQ for their review fees), Development Services will issue final design approval and the required construction permits. Following issuance of the construction permits, two (2) sets of construction documents will be returned to the Engineer for use during construction. The construction Contractor shall at all times use approved plans during construction, and shall maintain such on site.

h. As-built Drawings

Submit one (1) complete set of both paper and electronic as-built drawings.

i. Operation and Maintenance Manual

Submit draft copies to District and DEQ for review. Submit six (6) copies

of the final manual. Pump station start-up shall not proceed if the O&M manual submittals are not complete. District will submit final approved copy of Volume 1 to DEQ.

j. Project Acceptance

The pump station can be placed into operation and the District will assume facility operations after all start-up, testing, punch list, O&M manual, and maintenance assurance requirements have been completely satisfied. The pump station shall not be placed into operation until all these requirements have been addressed, including completion of all punch list items.

k. Timing for Project Reviews

The WTD review process is separate and independent from the Development Services processes, including those related to public/private sanitary sewer improvements. Development Services' pump station/force main plan review timing will not start until the WTD review process is complete. Upon acceptance of the complete submittals as described in these Standards, WTD will endeavor to approve, return for revision, or reject the documents within 10 working days. Reviewed submittals will be returned to the Engineer, with comments and/or revisions to the documents shown in red.

For construction submittals/substitution requests, the District will endeavor to approve, return for revision, or reject the submittal within 10 working days.

9.01.10 Performance and Other Assurance Requirements

Project performance assurance, "as-built" assurance and maintenance assurance shall be provided as required in Chapter 2 of these Standards. As specified in Chapter 2, construction punch list generated for the pump station and force main shall be completed prior to release of performance assurance. WTD staff will prepare the construction punch list, following successful pump station start-up.

9.02 Design and Construction Requirements

9.02.1 General

The following requirements are the minimum for the design and construction of wastewater pump stations and force mains. The Engineer shall prepare the design to conform to these requirements and any additional project specific requirements identified during the Project Kick-off meeting and subsequent District reviews. In addition, the design and construction shall comply with

all other District standards, as applicable and as referenced herein. In the event of conflicts, these Chapter 9 Standards shall govern.

In general, these Design and Construction Standards require a complete submersible sewage pumping system, equipped with a minimum of two submersible sewage pumps installed in a concrete wetwell. The pumps shall discharge into a sewage force main that empties into a gravity sanitary sewer pipeline. Equipment redundancy shall be provided, unless otherwise specifically noted. The pumping system shall be operated with a fully independent and automatic control system. Sufficient valves and a flow meter, installed in concrete vaults, shall be provided on the force main. The pump station shall be constructed on a parcel of sufficient size to allow for all required District operations, and the site shall be accessible under any weather condition by District vehicles. The pump station site shall be protected from flooding, and shall be fenced. The pump station shall be provided with all required public and private utility services.

9.02.2 Site

a. Flood Plain

The entire pump station site and access to the site shall be no less than two (2) feet above the 100-year flood plain level. Mapping shall be provided to verify that this requirement has been met.

b. Clearances/Setbacks

Clearances/setbacks from all equipment and structures shall be in accordance with applicable codes, including but not limited to building and electrical codes. Minimum clearances shall be 42 inches in front of all electrical control panels, and 48 inches around the standby generator. Sufficient clearances shall be maintained within the fenced site for access to and ease of equipment maintenance. Setbacks shall also be maintained consistent with local planning requirements.

c. Grading and Drainage

Surface water around the perimeter of the site shall be directed away from the pump station. Floors shall be sloped to prevent ponding and to direct water to drains and sumps. All on-site drainage shall drain off the pump station site to an approved point of disposal with the exception of the pump wash-down area. Catch basins, if required, shall be Lynch-style, trapped, and minimum four square feet open area. If the catch basin is for the pump wash-down area, it shall be a standard catch basin style and have a minimum four square feet open area. Drainage provisions shall be in compliance with District standards for water quality and erosion control

and with all local building codes.

Provisions shall be constructed to prevent flooding of below grade structures with the exception of the pump station wet well. Footing/subsurface drains shall be installed where such drains can be daylighted. See also Section 9.02.3.

The entire site shall be graded for positive sloping at a minimum of 2% and a maximum of 7%, including equipment pads. No bird paths shall be constructed.

d. Access

A minimum twenty (20) foot wide right-of-way and minimum fifteen (15) foot wide asphalt surfaced access road shall be provided for access to the pump station site. Access roads longer than 50 feet shall include at least one turn-around outside the fenced area. Turn-around shall be of sufficient size for the District's pump station O&M crew vehicle. Turn-around shall be designed based on a minimum 30 foot vehicle turning radius, and with no more than two (2) turning maneuvers required to turn the vehicle 180 degrees. Road grades shall not exceed seven (7) percent. No private gates will be permitted across the access road. Access road shall be designed to provide safe entrance/exit and stopping areas, in accordance with standard road design guidelines.

Within the pump station site, access shall be provided to all structures/equipment for the District's equipment maintenance vehicles.

Access of a minimum of 5 feet shall also be provided around the entire fenced site to perform required maintenance (see also Parcel Size requirements in Section 9.01).

e. Fencing/Security

The pump station site, including all equipment and structures, shall be enclosed by a six-foot high fence with access gate. Fencing may consist of chain link or it may consist of decorative split face concrete masonry units. Chain link fence shall be 2-inch mesh, 9-gauge copper bearing steel wire, with minimum 15-mil PVC coating. Color shall be black conforming to ASTM F934, with a minimum of 10-15 mils of thermal bonded and fused coating. Fence installation shall maintain sufficient clearance, per Standard Detail 1005, from the station and associated structures such that maintenance operations can be accomplished without removal of the fence. Inside of the fence to the nearest equipment shall be a minimum of

six feet. See also Clearances/Setbacks.

Access gates shall be rolling or swinging. Swinging gates shall be placed such that both panels can be fully opened to allow entry into the pump station. Gate opening shall be a minimum 15 feet. As applicable, the gate shall be installed to allow a maintenance vehicle to be pulled completely off the public roadway prior to unlocking the gate, 32 feet minimum. Access gates shall allow for padlocking, but security wire and inclined brackets at the fence top shall not be required except in special situations. Gate stops shall be provided for swinging gates (see Drawings). Swinging gate center stop shall be mushroom-type.

f. Paving

The access road and entire pump station site shall be surfaced with 8-inches of 3/4 inch minus crushed rock overlain by a 1-1/2 inch thick lift of Class 'B' asphaltic concrete and a 1-1/2 inch thick lift of Class 'C' asphaltic concrete. Compact the crushed rock to 95% maximum dry density in accordance with AASHTO T-99. Compact the asphalt to 92% maximum density in accordance with AASHTO T238 (Method A or B). Place the crushed rock on compacted subgrade. Install geosynthetic fabric on top of compacted subgrade for the full width/length of the access road and within the pump station site. Perform a minimum of two compaction tests for both the base rock and asphalt surface.

g. Landscaping

Landscaping shall be provided as required by the development's Land Use Permit. In general, it should be designed to blend-in with surroundings and require little regular maintenance, and be drought resistant to eliminate the need for an automatic irrigation system. Shrubs and/or bushes with thorns shall not be allowed.

Landscaping Drawings and Specifications shall be included in the Contract Documents and submitted for District review. They shall include the Standard Details presented within this document.

The irrigation controller shall be a Rainbird ESP-SMTe Smart Controller, or equal.

Sprinkler heads shall be Rainbird 1800-SAM-PRS, or equal.

h. Lighting

Area lighting shall be provided in accordance with the Electrical requirements as specified herein.

i. Site Sign

District will provide a sign. The sign is 18 inches by 24 inches and made of aluminum. The sign shall be securely mounted to the fence gate, unless otherwise specified or required by the District.

9.02.3 Wetwell, Vaults, and Other In-Ground Structures

a. General

1. Applicable Building Codes - Structures shall be designed and constructed consistent with the seismic zone and applicable requirements as specified in the Oregon Structural Specialty Code (OSSC).

2. Testing - Special inspections and/or testing shall be performed on all cast-in-place concrete, anchors, and other structural items as specified in the OSSC.

3. Structural base fill shall consist of 3/4-inch minus crushed rock, compacted to 95% maximum dry density in accordance with AASHTO T-99. Total thickness shall be a minimum of 12 inches. Design shall also incorporate recommendations from the geotechnical investigations. Backfill shall be 3/4-inch minus crushed rock, compacted to 95% maximum dry density in accordance with AASHTO T-99. Backfill shall not be placed against forms or temporary construction materials, or over any debris material. Backfill shall not be placed against poured concrete until 28 days have passed from completion of original concrete pour. Compaction within 5 feet of the walls shall be accomplished using hand operated vibratory plate compactors or tamping units. Particular care shall be taken to avoid damage to the pipe connections and to the structure.

b. Wetwell (see also Chapter 8 of these Standards)

1. Configuration - The wetwell shall be a circular configuration, with consistent diameter throughout. The floor shall be sloped for proper installation and function of the pump inlets. The wetwell shall be designed to minimize the potential for vortexing, rag and debris build-up, and other possible inlet problems. If needed to prevent inlet problems, a stainless steel plate can be placed in front of the influent sewer entrance into the wet well to direct the

influent in the downward direction. Flow from the influent sewer shall not be directed towards the pump chains and cables. Pump inlets shall be designed at a distance of 0.3D to 0.5D above the wetwell floor (where D is the diameter of the inlet), but not less than 3 inches. Sump bottom shall be grouted to provide inclined surfaces (60-degree angle to horizontal) to direct solids to the pump inlets. Grout shall be anchored into the precast concrete structure using rebar or other similar products. Wetwell shall have one common sump; no split sumps or any barriers shall be installed between pump inlets.

2. Finished Grade Elevation - Wetwell lid shall be a minimum 2 inches and a maximum of 7 inches above finished grade, to prevent surface water from draining over the lid and into the wetwell. The lip of the wet well shall be painted safety yellow to indicate a potential trip hazard.

3. Materials of Construction - Structure shall preferably be precast. Precast concrete wetwells shall meet the standards in Chapter 8 of the District's Standards. Floor slab shall be a minimum 12 inches thick. Top slab shall be designed for H20 loading. Joints shall be watertight, sealed with rubber ring per ASTM C 443 or mastic gaskets. Joints shall be grouted outside with high strength, non-shrink grout (see also Chapter 8). No lift holes shall be allowed. Alternative lifting mechanisms shall be designed into the structure.

4. Explosion Resistance - All equipment and fixtures installed in the wetwell shall be explosion proof rated in accordance with the applicable electrical codes and as specified herein.

5. Sanitary Sewer Inlet Piping/Isolation - Only one sanitary sewer inlet into the wetwell shall be allowed. Connection shall be flexible, in accordance with Chapter 8 of these Standards. Penetration shall be pre-cast into structure; field constructed penetrations shall not be allowed. No wetwell penetrations shall be made within 6 inches of a wetwell joint. Inside/outside drops shall not be allowed. A pipe joint shall be provided within 12 inches of outside wall of the wetwell. Inlet discharge shall be above the normal pump operating levels, while minimizing the vertical drop to prevent air entrainment conditions. Inlet piping shall be designed to avoid vortexing and cavitation. Additional items on this topic are located in 9.02.3. b.1. The design shall provide for the isolation of the wetwell, to allow for maintenance.

6. Force Main and Other Pipe Penetrations - Penetrations for the force mains, vault drains, and other required connections shall be

pre-cast into structure; field constructed penetrations shall not be allowed. Such pipe penetrations shall be sealed with link seal type seals. For pipe sizes too small for link seals, seal with epoxy sealant.

7. Operating Levels - Inlet piping shall not be used for storage. 'Pumps off' level shall be established to prevent vortexing, and also to provide motor cooling as required by the motor specified. See also pump and motor design requirements and Instrumentation and Control section for additional requirements.

8. Installation - The construction installation method shall be specified and shown on the construction drawings. For any proposed special installation procedures, such as caisson construction, sufficient detail shall be provided for District review.

9. Testing - Perform hydrostatic test in accordance with District standards for manholes.

c. Vaults

1. Size - Vaults shall be no deeper than five feet (5'-0") from the rim to the vault floor. Minimum of 12-inch spacing shall be provided between all piping, edge of pipe to edge of pipe. Minimum of 6-inch spacing shall be provided between valves, edge of valve to edge of valve. Minimum of 24-inch spacing shall be provided between all piping and vault walls/floor, edge of pipe to inside surface of vault. Vaults shall be large enough to allow for a worker to enter and perform routine maintenance.

2. Finished Grade Elevation - Vault lids shall be a minimum 2 inches and maximum of 7 inches above finished grade, to prevent surface water from draining over the lid and into the vaults.

3. Materials of Construction - Vaults shall be constructed of precast concrete, unless otherwise approved by the District. Vaults shall comply with the requirements of ACI 318-99. Concrete shall have minimum 4000 psi, 28 day compressive strength. Joints shall be keyed and shall be provided with a watertight gasket.

4. Construction - Vaults may be formed with separate top and bottom slabs. Walls shall be cast so that all sides are continuous at corners and their full length with no blockouts or knockouts. All pipe penetrations shall be pre-formed or core drilled at the required locations.

5. Pipe Penetrations - Seal all wall pipe penetrations with link seal type seal. For pipe sizes too small for link seals, seal with epoxy sealant.

6. Drain - Vault shall gravity drain to the wetwell. Sump pump shall not be allowed. Drain pipe shall be minimum 4-inch diameter. A maintenance-accessible flap valve shall be provided at the discharge end. A P-trap, primed continuously through a connection to the on-site water supply shall be provided as follows. Extend minimum 3/4-inch diameter water line into the vault, terminating at a non-freeze hose bib mounted on the vault wall. Install 1/4-inch tee and ball valve, and extend 1/4-inch diameter copper tubing to the vault drain to serve as the priming supply. Secure all piping to the vault with stainless steel hardware. If water cannot be supplied to the pump station site prior to Facility Startup, a bell drain may be used in place of a P-trap.

7. Testing - Perform hydrostatic tests in accordance with District Standards for manholes.

d. Force Main Discharge Manhole

Discharge manholes shall comply with the District's standards for sanitary sewer collection systems. When required herein under hydrogen sulfide management requirements, discharge manholes shall be coated with a District approved protective coating or chemical additive in the concrete. Discharge manhole lids shall be fitted with carbon baskets.

e. Access

Wetwell and vault access shall be provided through a minimum double door, 3-foot square opening. The door shall be aluminum, diamond plated, H20 rated, and spring assisted to produce an apparent weight less than 50 pounds. The door shall be provided with a recessed padlock clip for locking with a standard padlock.

The wetwell access hatch shall be provided with the fall prevention system described herein and vault access hatches shall be provided with perimeter drain channels, which shall discharge to daylight through minimum 1-inch diameter pipes at the perimeter of the concrete lid.

f. Fall Prevention Equipment/Personnel Removal System

Wetwell and vaults shall be designed to conform to Oregon-OSHA requirements. Design shall also comply with District safety standards for personnel entry/removal. Railings, safety grates, or other approved and acceptable systems shall be provided. Safety nets will not be approved. For wetwells, a grated fall prevention system integral with the access hatch system shall be provided that meets the following minimum specifications:

1. Provides complete coverage of the wetwell opening when access hatch has been opened.
2. Design allows for visual inspection of the wetwell without opening the fall prevention system.
3. Grating shall be of aluminum construction, with epoxy powder coating, color orange.
4. All stainless steel hardware.
5. 300 psf pedestrian rated.
6. Opens separately from the access hatch. Access hatch must be opened first.
7. Installs and operates without interfering with the pump guide rails. Does not interfere with pump removal.
8. Apparent weight shall be less than 50 pounds.

System shall be the Aluminum Safe Hatch, as manufactured by Syracuse Castings, or equal.

g. Ladders and Miscellaneous Hardware

Access ladders shall not be installed in the wetwell or vaults.

h. Buoyancy

Engineer shall evaluate the buoyancy potential for all buried structures. Engineer shall perform evaluations assuming ground water level at ground surface, and for the wetwell assume that the water level is at "pumps off." Factor of safety against buoyancy shall be a minimum of 1.25 under gravity conditions.

9.02.4 Mechanical

a. Heating and Ventilation

Wetwell and vaults shall be passively ventilated. Electrical equipment

within these structures shall be designed to comply with the National Fire Protection Association (NFPA) 820 requirements and the applicable electrical code for this ventilation condition. For the wetwell, passive ventilation through the access hatch alone shall not be sufficient. Vent(s) shall be installed so as not to interfere with vehicular or pedestrian activity related to accessing and maintaining the pump station facility. Above grade vent pipe shall be Schedule 80 galvanized pipe, protected with a non-corrosive wire mesh screen at the end of the pipe to prevent the entrance of birds, rodents and other small animals. See also the District's Electrical and Instrumentation Control requirements elsewhere in these Standards for the design of electrical components inside these structures.

Heating and ventilation shall be provided for all electrical and control panels, in accordance with the requirements herein under the "Electrical and Instrumentation Control Requirements."

b. Plumbing

1. Drainage - Vault drain piping material shall be in accordance with the Uniform Plumbing Code. Site drainage piping material shall be as required for the depth of bury and traffic loading condition. For PVC piping, glue system shall be two-part, including primer and glue. "One Step" systems shall not be allowed. Minimum pipe size shall be 4 inches in diameter.

2. Water Supply - On site potable water supply shall be provided through a metered 1-inch water supply connection to the municipal water supply, with a backflow preventer and a 1-inch yard hydrant. Water piping shall be copper. Yard hydrants in exposed locations subject to freezing shall be of the non-freeze type. Yard hydrant shall be located out of the way of traffic, and shall be secured to and protected by 4-inch diameter galvanized steel bollard filled with concrete.

3. Backflow Prevention - A Conbraco Apollo 40-200 series (1-inch diameter) reduced pressure backflow device shall be installed on the potable water piping entering the pump station site and upstream of any service connections. This device also shall be approved by the Oregon State Health Division. Double check valve assemblies are not acceptable. Backflow device shall be installed above grade in a fiberglass enclosure. Above-ground water pipe shall be provided with PVC jacketed insulation and thermostat-controlled heat tape. Power supply to the enclosure shall be provided through a dedicated circuit breaker.

4. Plumbing shall be tested in accordance with Uniform Plumbing

Code requirements. A copy of certified test results for the backflow prevention device shall be provided.

c. Hydrogen Sulfide Control System

Where an active hydrogen sulfide control system is required by these Standards, system type shall be as directed by the District and design shall be approved by the District and comply with DEQ guidelines. Systems shall be designed to maintain the dissolved sulfide content of the pumped sewage below 0.1 milligrams per liter at the point of discharge into the gravity sewer manhole.

9.02.5 Force Main and Appurtenances

a. General

Engineer shall design the force main and appurtenances in accordance with American Water Works Association (AWWA) requirements. Minimum force main size shall be four (4) inches in diameter. Design force main velocity shall be 3.5 to 8.0 feet per second. Force main shall be designed to continuously ascend from the pump station to its discharge location, unless otherwise approved by the District. Alignment shall minimize distance from pump station to discharge manhole. Force main shall be installed inside a public right-of-way or permanent easement dedicated to the District (minimum 15 feet wide). Horizontal bends shall be minimized. Use two-45 degree bends in lieu of 90-degree bends. The system shall be designed to allow for the easy removal of pumps, check valves, and flow meter while maintaining the facility in continuous operation.

b. Force Main Pipe and Fittings

All force main piping shall be of the same diameter. Force main piping in the wetwell and through all vaults shall be cement lined, minimum thickness class 53 ductile iron pipe conforming to AWWA C151, without exception. Buried pipe between the vaults and discharge manhole may be cement lined, minimum thickness class 52 ductile iron pipe or polyvinyl chloride (PVC). PVC pipe shall meet AWWA C900, Class 200 (less than or equal to 12 inch diameter) or C905, Class 235 (greater than 12 inch diameter) standards. PVC pipe joints shall meet ASTM D3139 and F477 standards. Fittings shall be factory fabricated cement lined ductile iron, minimum 250 psi rated. Merging of the pump discharge manifold into a common force main shall be made using a 'wye'. Buried joints shall be push-on or mechanical. Flanged buried joints shall not be allowed. Exposed joints shall be flanged. For vertically oriented flanged pipe (e.g. inside the wetwell), piping shall be installed with permanent flanges

located on the lower end at all times. Joint restraint shall be accomplished mechanically or with concrete thrust blocks. Flexible, restrained connections shall be made outside and within 12 inches of each structure.

Copper solid core toning wire (Copperhead SoloShot #12 AWG hard drawn or equal, color green) and locate tape shall be installed with all buried force main piping. Toning wire shall be installed inside 1-1/2" PVC SCH 80 conduit and terminated at Pipe Warning Signs as shown in the Standard Details every 500 feet along the force main alignment, or as otherwise required by the District. If approved by the District, offset boxes may be replaced with Copperhead SnakePit Tracer Roadway RB14*TP valves boxes. Conduit for the toning wire shall be taped to the top of forcemain at a minimum of every 10 feet. Toning wire shall also be installed for all piping associated with the pump station and forcemain. This includes air/vacuum valve piping and drain piping. Prior to pulling wire through conduit, wire shall be lubricated. Locate tape shall be 4 inches wide, with "WARNING-SANITARY SEWER PIPELINE" or similar printed in large letters on the tape. Toning wire shall be installed within conduit on top of the force main; locate tape shall be installed 12 inches above the force main.

Installation of force main and appurtenances shall conform to Chapters 7 and 8 of these Standards, AWWA C600 for ductile iron pipe installation, and AWWA C605 for PVC pipe installation. Prior to installation of the forcemain, the Contractor shall submit survey cutsheets.

c. Check Valves

Each pump discharge shall be fitted with an AWWA C508 check valve installed inside a valve vault. Check valves shall be swing check-type with weighted external arm using metal bushings, mounted in the horizontal position, with flanged end connections. Valves shall be of cast/ductile iron construction, with cast/ductile iron disc, stainless steel hinge pin shaft passing through a stuffing box, replaceable body seat ring, and epoxy lining and coating. O ring shaft seals shall not be acceptable. Check valves shall be provided with valve (with threaded ends) for pressure relief installed in the top plate or inspection cover, with drain tubing to the vault drain. The valve operators and their orientation shall be drawn to scale on the drawings to clearly identify available operating space. Check valves shall not be installed in the wetwell.

d. Isolation Valves

Each pump discharge shall be fitted with an isolation valve, located inside the check valve vault and immediately downstream of the check valve. An isolation valve shall be installed in the common force main

downstream of the flow meter.

Isolation valves shall be cast or ductile iron eccentric plug valves, with flanged end connections and with cast/ductile iron plug. Plug valves 4 inches and larger in diameter shall be gear driven. Valves shall have grit seals on both the upper and lower stem journals. Seat area shall be raised, with raised area completely covered with not less than 90% pure nickel weld. Shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. Plug valves shall be installed such that the plug opens to the top and the valve seat is located on the pump side of the valve. Valves in vaults shall have handwheels, with the handwheels operating facing up. Buried valves shall have gear box hermetically sealed and be equipped with 2-inch square AWWA operating nut. The valve operators and their orientation shall be drawn to scale on the drawings to clearly identify available operating space.

e. Air Release Valves

Air relief and air vacuum release, or combination air release and vacuum valves shall be installed at locations along the force main to prevent air from being captured inside the piping, and to allow for draining of the force main. Each such valve shall be sized with the proper orifice size suitable for the volume of air to be admitted or released. Such valves shall be provided with an isolation valve, and with a bleed-off valve at the base. Air release valves shall be stainless steel as manufactured by Vento-o-Mat. Air release valves shall be installed above ground, within an enclosure if feasible. Above ground enclosures and underground vaults shall be adequate size for equipment installation and large enough to allow a worker to enter and perform routine maintenance. Above ground enclosures, if approved shall be composed of fiberglass 6 feet length by 6 feet width by 4 feet height minimum. Additional details on the above ground enclosures can be found on the Air Release Valve Standard Details. For the underground vault, the minimum horizontal vault dimensions shall be 4 feet by 6 feet depth of vault shall be no greater than 5 feet from the rim to the vault floor. Vault access shall be provided through a double door, with a minimum 3 feet by 3 feet square opening. Door shall be aluminum, diamond plated, H20 rated, spring assisted. Door shall be provided with a recessed padlock clip for locking with a standard padlock. All components shall be corrosion resistant, appropriately cathodically protected if key components are buried, and composed of schedule 40 stainless steel, schedule 80 PVC, or approved equal.

f. Bypass Connection

Force main shall be provided with a bypass connection at the pump station to allow for temporary bypass pumping and for force main cleaning. The connection shall be exposed, unless otherwise approved by the District to be placed in an underground vault. The connection shall be downstream of the common force main isolation valve. The connection shall be as shown in the Standard Details.g. Force Main Discharge

Force main shall discharge into a manhole at the manhole invert. Force main invert elevation shall not be greater than five feet below ground surface. Where existing sanitary sewer collection system manholes exceed this depth, a separate, dedicated force main discharge manhole shall be provided, with a gravity connection to the sanitary sewer collection system. Where possible, discharge alignment shall be in line with the manhole outlet. Discharge alignment shall not be less than at a 90-degree angle with the outlet.

h. Flow Meter

A flow meter shall be provided on the common force main, either installed in the valve vault or in a separate vault. Flow meter shall be as specified under Electrical and Instrumentation Control Requirements. Flow meter display shall be mounted between four and six feet above finish grade.

i. Gauges

A pressure gauge shall be installed on each pump discharge, upstream of the check valve. A pressure gauge shall also be installed on the common force main, downstream of the check valves. Gauges shall be 3-1/2-inch diameter with stainless steel case, polycarbonate glass window, stainless steel movement, blowout disc and 1/2-inch NPT stainless steel lower connection. Gauge shall be selected such that the gauges will read from 40 to 70 percent of full scale under normal operating conditions and not exceed 90 percent of full scale under pump curve shut-off condition. Gauges shall be Ashcroft or equal. Gauges shall be mounted to a stainless steel diaphragm seal and filled with glycerin. Gauges and diaphragm seals shall be connected to the force main per the Force Main Pressure Gauge Standard Drawing.

j. Surge Protection

Engineer shall evaluate the pump and force main system to identify the potential for transient pressures or column separation conditions that could damage the pump-force main system. Documentation of the surge

analysis shall be included in the design report. Surge protection shall be designed as necessary to avoid a pressure gradient change from positive to negative. Surge protection/column separation prevention measures shall include air cushion check valves, surge anticipation/relief valves, or air relief valves.

k. Supports

Engineer shall size and design pipe supports, as required, for piping in the wetwell and vaults. Supports shall be designed to meet UBC seismic requirements, as applicable, and shall also be designed to resist maximum expected surge. Pipe supports in vaults shall be laid out considering maintenance and removal of valves and the flow meter. Pipe supports in the wetwell shall be designed to minimize horizontal movement of the pipe. In all cases supports shall be provided to prevent transfer of load to flanges, valves, and flow meter.

Supports shall be constructed of 316 stainless steel. Anchors and bolts/nuts shall be minimum Type 316 stainless steel. All concrete anchors shall be epoxy-based.

l. Odor Control System

Engineer shall evaluate the potential for generating odors within the wet well, at the force main discharge manhole and at any air valve locations. As required, the Engineer shall size and design an odor control system to minimize or prevent production of odorous compounds. The proposed odor control system shall be reviewed and approved by the District during preliminary design.

m. Painting

Piping and valves in the wetwell and vault(s) shall be painted with epoxy. Prepare and paint in accordance with the Steel Structures Painting Council standards. Paint system shall be applied in minimum three coats, with the first coat being a zinc-based primer. Each paint coat shall be 4 to 6 mils thick. Color shall be as selected by the District.

n. Force Main Testing

Field testing of the force main and appurtenances shall be completed by a hydrostatic test with potable water that meets the following requirements. Contractor shall be responsible for making all necessary provisions for conveying water to the points of use and for disposal of the test water, including temporary taps and plugs.

1. Prior to the start of the hydrostatic test, all trenching shall be backfilled and compacted per the requirements of Chapter 7.

2. When concrete thrust blocks are used, the hydrostatic test shall be conducted at least five days after thrust block installation.

3. Seal pipe ends and secure pipe with temporary thrust restraint, as required, to maintain line and grade and to prevent damage.

4. Furnish all equipment and materials for the test including:

   A) Test pump approved by the District.
   B) Suitable suction and discharge pipes and hoses.
   C) Suitable graduated containers for measuring water loss.
   D) Pressure gages with pressure range at least 20% greater than the required test pressure and with graduations in 2 psi maximum increments. Gages shall have been calibrated within 90 days of the test.

5. Conduct the hydrostatic test so the lowest point along the test section is subjected to a hydrostatic pressure of 150 psi or 1.5 times the operating pressure, whichever is greater.

6. Fill the test section with water and allow it to stand at two-thirds of the test pressure for a minimum of 12 hours. Expel air from the test section. Apply and maintain the test pressure for a minimum duration of two hours and measure the leakage during this period. Operate the test pump as required to maintain the pressure within plus or minus 5 psi of the test pressure throughout the test period.

7. At the conclusion of the test period, operate the pump until the test pressure is obtained. The pump suction shall be in the graduated container so the amount of water required to restore the test pressure is accurately measured.

8. The measured leakage shall not exceed the allowable leakage amount calculated by the following formula:

$$AL = \frac{LD(P)^{1/2}}{133{,}200}$$

   where: AL = Allowable Leakage in gallons per hour
   L = Length of pipe tested in feet
   D = Diameter of pipe (nominal) in inches, and
   P = Test Pressure in pounds per square inch

9. If the measured leakage is in excess of the allowable leakage, the section of pipe tested shall be repaired and re-tested until the actual leakage is reduced below the allowable amount.

10. Visible leaks in the wetwell and vaults shall be eliminated regardless of the leakage amount.

9.02.6 Pump and Motor

a. General

1. Materials and equipment shall be standard products of both a manufacturer and distributor regularly engaged in both the manufacture and distribution of such products for at least 2 years, and shall be suitable for the service intended. All materials and equipment shall be new and unused.

2. The pumps shall be supplied by a distributor authorized to service them throughout the warranty period and beyond. The distributor shall be located within a 50-mile radius of the site, and shall be capable of providing 24-hour, 7-day service.

3. The pumps shall be warranted by the manufacturer for a minimum of two (2) years from the date the pump station is placed into operation and accepted by the District.

4. Where two or more pieces of equipment performing the same function are required, they shall be duplicate products of the same manufacturer.

5. Wetted parts shall be compatible and suitable for use with raw wastewater.

6. Nameplates - Equipment shall be fitted with a stainless steel nameplate indicating (as applicable) serial number, rated head and flow, horsepower, impeller size, rotating speed and manufacturer's name and model number. Attach second name plate to starter/VFD cabinet.

7. The entire pump station assembly shall be UL approved as Explosion Proof for operation in a Class 1, Division 1, Group D hazardous location.

b. Compatibility

Pumps and pump station equipment shall be compatible with other District

pumping stations, and final equipment selection shall be approved by the District.

c. Solids Handling

Pumps shall be capable of handling and passing minimum 3-inch spherical solids and any trash or stringy material.

d. Pumps

1. The Engineer shall select pump(s) that will operate under the determined hydraulic system curve conditions and at the highest efficiency possible. Selection of pump(s) with flat operating curves (e.g. where a small change in total dynamic head results in a large change in pumped flow) shall be avoided. Pump(s) shall operate in accordance with the manufacturer's recommendations under all operating conditions. The entire pump curve shall be non-overloading.

2. Pumps shall be manufactured by Flygt.

3. Pumps shall be designed for continuous operating service for pumping raw, unscreened sewage, and constructed to meet the intended service.

4. A minimum of two pumps per station shall be provided.

5. Pumps shall have tandem double mechanical seals. Lower (primary) seal faces shall be silicon-carbide or tungsten-carbide. Metal parts shall be Type 316 or 316L stainless steel. Probes shall be provided between seals to detect moisture and associated seal failure. A seal leak monitoring system shall be provided by the pump manufacturer. System shall monitor probes continuously for seal leakage. Seal leak monitoring system shall be integrated into the Pump Sequence Control Panel, with a discrete alarm light provided on the front of the control panel.

6. Pumps shall have replaceable impeller and volute/impeller wear rings. Wear rings shall be constructed of stainless steel.

7. Impeller shall be of cast/ductile iron construction, non-clog type with pump-out vanes on the back side to reduce pressure on the shaft seal and help eliminate buildup of foreign materials.

8. Pump assembly shall be painted with a zinc-based primer and a water-based air-dried enamel finish coat. Total paint system

thickness shall exceed 2.0 mils, with each coat exceeding 1.0 mil minimum thickness.

9. Rotational Direction - All pumps shall have the same rotational direction.

10. Submersible pumps shall not exceed 50 HP. Where a two-pump system would require greater than 50 HP units, three or more units less than or equal to 50 HP shall be installed, with a minimum of two units delivering the design flow rate.

e. Discharge Elbows

Each pump shall include a separate cast iron discharge base elbow, securely mounted to the wetwell floor with stainless steel epoxy anchors and as specified by the manufacturer. Anchor installation shall be tested in accordance with UBC requirements prior to installation of base elbow. Base elbow shall be a reducing diameter type, as necessary, to transition between pump discharge and the full diameter force main. Pump shall be designed to automatically and firmly connect to the discharge connection, with sealing of the pump unit to the discharge connection accomplished by a machined metal-to-metal watertight contact.

f. Motors

1. Motors shall be Factory Mutual or Underwriter's Laboratories approved. Pump motor shall be induction type with a squirrel cage rotor, shell type design. Motor shall be housed in a sealed, submersible and explosion proof rated, air or oil filled shell. Motor shall be rated for continuous duty either completely dry or fully submerged in the pumped liquid. A minimum 1.15 service factor shall be specified.

2. Motor shall be minimum NEMA design B with minimum Class F insulation. Stator windings shall be of high conductivity copper magnet wire. Heat sensors shall be embedded into the motor windings, and shall be set to open upon exceeding the motor design temperature. The sensors shall be connected to an alarm in the control panel. Upon a thermal overload, control system shall turn off and lock out pump operation until manually reset.

3. Bearings - The pump and motor assembly shall rotate on two bearings. An upper radial bearing and lower thrust bearing shall be required. These shall be heavy-duty single row ball bearings which are permanently lubricated. Bearings requiring lubrication according to a prescribed schedule are not acceptable. The

bearings shall be rated at a minimum B-10 bearing life of 50,000 hours at design loads.

4. Motor nameplate horsepower shall exceed the maximum required by the pump under all possible operating conditions. Significant motor oversizing, however, shall be avoided.

5. Electric Cables - Motor and sensor cables shall be heavy duty, submersible type rated to 600 volt and 60 degrees C. The power cable and cap assembly shall be designed to prevent moisture from wicking through the cable assembly. Electrical cables shall be of sufficient length to require no splicing between motor and air gap panel.

6. Cable Entry - The cable entry seal shall be designed to ensure a watertight and submersible seal. Power and control cable entry into the lead connection chamber shall include elastomer grommets, washers, and epoxy sealed leads. Epoxies, silicones, or other secondary sealing systems alone shall not be considered acceptable.

7. Motor Starting Frequency - Sufficient wetwell operating volume shall be provided such that motor starting frequency and minimum time between motor starts complies with NEMA requirements.

g. Guide Rails

Each pump shall be easily removed and replaced on two, 2-inch diameter stainless steel guide rails without disturbing the discharge piping. Single rail or cable systems shall not be allowed. Pump assembly shall have lower guide rail supports securely fastened to the base elbow. Guide rails shall be secured to the wetwell lid. Intermediate guide rail supports shall be provided as recommended by the pump manufacturer. Guide rail supports shall not interfere with pump removal or re-installation. Pump discharge shall automatically connect to the base elbow when lowered into place. The entire rail system assembly shall be constructed of stainless steel.

h. Lifting Devices

Each pump assembly shall be provided with a stainless steel lifting chain and stainless steel lifting knuckles of adequate strength to support 150% of the entire assembly weight. Chain links shall be minimum 5/16-inch inside diameter. Chain shall be continuous and rated for lifting.

i. Pump Removal

An on-site hoist and crane shall be provided for pump assembly removal, unless the District's truck-mounted lift has sufficient capacity to lift the pump assembly.

j. Testing

1. Prior to startup testing, Contractor shall remove and re-install each pump to verify that the removal system functions correctly, and that the pump/base elbow/guide rail system was installed correctly.

   Following successful completion of the startup testing, each pump shall again be removed and re-installed. Each pump shall then be operated to verify that operating conditions at the actual operating point remained constant.

2. Pumps - At a minimum, perform the following tests on each pump:

   A) Startup, check, and operate the pump system over its entire range. Perform vibration analysis as applicable. Vibration analysis shall be within the amplitude limits specified and recommended by the Hydraulic Institute Standards.
   B) Measure and record the shutoff head and power draw at shutoff head.
   C) Measure and record flow rate, operating head and power draw at actual operating point and at two partially throttled conditions.
   D) Measure and record static head.

   Verify that each pump is operating in accordance with its pump curve and as designed. Coordinate with pump manufacturer's representative and Contractor to correct any problems. The pump station shall not be accepted until design pump capacity has been demonstrated.

   For all pump tests, ensure that the force main is full of liquid during the testing. The facility shall be tested using potable water, unless otherwise approved in writing by the District.

   The Engineer shall obtain and provide to the District written certification from the manufacturer's representative that the installation is correct and that the equipment has operated satisfactorily.

3. Motors - Simulate High Motor Temperature and Seal Failure to verify that the system provides warnings and protects each pump

and motor.

9.02.7 Standby Power

a. General

1. A permanent, skid mounted standby AC power engine generator shall be provided on site. The unit shall be mounted on structural channel rails. Install generator on a concrete pad.

2. The generator shall be capable of starting and operating the entire pump station, including all pumps.

3. The entire engine-generator system shall be built, tested, and shipped so as to ensure the unit is factory engineered and assembled so there is one source of supply, service, and warranty responsibility.

4. The height of the engine-generator shall not exceed 8 feet. The height of the control panel shall not exceed 5 feet.

5. The unit shall be provided with a minimum of four spring-type vibration isolators with adjusting screws and earthquake restraints for mounting.

6. The generator unit shall be provided with enclosure that yields a "quiet" operation with a maximum average free-field of 69 decibels measured at a distance of 23 feet (7 meters) from the center of the unit. Additional sound dampening shall be provided to meet local noise control code requirements, as required. The entire engine-generator enclosure shall be rated for all-weather outdoor operation. All bolts shall be rust resistant, with lock washers. Doors shall be provided on each side for easy access to the unit, and shall be provided with continuous hinges. Doors shall be equipped with adjustable plated pad type locking latches with matched keys. Interior lights shall be provided.

7. The engine-generator system shall be UL rated under Standard 2200 for Stationary Engine Generator Assemblies.

b. Generator Unit

1. Generator frequency output shall be 60 Hertz, adjustable from 56

to 64 Hertz.

2. Voltage output shall be 480 volt, 3-phase. The generator shall have a solid-state voltage regulator capable of maintaining voltage within 1.5 percent at any constant load from 0-100 percent of rating.

3. Upon application of pump station rated load (all pumps), the instantaneous voltage dip shall not exceed 20 percent (15 percent for VFD driven pumps), and shall recover to the rated voltage within one second.

4. The generator shall be the brushless alternator type, and windings shall be constructed of copper only.

5. The generator shall be provided with a unit-mounted circuit breaker with terminals sized for the actual feeder cable.

6. A hospital grade spark arresting silencer connected to the engine via a stainless steel flexible coupling shall be provided.

c. Fuel

1. The engine generator shall be diesel fueled. The fuel tank shall be full at the time of District acceptance of the facility.

2. The day tank shall provide for a minimum of 24 hours of operation under design peak influent flow loading conditions. The fuel tank shall be a double walled steel tank. The fuel tank shall be integral with the engine generator and installed under the generator, unless such installation would cause the engine generator unit height to exceed that specified herein. A separately mounted tank shall be installed on a concrete pad, and in close proximity to the engine generator.

3. The tank shall be provided with a desiccant dry air filter on vents to prevent condensation of water within the tank. The fuel line to the engine shall be fitted with a large capacity fuel filter and water separator.

4. The fuel tank shall be installed and oriented such that fuel re-filling can be accomplished with no more than 16 feet of hose.

5. The fuel tank shall be equipped with a fuel gauge.

d. Engine Unit

1. Engines shall be air cooled whenever possible. Water cooled engines shall be provided with anti-freeze protection.

2. Turbochargers shall not be allowed.

3. The maximum engine speed shall be 1800 rpm.

4. The engine shall be equipped with an oil sump heater for air cooled types, or an engine block coolant heater with a pumped circulation system for water cooled types. Heater units shall be rated to ensure a preheating temperature of 100 degrees F, and shall provide anti-freeze protection equal to zero (0) degrees F. Heaters shall automatically disconnect upon engine start. Heaters shall be provided with a dedicated circuit breaker in the main electrical panel.

5. The engine shall be equipped with a heavy duty battery starting system. The battery shall be sized to provide sufficient charge for minimum five (5) cranking cycles at minimum 10-seconds per cycle. A 120-volt trickle charging battery charger with a dedicated circuit breaker in the main electrical panel shall be provided. Chargers shall be equipped with an ammeter and voltmeter. Chargers shall be capable of recharging the battery to full charge within one hour. Generators shall provide power to the charger when it is operating.

6. The engine shall have an electronic speed governor that shall hold the engine speed to within 1/2 cycle per second of rated value.

e. Controls

1. The following instruments shall be provided to monitor the engine: oil pressure gauge, engine temperature gauge, RPM tachometer, and total run time meter (hours, non resettable). If the option is available, fuel tank volume shall be displayed on the control panel.

2. The following instruments shall be provided to monitor the generator: voltmeter, ammeter, and frequency meter. A panel illumination light shall also be provided.

3. Panel lights shall be provided for the following conditions: emergency generator run status, engine failure due to overheat, low oil pressure, speed (RPM) exceeded, low fuel, and low battery charge.

4. A push-to-test button shall be provided for testing all panel indicator lights.

5. A test-auto-off switch shall be provided for operating the generator.

6. Automatic-emergency shut down shall be provided for the following conditions: over cranking, over speed, low oil pressure, and high coolant temperature. Controls shall be interlocked to drop the electrical load prior to an emergency shut down, and the controls or transfer switch shall include an unloaded generator cool-down delay.

f. Transfer Switch

1. An automatic transfer switch shall be provided that will integrate with and operate the standby generator. The transfer switch shall be UL rated under Standard 1008 for Transfer Switch Equipment. The switch shall be furnished in a UL rated NEMA 1 enclosure and shall be mounted inside weatherproof electrical enclosure #2. The transfer switch shall be provided with a manual operating handle, shielded termination, and over-center type contact mechanisms to allow effective, manual operation.

2. The transfer switch shall be electrically operated and mechanically held. The switch shall be mechanically interlocked to ensure only one of two possible positions - normal or emergency.

3. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

4. The switch shall be provided with a microprocessor-based control panel to direct operations. The control panel shall be provided with a keyed disconnect plug to enable the panel to be disconnected from the transfer switch for routine maintenance.

5. Voltage and Frequency Sensing:

A) Voltage for each phase of the primary power source shall be monitored continuously, with pickup adjustable from 85% to 100% of nominal, and dropout adjustable from 75% to 98%.
B) Single-phase voltage sensing of the emergency source shall be provided, with pickup voltage adjustable from 85% to 100% of

nominal and independent frequency sensing with pickup adjustable from 90% to 100%.

C) Accuracy shall be within ±2%.
D) Voltage and frequency settings shall be field adjustable in 1% increments without the use of tools, meters, or power supplies.

6. Time Delays - the following time delays shall be provided, which shall be field adjustable without use of tools:

   A) Time delay Start: adjustable (0-15 sec) - to prevent nuisance generator set starts in the event of momentary power system loss.
   B) Transfer Time Delay: adjustable (2-120 sec) - to allow generator set to stabilize before application of load.
   C) Retransfer Time Delay: adjustable (6-30 minutes) - to allow the power system to stabilize before retransfer of the load.
   D) STOP delay: adjustable (2 sec to 10 minutes) - to maintain availability of generator set for immediate reconnection in the event the normal source fails shortly after retransfer and to allow gradual generator set cool down by running unloaded.

7. A "commit/no commit to transfer" selector switch shall be provided to select whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

8. Auxiliary contacts shall be provided, consisting of one contact when the switch is connected to the normal source and a second contact when the switch is connected to the emergency source.

9. Indicating lights shall be provided, one to indicate when the switch is connected to the normal source (green) and one to indicate when the switch is connected to the emergency source (red).

10. The switch manufacturer shall be certified to ISO 9001 and shall have third party certification verifying quality assurance in design/development, production, installation, and servicing in accordance with ISO 9001.

11. A minimum 100-hour battery backup power supply shall be provided to maintain clock settings during normal loss of power.

g. Testing

1. A factory test shall be performed and a logged test report provided to the District. The test shall be performed using a load bank, with both full load and half load tests performed. Each test shall be performed for a minimum of 4 hours, and all operating parameters recorded on 15 minute intervals.

2. The generator unit shall be tested on site under full load conditions for two hours. All operating parameters shall be recorded on 15 minute intervals.

3. Generator shall be refueled after startup testing.

9.03 Electrical and Instrumentation Control Requirements

9.03.1 General

a. The pump station is a typical duplex configuration and is equipped with two submersible pumps. The design intent is that one pump is capable of fully operating the pump station and the other pump is a backup. The operating elevations of the pump station are based from the pump system curves and the known pump station flow capacities as well as the projected future flows. The primary control system of the pump station shall be through a submersible level transducer.. The level unit controls the starting and stopping of the pumps automatically.

b. An independent backup high level float switch with a true time off cycle timer hardwired relay logic to start and stop both pumps (sequentially start) in the event the primary level control system should fail. The true off timer is to eliminate the need for a low level float switch to shut down pumps. The pump station control modes in descending priority are:

1. Level transmitter
2. High level float switch and hardwired cycle off-timer relay logic.
3. Manual control.

c. Both pumps shall automatically alternate after each pumping cycle. A pump lead selector switch shall be provided for dedicated pump lead selection. The pump equipment is protected by hardwired interlock to shutdown the pump on motor over temperature alarm or motor overload alarm condition. The pump shall not be shut down on motor seal leak/moisture alarm condition.

d. A Wireless Mission Control unit shall monitor a minimum of eight discrete critical alarms from the pump station and four analog inputs for both motor amps, level and flow. The high level alarm should be generated by the

primary level control and the high level float switch which shall turn on the external flashing beacon light at the pump station and call out the high level condition over Missions. The beacon light is automatically reset when the high alarm condition is cleared and the Missions alarm has to be acknowledged by authorized personnel..

e. The pump station has a utility (normal) power and an in-station permanent standby generator for backup power capable of operating the entire station with all connected loads. The generator is capable of starting one pump while the other pump and miscellaneous equipment are running.

f. Electrical Service: Standard voltage services for pump station is 480Y/277-Volts, three-phase, 4-wire underground service, unless otherwise approved by the District. The name and phone number of the power company customer service engineer or the Contractor shall be listed in the specifications in case they need to be contacted during construction.

g. Area Definitions

1. Dry: Location within electrical enclosures shall be defined as dry locations.
2. Wet: Locations which are not dry locations shall be defined as wet locations.
3. Hazardous: Hazardous locations per NEC Article 501 are identified in the Drawings.

9.03.1.01 Summary

a. Furnish the electrical control equipment as shown on the Drawings and as specified herein.

b. The Control System Supplier/Integrator shall have a panel shop located within 250 miles of the Project Site that is equipped to perform a factory demonstration test.

c. The Control System Supplier/Integrator shall provide a factory demonstration function test of both electrical enclosures-01 and -02 in the presence of the District's representative. The test shall be performed per District's Operational Readiness Test (ORT) standard. Prior to the factory demonstration test, continuity and function tests for all connected components and wires must have been thoroughly inspected for proper use of materials, methods of construction, function test, and nameplate spelling. Provide a minimum of 7 days notice prior to the demonstration test.

d. Unless otherwise specified, electrical and instrumentation

equipment and materials shall be listed and labeled for the purpose for which they are used by Underwriters Laboratories Inc. (UL) or Factory Mutual (FM).

9.03.1.02 Qualifications

a. Certification for custom control panel (electrical enclosure) construction and labeling under UL 508 and UL 698.

b. The Control System Supplier/Integrator shall be regularly engaged in the design and assembly of systems of similar scope and complexity for at least 3 years, with demonstrated experience in providing control systems for municipal sewage pump stations.

c. The Control System Supplier/Integrator shall be a single firm which shall be responsible for engineering and furnishing technical advice for installation, documentation, testing and startup of the complete control system. All control panels (EE-01 & EE-02) shall be affixed with a UL 508 and UL 698 label prior to shipment to the jobsite. Any control panels which arrive to the jobsite without a UL 508 and UL 698 labels and without District's approved factory demonstration test shall be rejected and sent back to the panel shop.

d. PVC-Coated, Rigid Steel Conduit Installer: Shall be certified by conduit manufacturer as having received a minimum of 2 hours of training on installation procedures.

e. Testing Firm Qualifications: Professionally independent of manufacturers, suppliers, and installers, or electrical equipment and system being tested.

9.03.1.03 Definitions

a. AHJ: Authority Having Jurisdiction.
b. TVSS: Transient Voltage Surge Suppressor.
c. SVR: Surge Voltage Arrestor
d. EE-0X: Electrical Enclosure 0X or Electrical Control Panel 0X
e. ATS: Automatic Transfer Switch
f. LP: Lighting Panel, Load Center
g. PSCP: Pump Sequence Control Panel
h. ISR: Intrinsically Safe Relay
i. MOV: Metal Oxide Varistor
j. RVSS: Reduced Voltage Soft Starter

9.03.1.04 Submittals

a. Action Submittals, Shall include the following information:
   1. Electrical Enclosures, EE-01 & EE-02: Arrangement drawings, schematic and wiring diagrams, bill of materials, nameplate schedules, manufacturer information on each component.
   2. Bill of Materials for each electrical enclosure, EE-01 & EE-02, and each sub control panel, PSCP, Motor Control Panel, etc. shall include:
      A) Equipment item number
      B) Quantity
      C) Tag number
      D) Description
      E) Manufacturer
      F) Model # or Part #
      G) Serial #
      H) Vendor/Supplier
      I) Vendor Phone Number
   3. Arrangement Drawings shall include:
      A) Panel and sub panel materials of construction, dimensions, and weights.
      B) Panel access openings.
      C) Internal-external conduit and wireway layouts.
      D) Internal wiring and terminal block layouts including wire and terminal block numbers.
   4. Lighting controls
   5. Luminaries
   6. Instruments, including flow transmitter, wet well level transmitter, Mission unit, float switches, and level flood switch.
   7. Service entrance main breaker and metering equipment
   8. Load center and circuit breakers
   9. Feeder breakers
   10. Transformer
   11. Wiring devices
   12. Conduit, fittings, and accessories
   13. Conduit tags and tag number schedule
   14. Wireways
   15. Conductors, cables, and accessories
   16. Conductor tags and tag numbers
   17. Control devices, terminal blocks, and relays
   18. Boxes and device plates
   19. Precast manholes and handholes
   20. Underground cable trays
   21. Support and framing channels

22. Panel unit heaters and thermostats
23. Surge arrester and Transient Voltage Surge Suppressor
24. Nameplates and nameplate schedule
25. RVSS motor starter
26. Across the line motor starter

b. Information Submittals:
   1. Submit Proof of Qualifications described in Article Qualifications.
   2. Factory test reports.
   3. Field test reports.
   4. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.
   5. Operation and Maintenance Data:
      A) As specified in other related Operation and Maintenance Section for Operation and Maintenance Data.
      B) Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance.
      C) Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.
      D) Electrical enclosure Drawings and information as described in Article Submittals. Electrical enclosure operation and maintenance data shall be submitted in hard copy and electronic copy on jump drive.

9.03.1.05 Approval by Authority Having Jurisdiction

a. Provide the Work in accordance with the latest NFPA 70, National Electrical Code (NEC).

b. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listed mark or label.

9.03.1.06 Extra Materials

Furnish, tag, and box for shipment and storage the following spare parts and special tools.

a. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.
b. Indicating Lights: Six lamps each type provided.

9.03.2 Products

9.03.2.01 General

a. Products shall comply with all applicable provisions of NFPA 70.

b. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

c. Hazardous Areas: Products shall be acceptable to the regulatory authority having jurisdiction for the class, division, and group of hazardous area indicated.

d. Equipment Finish:
   1. Manufacturer's standard finish color, except where specific color is indicated.
   2. If manufacturer has no standard color, finish equipment in accordance with light gray color finish as approved by Engineer and District.

9.03.2.02 Service Entrance Equipment and Metering

Equipment, installation arrangement, and scope of work shall be provided in accordance with requirements of power company service provider.

a. Provide meter base per power company's standards.
b. Provide main breaker rated for use as service entrance. UL 489 listed for use at location of installation.
   1. Main breaker shall be thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.
   2. Suitable for use with 75 degree C wire at full NFPA 70, 75 degrees C ampacity.
   3. Locking: Provisions for padlocking handle.
   4. Enclosure: NEMA 4X stainless steel 304.
   5. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.
   6. Minimum Interrupting Rating: Per Drawing.
   7. Manufacturers: Eaton, General Electric Co., Square D Co., or Siemens Co.

9.03.2.03 Pump Disconnect Air-Gap Enclosure

a. Provide a disconnect air-gap panel to intercept the submersible pump power and control cables. The air-gap enclosure shall be installed on a stainless steel pedestal at 4-feet height above ground level, and at minimum 5-feet HORIZONTAL from the wet well wall to leave room for pump service access. The air-gap enclosure mounting distance incorporated with the UNDERGROUND CABLE TRENCH configuration is to eliminate the need of providing conduits seal-offs for all homerun conduits between the wet well and the air-gap enclosure, and between the air-gap enclosure and the electrical enclosure.

b. Fabricate the disconnect air-gap enclosure with equipment arrangements as shown on the Drawings.

c. The air gap shall be NEMA 4X, stainless steel 304 enclosure with back panel, hasp and staple for padlock.

d. Provide each cable cutout hole with rubberized edges and rubberized skirt to prevent bees inside the panel.

e. Pump power cable and pump control (motor over temp and seal-leak) cables shall use the same disconnect of non-fused mechanical interlock ON-OFF disconnect receptacles for connecting one end of pump submersible cables with the matching plugs. Provide strain relief at matching plug cables. The ON-OFF switch shall enable control of a plug connected load which includes an interlocking feature to prevent the plug from being pulled/disconnected while the receptacle is energized.

f. High and Overflow float switches shall also be intercepted at the air-gap enclosure. Provide float cables disconnects which consist of gray terminal strips mounted on DIN rail.

g. Wet well pressure level transducer cable shall also be intercepted at the air-gap enclosure. Provide float cables disconnects which consist of blue terminal strips mounted on DIN rail. Transmitter/controller is located in the electrical enclosure. Cable splice for transducer is NOT allowed, order correct cable length needed.

h. Panels shall be labeled and listed UL 508.

9.03.2.04 Underground Cable Trench

a. Provide one common underground cable trench between the wet well and air-gap enclosure.

b. Install cable trench per details shown on Drawings with template pictures. One end of the cable trench shall penetrate the wet well under the top ring, the other end shall intercept the hand box located below the air-gap box.
   1. The cable trench shall be sized accordingly per total cable size requirement and also per the next factory available standard sizes to minimize the delivery time. The cable trench shall be a minimum of 6-inches wide by 9-inches deep with ½-inch thick removal top cover, and with a divider to separate the homerun power and control cables.
   2. Manufacturers and Products: The cable trench shall be by Synertech Product. No substitution allowed.

9.03.2.05 Electrical Control Panels

a. Electrical Enclosure-01 and –02:
   1. Electrical enclosure shall be a minimum NEMA 3R, stainless steel 304, free-standing 72”H x 72”W x 24”D, with 12-inch-tall floor stands welded to the enclosure, with back panel, padlock compatible doors with no center post, door stops, back panels, and work platform for laptop. The front of the enclosure shall be provided with 24” stainless steel extended rain shields with spacers as shown on the Drawings.
   2. All enclosure hardware shall be stainless steel. Enclosure exhaust fan with filter louver shall be sized adequately for all heat loss generated by interior equipment in the enclosure. Exhaust fan shall be located near upper part of enclosure.
   3. Fabricate each electrical enclosure with equipment arrangements as shown on the Drawings.
   4. Interior raceways: Provide metal raceways for all wiring connected between panels, located within the electrical enclosures. Interior raceway shall be EMT conduit or metal wireways and routing layouts shall be submitted to District for approval prior to panel construction. Exposed wire is not acceptable.
   5. Exterior raceways: All homerun raceways/conduits shall be entered from the bottom of the electrical enclosure directly into the bottom wire way.
   6. The entire assembly of electrical enclosure shall be affixed with a UL 508 and UL 698 labels.
   7. Both electrical enclosures shall be installed side by side; unless site condition prohibit. The site layout has to be approved by the District.

8. Install cabinet light with fixture mounted motion sensor.
   A) Light 4' LED 5K Color, 7000 Lumens – Lithonia type CLX L48 or current model
   B) Occupancy Sensor – Wattstopper – HBP-112-L7
9. All grounding/bounding shall be routed and landed at one ground bar location.

9.03.2.06 Pump Sequence Control Panel (PSCP)

a. The panel shall be NEMA 12 enclosure. Provide enclosure dimensions per actual equipment requirement, plus a minimum of 10-percent spare space available within the panel.

b. The entire assembly shall be UL 508 and UL 698 labels.

c. Control power to the pump sequence control panel shall be separately fed from the power panelboard as shown on the Drawing.

d. Install the wet well control set points in chart format on front of PSCP with bottom of wet well, top of wet well lid elevations, pump on levels, pump off levels.

e. PSCP shall be provided with controls and control devices as shown on the Drawings

   1. Control Relays:
      A) Relay Mounting: Plug-in type socket.
      B) Relay Enclosure: Clear polycarbonate dust cover with clip fastener with energized status indication and override flip for testing.
      C) Socket Type: Screw terminal interface with wiring.
      D) Socket Mounting: DIN rail mounted.
      E) Blade type connector.
      F) Contact Arrangement: 3 Form C contacts.
      G) Contact Materials: Silver Cadmium oxide alloy.
      H) Contact Resistance: 50 m ohm max (initial value).
      I) Switching capacity: 10 amps.
      J) Coil Voltage: 120V ac or 24V dc as shown.
      K) Life Expectancy:
         (i) Electrical: 500,000 operations or more.
         (ii) Mechanical: 50,000,000 operations or more.
      L) Indication Type: LED indicator lamp.
      M) Push-to-Test button.
      N) Manufacturers and Products:
         (i) Idec Corporation.

(ii) Potter and Brumfield, Series KUP.

2. Time Delay Relays – On Timer and True Off Timer:
   A) Heavy Duty.
   B) Operates on 117V ac (plus or minus 10 percent) power source.
   C) Contact Rating: 10 amp resistive at 240V ac.
   D) Solid-state construction.
   E) Multi-function operation with two Form-C delayed output contacts.
   F) Time delay range as specified or shown in the Drawings.
   G) True Off Timer is built with internal capacitor and is capable to initiate a time delay for up to ten minutes after the power has been removed from the timer.
   H) Manufacturers:
   Idec Corporation: On Timer - GT3A, True Off Timer – GT3F.

3. Alternator Relay:
   A) Duplex pump alternator, 120V ac, SPDT.
   B) Contacts and coil rated for 120V ac, 60-Hz.
   C) Alternator relay shall alternate the state of its contacts in response to impulses applied to its coil.
   D) Manufacturers and Products: Diversified Electronics, ARA-120-ABA.

4. Pump Amp Digital Display
   A) 120 Vac digital display by Red Lion with capacity to provide 24Vdc loop power for analog signal from CT to Mission.

5. Intrinsically Safety Barriers (Relays):
   A) GEMS Model 14460 Intrinsically Safe Relays provided in a segregated intrinsically safe zone inside the PSCP enclosure.
   B) Ul or FM approved for use with remote pilot device contacts located in Class 1, Division 1, Groups C & D atmospheres.
   C) Provide a grounded metal partition inside the PSCP enclosure to separate the intrinsically safe relays from non-intrinsically safe components.
   D) Route the Float Switches Cables in conduit directly into the PSCP intrinsically safe zone.
   E) Use a low-power, electrically isolated relay to safely interface with devices located in hazardous areas.

F) Provide with green and red LED for indication of module and field circuit status.
G) Provide 750 ohms resistor in parallel/across the intrinsically output contact to minimize the leaked current which may be introduced to the control circuit.
H) External Power: 120V ac, 60-Hz.
I) Pole reversal protection.
J) Response Time: less than 20 ms.
K) DIN rail mounting except the GEMS

6. Wireway Within PSCP:
Plastic slotted wall, wiring duct. Type F with sizes as indicated plus 25-percent extra space. Color shall be the manufacturer's standard. Plastic wireway shall be used inside PSCP only as shown on the Drawings. Use EMT raceway inside the electrical enclosure between panels/fixtures.

7. Wires Within PSCP:
A) Type: 600-volts class insulated, stranded copper, MTW type.
B) Size: For current to be carried, but not less than No. 14 AWG enclosed in either sheet metal raceway or wiring duct.
C) Analog or dc Signal Circuit: Twisted shield pairs minimum 18 AWG, separated at least six inches from power wiring.
D) Wire Identification: Numbered and tagged at each termination. Wire tag names shown on wiring diagrams, to be assigned during submittal and approved by the District prior to construction. Wire Tags: Printed sleeve of the heat shrink type. All such sleeves shall be shrunk to the conductor insulation.
E) Restrain by plastic ties or ducts or metal raceway.
F) Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

8. Fuses:
A) Terminal strip mounted on fuse blocks designed to snap into contact strips.
B) Manufacturers and Products: Allen-Bradley part No. 1492-H4 or equal with typewritten identification on each one.
C) Provide fuse blown-out indicator.

9. Terminals:

A) Heavy duty double screw type with strap screw clamp, 600-volt rated and mounted on mounting channels.
B) Manufacturers and Products: Entrelec or Allen-Bradley Part No. 1492-H1 for control signal. Provide type written terminal block identification for all terminals.

10. Pushbuttons, Indicating Lights, and Selector Switches:
    A) Type: Heavy-duty, corrosion resistant, NEMA 250 Type 4X. Provide contact arrangements, colors, inscriptions, and functions as shown.
    B) Standard size, white field, legend plates with black markings, for service legend.
    C) Labels will also be provided and installed on the back of PSCP door above device.
    D) Contact Rating: NEMA ICS 2, Type A600.
    E) Manufacturers and Products:
        (i) Eaton; Type T.
        (ii) Square D; Type K.
    F) Unless otherwise shown, provide the following features:
        (i) Selector Switch Operating Lever: Block knob type. Single hole mounting, accommodating panel thicknesses from 1/16 to ¼-inch.
        (ii) Indicating Lights: Push-to-Test, LED-Type.
        (iii) Pushbutton Color:
            (I) Test: Black
            (II) Reset: Red.
        (iv) Contacts rated 10 amps continues at 120V ac.

11. Elapsed Time Meters:
    A) Type: Synchronous motor drive, 0 to 99,999.9 hours range, nonreset, suitable for semiflush, panel mounting, spare case, 4-inches, minimum.
    B) Manufacturers:
        (i) Eagles Signal Controls.
        (ii) General Electric Co.
        (iii) Veeder-Root.

9.03.2.07 Outlet and Device Boxes

a. Cast Metal:
    1. Box: Cast ferrous metal, Deep.
    2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
    3. Hubs: Threaded.
    4. Lugs: Cast Mounting.
    5. Manufacturers and Products, Nonhazardous Locations:

A) Crouse-Hinds; Type FS or FD.
B) Appleton; Type FS or FD.

6. Manufacturers and Products, hazardous Locations:
   A) Crouse-Hinds; Type GUA or EAJ.
   B) Appleton; Type GR.

9.03.2.08 Junction and Pull Boxes

a. Outlet Boxes Used as Junction or Pull Box: As specified under article Outlet and Device Boxes.

b. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.

c. Concrete Box, Nontraffic Areas: As shown on Drawings.

9.03.2.09 Wiring Devices

a. Receptacle, Single:
   1. NEMA WD 1 and FS W-C-596.
   2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
   3. High strength, thermoplastic base color.
   4. Color: Ivory.
   5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
   6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
   7. One-piece mounting strap with integral ground contact (rivetless construction).
   8. Manufacturers and Products:
      A) Arrow Hart; 5262 Series.
      B) Leviton; 5262/5362 Series.
      C) Bryant; 5262/5362 Series.
      D) Hubbell; 5262/5362 Series.

b. Receptacle, Ground Fault Circuit Interrupter:
   1. Duplex, listed Class A to UL Standard 943, tripping at 5mA.
   2. Color: Ivory.
   3. Rating: 125 volts; NEMA WD 1, Configuration 5-20R, 20 amps.
   4. Size: For 2-inch by 4-inch outlet boxes.
   5. Standard Model: NEMA WD 1, with screw terminals and provisions for testing.
   6. Impact resistant nylon face.
   7. Manufacturers and Products:

A) Arrow Hart.
B) Leviton.
C) Bryant.
D) Hubbell.

9.03.2.10 Device Plates

a. General: Sectional type plates not permitted.

b. Cast Metal:
   1. Materials: Malleable ferrous metal.
   2. Screw: Oval-head stainless steel.

c. Weatherproof:
   1. Receptacles, Wet Locations.
      A) Impact-resistant, nonmetallic, single-gang, horizontal-mounting, providing, while in-use, NEMA 3R rating; unless otherwise noted on the Drawings.
      B) Stainless steel mounting and hinge hardware.
      C) Lockable, paintable.
      D) Color: Gray.
      E) Manufacturers:
         (i) Carlon.
         (ii) Leviton.

9.03.2.11 Equipment Nameplates

a. Provide nameplates on all equipment. Nameplate schedule shall be included in all equipment submittal.

b. Provide weatherproof rating for all nameplates located outdoors.

c. Color: Black backgrounds with white letters.

d. Exterior Enclosures: Enclosures-01 and 02, main breaker enclosure, Current Transformer (CT) can, air-gap enclosure, etc., the nameplates shall be:
   1. Located on the enclosure face.
   2. Rectangular screw-on type with self-tapping 316 stainless steel screws for weatherproof rating.
   3. Provide 2.25-inch high with 1-inch high lettering.

e. Interior Panels: Enclosure located within electrical enclosure –01 or –02, such as pump sequence control panel, motor control panels, automatic transfer switch, load center, transformer, Mission panel, etc., the nameplates shall be:

1. Located on the enclosure face.
2. Rectangular screw-on type with self-tapping 316 stainless steel screws.
3. Provide 1-inch high with ½-inch high lettering.
4. Provide and install pump name plate on the front of each starter cabinet.

f. Component nameplates-Panel Face (Front): Component nameplate located on panel face under or near component, the nameplates shall be:
   1. Materials: Adhesive backed, laminated plastic.
   2. Provide ½-inch high with 3/16-inch high lettering.

g. Component nameplates-Back of Panel: Component nameplate located on or near component inside of the enclosure, the nameplates shall be:
   1. Materials: Adhesive backed, laminated plastic.
   2. Provide ½-inch high with 3/16-inch high lettering.

9.03.2.12 Circuit Breaker, Individual, Heavy Duty Disconnect 0 To 600 Volts

a. UL 489 listed for use at location of installation.

b. Main breaker shall be thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.

c. Main Heavy Duty Disconnect shall be non-fuses after main breaker. Main Heavy Duty Disconnect shall be mounted downstream of the Main breaker. This disconnect will be used to test the standby generator by manually disconnecting the utility power from the station.

d. Suitable for use with 75 degree C wire at full NFPA 70, 75 degrees C ampacity.

e. Locking: Provisions for padlocking handle.

f. Enclosure: NEMA 4X stainless steel 304 for outdoor installation and NEMA 1 for indoor.

g. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

h. Minimum Interrupting Rating: Per Drawing.

i. Manufacturers:
   1. Eaton.
   2. Square D Co.
   3. Siemens Co.

9.03.2.13 Dry Type Power Transformers, 0 To 600 Volts Primary

a. Type: Self-cooled, two-winding.

b. UL 1561 and NEMA ST 20.

c. Insulation Class, Temperature Rise, and Impedance: Manufacturer's standard designed for 115 degrees C maximum temperature rise.

d. Enclosure: NEMA 250, Type 3R, non ventilated.

e. Voltage Taps: Full capacity, 2-1/2 percent, two above and two below normal voltage rating.

f. Sound Level: Not to exceed NEMA ST 20 levels.

g. Vibration isolators to minimize and isolate sound transmission.

h. Manufacturers:
   1. Eaton.
   2. Square D Co.
   3. Siemens Co.

9.03.2.14 Lighting Power Distribution Panel

a. Nema PB 1 NFPA 70, and UL 67.

b. Panelboard and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

c. Short-Circuit Current Equipment Rating : Fully rated; series connected unacceptable.

d. Rating: Applicable to a system with available short-circuit current of 10,000 amperes rms symmetrical at 120/240 volts.

e. Cabinet:
   1. Eaton,
   2. NEMA 250, Type 12

3. Material: Code-gauge, hot-dip galvanized sheet steel with reinforced steel frame. Interior and exterior paint shall be manufacturer's standard.
4. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
   A) Trim Size: As required by mounting.
   B) Finish: Manufacturer's standard.
5. Interior:
   A) Factory assembled; complete with circuit breakers.
   B) Spaces: Cover openings with easily removable metal cover.
6. Door Hinges: Concealed
7. Locking Devices:
   A) Flush type.
   B) Doors over 30 inches in height: Multipoint.
   C) Identical keylocks, with two milled key each lock.
8. Circuit Directory:
   Metal frame with transparent plastic face and enclosed card on interior of the door. Provide a type written circuit directory with actual circuit assignments.

f. Bus Bar:
   1. Material: Copper full sized throughout length.
   2. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
   3. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw on each circuit.
   4. Lugs and Connection Points:
      A) Suitable for copper conductors.
      B) Solderless main lugs for main, neutral, and ground bus bars.
      C) Subfeed or through-feed lugs as shown.

g. Circuit Breakers:
   1. UL 489.
   2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
   3. Type: Plug-in circuit breakers.
   4. Multi-pole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
   5. Do not use tandem or dual circuit breakers in normal single-pole spaces. Ground Fault Equipment Protector (GFEP): 30mA trip, 10,000 amps interrupting capacity circuit breaker, and UL listed for equipment ground fault protection.

6. Use GFCI breakers for circuits the feed exterior circuits (example – Heat Trace or Hot Box)

h. Manufacturers:
   1. Eaton.
   2. Square D Co.
   3. Siemens Co.

9.03.2.15 Combination Full-Voltage, Magnetic Motor Starter Panels, RVSS

a. For all pump motors rated less than 20 horse power, each combination motor starter panel shall be furnished with motor circuit protection (MCP), magnetic type only breaker, and a NEMA full size rated across-the-line starter. NEMA half sizes and IEC contactors are not permitted. Combination motor starter panel shall be in NEMA 250 Type 1 enclosure. The front of the enclosure shall consist with an ammeter, which has a range double the actual motor full load amps, and a motor overload reset pushbutton.

b. Panels shall be labeled and listed UL 508.

c. General:
   1. Make adjustments as necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors and motor ratings actually provided.
   2. Rating: Horsepower rated at 600 volts, UL labeled for actual short-circuit rating as shown on the Drawings.
   3. Control: As shown on the Drawings.
   4. Thermal Overload Protection:
      A) Inverse-time limit characteristic.
      B) Heater: Bimetallic overload, adjustable trip.
      C) Relay Trip: Standard, Class 20.
      D) Provide in each ungrounded phase.
      E) Mount within starter unit.
      F) Manual Reset. External to the enclosure.
   5. Control Transformer:
      A) Two winding, 120-volt secondary, primary voltage to suit.
      B) Two current-limiting uses for primary circuit.
      C) One fuse in secondary circuit.
      D) Mount within starter unit.
      E) Capacity: 140 percent of load.
   6. Enclosure: NEMA 250, Type 1. Padlockable operating handle.
   7. Operating Conditions:

A) Ambient Temperature: Maximum 40 degrees C.
B) Equipment to be fully rated without any derating for operating conditions listed above.

8. Equipment finish:
   A) Electrocoating process applied over rust-inhibiting phosphated base coating.
   B) Exterior Color: Manufacturer's standard.
9. Pump protection monitor (MiniCas or MasCas)
   A) Pump protection monitor shall be provided by the furnished pump manufacturer. Coordinate and install the pump protection monitor as part of the combination starter cabinet. Wire the unit as per design intent.
   B) Pump protection monitor shall be panel mount type.
10. Manufacturers:
    A) Eaton.
    B) Siemens.
    C) Allen Bradley.
    D) Reduced Voltage Soft Start:
       A. For pump motors rated over 20 horsepower or where deemed necessary the station will employ a reduced voltage starter to ramp the motor up to full speed. The RVSS panel will include a separate across the line bypass starter to act as a back-up ONLY in the event of a failure of the RVSS. The selection of RVSS or bypass starter will be via a local switch located on the RVSS panel.

       B. Manufacturers:

Eaton 8119.03.2.16 TVSS Design

a. Balanced Suppression Platform: The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform shall provide equal impedance paths to each matched MOV.

b. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 55 dB at 100 kHz using MIL-STD-220A insertion loss test method.

c. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.

d. Overcurrent Protection Fusing:

MOVs shall be individually fused.

e. Safety and Diagnostic Monitoring: Each unit shall provide the following three levels of monitoring:
   1. Continuous monitoring of fusing system.
   2. Continuous monitoring of individual MOVs (including neutral to ground). The system shall be capable of identifying open circuit.
   3. A green/red solid state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light shall indicate which phase(s) have been damaged. Fault diction will activate a flashing trouble light. Units which cannot detect open-circuit damage, thermal conditions, and over current will not be accepted.
   4. The unit shall be equipped with a transient event counter.
   5. All monitoring diagnostics features such as indicator lights, trouble alarms, and surge counter shall be mounted on the display.
   6. Remote Status Monitor: The TVSS device shall include Form C dry contacts (one NO and one NC) for remote annunciation of unit status. The remote alarm shall change state during all fault conditions.
   7. Push-to-Test Feature: Each suppression unit shall incorporate an integral test feature which verifies the operational integrity of the unit's monitoring system.

f: Prior to manufacture submit Shop Drawing which also includes:
   1. Dimensioned tap enclosure drawing showing component arrangement.
   2. Bill of Material.
   3. Catalog cut sheets.
   4. Verification of UL 508.

9.03.2.17 Wet Well Float Switch

a. Free floating float switch suspended from PVC coated, multi-core connecting cable to hermetically sealed CPVC coated non-mercury switch.

b. Switch shall be Anchor Scientific Eco-Float Model G Type SI Suspended with a normally open, single pole contact and with manufactured cable length as required to run from installed level in the wet well to Disconnect Air-Gap Enclosure with appropriate slack, as shown on the Drawing.

9.03.2.18 Level Switch, Vault Flood

a. Type: Float actuated switch mounted to wall to actuate on water level 4 inches above floor.

b. Feature: Float, stem, cage, and guide tube connected to a switch enclosure.

c. Materials: Wetted parts 316 stainless steel.

d. Contact: DPDT snap action rated 10A continuous at 120V ac.

e. Enclosure: NEMA 4X.

f. Manufacturers: GEMS, Model LSP-800.

9.03.2.19 Remote Telemetry Unit

a. District will commission the Mission unit with support from Contractor.

b. Alarm inputs to each Mission unit shall be connected using normally open contacts as shown on the Drawings; unless otherwise noted. Field wiring connections to the Mission unit shall be made using No. 18 twisted shielded stranded copper conductors routed away from all other wiring.

A. M850: "My Dro" RTU – Wireless Real-Time Alarm System with Streaming Data – NEMA 1 Enclosure (Indoor wall mounting enclosure; Includes all parts for standard installation

a. ADAM: Option Board - Analog Input (4 additional analog inputs)
b. SP850-12: Service Package – MyDro M850 Series - 1 year
c. PW442: Battery - 7 Amp-hour (Sealed, Lead-Acid, 12 VDC)
d. Plug in Power supply unit
e. Unless otherwise stated, the standard configuration for the I/O of the Missions system will be:
    i. Discrete:
        1) Pump 1 Run
        2) Pump 2 Run
        3) Pump 1 Fail
        4) Pump 2 Fail
        5) Generator Running
        6) Generator Fail
        7) High Wet Well with valve or meter vault flood alarms if applicable.
        8) Overflow
    ii. Analog:

1) Pump 1 amps
2) Pump 2 amps
3) Flow
4) Wet Well Level

iii. Additional:

1) The power supplying the Missions RTU shall be tied to the PSCP power through an isolating relay such that if the PSCP control power is lost the Missions RTU also loses power which will trigger an AC lost alarm.

A 12Vdc light (ex ABB LC-501R) shall be wired through the #1 output relay powered by the Mission RTU's onboard power to indicate when the RTU is in Service Mode.

d. Manufacturers
1. Mission

9.03.2.20 Exterior Alarm Flashing Beacon Light

a. Beacon light shall be mounted above the Electrical enclosure; unless otherwise noted. The conduit shall be extended a minimum of 18-inches above the top of the electrical enclosure or high enough to be visible from the nearest public roadway. Conduit and conduit support and hardware shall be stainless steel materials.

b. Alarm exterior strobe beacon light shall be red color, weatherproof type, LED, and 120V ac.

c. Beacon light shall be connected to the high wet well level alarm contactors, initiated either from pressure level transducer high level or high float switch. Overflow float doesn't connect to the beacon light.

d. Manufacturer:
1. Federal Signal – 191XL
2. Allen Bradly – 855F.

9.03.2.21 Yard Light and Control Station

Provide and install yard light pole and fixture as shown on the Drawings. Pole shall have a hinged base that will lay down clear of anything.

b. Control station for the yard light shall be located in the electrical enclosure as shown on the Drawings. The control station shall be NEMA 1 enclosure and shall be manufactured by Intermatic switch Model FF32H, 2 hour adjustable timer.

9.03.2.22 Pressure Level Transducer and Level Controller

a. Level Indication Controller shall be by Endress+Hauser. Panel Meter RIA452, Model # RIA52-C114A11A
   1. 1 Channel, scalable, Panel mounting, Loop power supply, 7 digital LCD display.
   2. C – Approval: FM
      1 – Power Supply 90-250vac
      1 – Measuring Signal: 0/4-20mA
      4 – Output: 8x relay SPDT limit + 1x analogue + 1x pulse + integration + linearization for open channel
      A – Communication: Standard
      1 – Housing: 96x96 panel mounting, front IP65
      1 – Additional Option: Basic version
      A – Version: Standard, de,en,fr

b. Transducer shall be WIKA LH-20 Part #52730013. This type of transducer requires a stilling well as shown on drawings.
   1. LH-20 - High performance submersible pressure transmitter
   2. Specifications according to data sheet: PE 81.56
   3. Pressure range: 0...250 inWC gauge
   4. Cable material: PUR
   5. Unit of cable length: feet
   6. Cable length: 40
   7. Signal output: 4...20 mA, 2-wire HART compatible
   8. Accuracy: 0.2% of span
   9. Housing: stainless steel
   10. Approval: FM
   11. Type of protection: (IS) Intrinsic Safety
   12. Atmosphere: Dust and Gas Div. 1 (Cl I, II, III, Div.1)
   13. Process Connection: M14x1 female with protection cap
   14. Sealing Sensor: dual FKM (VP2/A)
   15. Pin assignment el. connection: U+=BN, U-=BU
   16. Power supply: 8...30 V DC
   17. Approval marking: FM (IS) CL I,II,III, DIV 1, GP ABCDEFG

c. Cable shall be of adequate length with appropriate slack for homerun from wet well to air-gap enclosure.

d. Operating Level Set Points: As shown on the Drawings.

9.03.2.23 Magnetic Flow Meter

a. Flow meter shall be electromagnetic type with a remote indicator converter/transmitter. Flow meter shall be rated for use in Class 1, Division 2 location, suitable for continuous submergence IP68.

Provide with standard features, zero stability feature to eliminate the need to stop flow to check zero alignment, no obstructions to flow, very low pressure loss.

b. The only electrical components within the flow tube shall be the flow tube coils, electrodes, and the cables necessary to connect the flow tube coils to the converter/transmitter.

c. Flow tube coils and connections to surface wiring shall be completely encapsulated and isolated from contact with fluid.

d. The cable between the flow tube and the transmitter shall be continuous, without splice, and potted The manufacturer shall provide adequate length of cable as shown on the Drawings. The flow transducer shall be located in the meter vault while the transmitter is located in the electrical enclosure.

e. Materials: The electrodes shall be made of Type 316 stainless and shall not be adversely affected by raw sewage. Flow tube housing shall be cast or ductile iron, Teflon lined, with ANSI Class 150 stainless steel flange materials, 316L stainless steel grounding electrodes or stainless steel grounding rings, and shall be sized to maintain an accuracy of 0.5 percent of flow above 3 feet per second.

f. Converter/Transmitter: The transmitter shall include a digital display of the instantaneous flow rate and totalized flow. The flow meter shall be equipped with a signal converter/transmitter to convert signal from the flow tube to an analog 4-20mAdc signal proportional to flow rate. Output span and zero shall be manually adjustable. Provide span adjustable capable of producing a full-scale analog output at flow rates that are 30 percent of maximum. Signal shall be linear with flow within the accuracy specified above. The transmitter shall operate from 120V ac, 60-Hz power supply.

g. Flow indicator/transmitter shall be programmed for
   1. Instantaneous Flow
   2. Totalized Flow: Thousand of gallons.

h. Special Tools: Furnish special tools that are necessary for the replacement of parts and the adjustment of the equipment.

i. Calibrations and Diagnostics:
   1. Advanced diagnostic (ex Rosemount DA2 option)

2. HART compatible

j. Factory Testing: The flow meter shall be factory tested and certified over entire specified flow range. Certified test records shall be submitted to the District for review.

k. Manufacturer:
   1. Rosemount:
      A) Transducer: 8705 Series
      B) Converter/Transmitter: 8712D Series

9.03.2.24 Conduit and Fittings

a. Electrical Metallic Tubing (EMT).
   1. Meet requirements of NEMA C80.3 and UL 797.
   2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

b. PVC Schedule 40 Conduit.
   1. Meet requirements of NEMA TC 2 and UL 651.
   2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90 degrees C insulated conduit.

c. PVC-Coated Rigid Galvanized Steel Conduit.
   1. Meet requirements of NEMA RN 1.
   2. Material:
      A) Meet requirements of NEMA C80.1 and UL 6.
      B) Exterior Finish: PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
      C) Interior Finish: Urethane coating, 2 mils nominal thickness.
   3. Threads: Hot-dipped galvanized and factory coated with urethane.
   4. Bendable without damage to either interior or exterior coating.

d. Flexible Metal, Liquid-Tight Conduit.
   1. UL 360 listed for 105 degrees C insulated conduit.
   2. Material: Galvanized steel, with an extruded PVC jacket.

e. Flexible Coupling, Hazardous Location.
   1. Approved for use in the atmosphere involved.
   2. Rating: Watertight and UL listed for use in Class 1, Division 1 and Division 2 ares.
   3. Outer bronze braid and insulating liner.
   4. Conductivity equal to a similar length of rigid metal conduit.

5. Manufacturers and Products:
   A) Crouse-Hinds, Type ECGJH or ECLK
   B) Appleton; EXGJH or EXLK.

f. Fittings.
   1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
   2. Rigid Galvanized Steel Conduit:
      A) Meet requirements of UL 514B.
      B) Type: Threaded, galvanized.
   3. Electrical Metallic Tubing (EMT):
      A) Meet requirements of UL 514B.
      B) Type: Steel body and locknuts with steel or malleable iron compression nuts. Setscrew and drive-on fittings not permitted.
      C) Electro zinc-plated inside and out.
      D) Raintight.
   4. PVC Conduit:
      A) Meet requirements of NEMA TC 3.
      B) Type: PVC, slip-on.
   5. PVC-Coated Rigid Galvanized Steel Conduit:
      A) Meet requirements of UL 514B.
      B) Fittings: Rigid Galvanized steel type, PVC-coated by conduit manufacturer.
      C) Conduit Bodies: Form 7 – Only Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
      D) Finish: 40-mil PVC exterior, 2-mil urethane interior.
      E) Overlapping pressure sealing sleeves.
      F) Conduit Hangers, Attachments, and Accessories: PVC-coated.
      G) Manufacturers:
         (i) Robroy Industries.
         (ii) Ocal.
   6. Flexible Metal, Liquid-Tight Conduit:
      A) Metal insulated throut connectors with integral nylon or plastic bushing rated for 105 degrees C.
      B) Insulated throat and sealing O-ring.
      C) Exterior PVC-coating
   7. Flexible Coupling, Hazardous Locations:
      A) Approved for use in the atmosphere involved.
      B) Rating: Watertight and UL listed for use in Class I, Division 1 and Division 2 areas.

C) Outer bronze braid and an insulating liner.
D) Conductivity equal to a similar length of rigid metal conduit.
E) Manufacturers and Products:
(i) Crouse-Hinds; Type ECGJH or ECLK.
(ii) Appleton; EXGJH or EXLK

9.03.2.25 Metal Wireways

a. Meet requirements of UL 870.
Meet requirements of NEMA C80.3 and UL 797.

b. Type: Steel-enclosed, with removable, hinge cover.

c. Rating: Indoor.

d. Finish: Gray, baked enamel.

e. Manufacturers:
1. Circle AW.
2. Hoffman.

9.03.2.26 Conduit Accessories

a. Duct Bank Spacers.
1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturers:
A) Underground Devices, Inc.
B) Carlon.

b. Conduit Identification (Tag)
1. Provide 12GA stainless steel ¾-inch by 2-inch minimum length tag with raceway number stamped in ¼-inch minimum height characters. Circular shape tag is also acceptable.
2. Neatly attached identification to the raceway with 316 stainless steel wire.
3. A combined homerun conduit with multi-circuit conductors shall have multi-identification tag, one for each circuit.

9.03.2.27 Support and Framing Channels

a. Stainless steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12 gauge.

b. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.

9.03.2.28 Fittings and Boxes

a. Stainless steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12 gauge.

b. Manufacturers:
   1. B-Line Systems, Inc.
   2. Unistrut Corp.

9.03.2.29 Conductors and Cables

a. Conductors 600 volts and Below:
   1. Conform to applicable requirements of NEMA WC 71, WC 72, and WC 74.
   2. Conductor Type:
      A) 120- and 277- Volts Lighting, No. 10 AWG and Smaller: Solid copper.
      B) 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
      C) All Other Circuits: Stranded copper.
   3. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW-2 insulation.
   4. Flexible Cords and Cables:
      A) Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
      B) Conform to physical and minimum thickness requirements of NEMA WC 70.

9.03.2.30 600-Volt Rated Cable

a. General:
   1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
   2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
   3. Suitable for installation in open air, in cable trays, or conduit.
   4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
   5. Overall Outer Jacket: PVC, flame-retardant, sunlight-and-oil-resistant.

b. Type WTD, No. 18 AWG, Twisted, Shield Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
   1. Outer Jacket: 45 mils nominal thickness.
   2. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   3. Dimension: 0.31-inch nominal outside diameter.
   4. Conductors:
      A) Base soft annealed copper, Class B, seven-stranded concentric, meeting requirements of ASTM B8.
      B) 20 AWG, seven-strand tinned copper drain wire.
      C) Insulation: 15 mils nominal PVC.
      D) Jacket: 4 mils nominal nylon.
      E) Color Code: Pair conductors black and red.
      F) Manufacturers: Okonite Co.

c. Accessories:
   1. Tape:
      A) General Purpose, Flame Retardant: 7mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
      B) Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
   2. Indication Devices:
      A) Sleeve of the heat shrink type, permanent, PVC, yellow or white, with legible machine-printed black markings. All such sleeves shall be shrunk to the conductor insulation.
      B) Manufacture and Products: Raychem, Type D-SCE or ZH-SCE.
   3. Connectors and Terminations:
      A) Nylon, Self-Insulated Crimp Connectors.
      B) Manufacturers and Products:
      C) Thomas & Betts; Sta-Kon.
      D) Burndy; Insulug.
      E) ILSCO.
   4. Cable Lugs:
      A) In accordance with NEMA CC 1.
      B) Rated 600 volts of same material as conductor metal.
      C) Uninsulated Crimp Connectors and Terminators:
         (i) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
         (ii) Manufacturers and Products.
            (I) Thomas & Betts; Color-Keyed.
            (II) Burndy; Hydent.

(III) ILSCO.

5. Uninsulated, Bolted, Two-Way Connectors and Terminators:
   A) Manufacturer and Products:
      (i) Thomas & Betts; Locktite.
      (ii) Burndy; Quiklug.
      (iii) ILSCO.
6. Cable Ties:
   A) Nylon, adjustable, self-locking, and reusable.
   B) Manufacturer and Products:
      (i) Thomas & Betts; TY-RAP.
7. Heat Shrinkable Insulation:
   A) Thermally stabilized, crosslinked polyolefin.
   B) Manufacturer and Products:
      (i) Thomas & Betts; SHRINK-KON.
8. Grounding:
   A) Ground Rods: Provide copper-clad steel with minimum diameter of ¾-inch, and length of 10-feet.
   B) Ground Conductors: As specified in Article Conductor and Cable.
   C) Connectors
      (i) Exothermic Weld Type:
      (ii) Outdoor Weld: Suitable for exposure to elements or direct burial.
      (iii) Indoor Weld: Utilize low-smoke, low-emission process.
   D) Manufacturer and Products:
      (i) Erico Products; Inc.; Cadweld and Cadweld Exolon.
      (ii) Thermoweld.
      (iii) ILSCO.

9.03.3 Execution

9.03.3.01 General

a. Install materials and equipment in accordance with manufacturer's instructions and recommendations.

b. Work shall comply with all applicable provision of NECA 1.

c. Install materials and equipment in hazardous areas in manner acceptable to regulatory authority having jurisdiction for the class, division, and group of hazardous areas shown.

d. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

9.03.3.02 Protection Following Installation

a. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.

b. Cap conduit runs during construction with manufactured seals.

c. Close openings in boxes or equipment during construction.

d. Energize space heaters furnished with equipment.

9.03.3.03 Conduit and Fittings

a. General:
   1. Crushed or deformed raceways are not permitted.
   2. Maintain raceway entirely free of obstruction and moisture.
   3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
   4. Sealing Fittings: Provide drain seal in vertical raceways where condensation may collect above sealing fitting.
   5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
   6. Group raceways installed in the same area.
   7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
   8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
   9. Block Walls: Do not install raceways in the same horizontal course with reinforcing steel.
   10. Install watertight fittings in outdoor, underground, or wet locations.
   11. Joints shall be tight, thoroughly grounded, secure, and free of obstructions in the pipe. 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.
   12. Paint threads and cut ends, before assembly of fittings, or PVC-coated galvanized conduit installed in exposed or damp location with zinc-rich paint or liquid galvanizing compound.
   13. Metal conduit to be reamed, burrs removed, and clean before installation of conductors, wires, or cables.
   14. Do not install raceways in concrete equipment pads, foundations, or beams.

15. Horizontal raceways installed under floor slabs shall lie completely under stab, with no part embedded within slab.
16. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
17. Install conduits for telephone cables, and data cables in strict conformance with the requirements of EIA/TIA 569.
18. Fittings for use with PVC-Coated rigid galvanized steel shall be PVC-Coated and shall be products of the same manufacturer as the conduit.
19. Male and female threads and internal surface shall have a 2-mil urethane coating.
20. Installation of steel conduit though a core-drilled hole in an exterior wall below grade shall utilize sealing devices manufactured by Link Seal or equal.
21. Conduit passing through wall or floors shall have plastic sleeves if the penetration is not fire-rated. Core drilling shall be performed in accordance with other specified Sections. UL-approved fire stopping shall be installed per manufacturer's instructions in the annular spaces to maintain fire ratings between rooms where the wall or floor is fire-rated.
22. Conduit, fittings, and boxes required for installation in hazardous classified areas shall be approved for the application and installed in strict accordance with NEC requirements.
23. Empty conduits shall be tagged at both ends to indicate the final destination. A 1/8" polypropylene pull-cord shall also be installed in each empty conduit. Empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes shall have a removable plug installed.

b. Conduit Application:
   1. Conduit, Adapters, and Fitting Application:
      A) Diameter: ¾-inch, minimum.
      B) Wet Locations: PVC-Coated rigid galvanized steel.
      C) Outdoor, in Vaults, Wet Well, Exposed: PVC-Coated rigid galvanized steel.
      D) Inside electrical enclosure-01 & -02: EMT.
      E) Direct Earth Burial:
         (i) PVC-Coated rigid galvanized steel for cables to flow or level elements.
         (ii) PVC Schedule 40 with PVC-Coated rigid galvanized steel elbows for all other locations.
   2. Provide conduit seal-offs at the following locations:
      In hazardous classified locations, in strict accordance with NEC.

c. Fitting and Boxes:
   1. General:
      A) Cast and malleable iron fittings for use with metallic conduit shall be the thread type with 5 full threads.
      B) Fittings and boxes shall have neoprene gaskets and non-magnetic stainless steel screws. 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.
      C) Boxes larger than standard cast or malleable types shall be 304 stainless steel, NEMA 4X.
      D) Conduits shall be terminated at panels in raintight hubs with grounding locknuts as manufactured by Myers, O.Z. Gedney, Appleton, or equal. Sealing locknuts shall not be used in lieu of hubs; except at the metal raceway located at the electrical enclosure-01 and -02 per District's approval. Provide PVC-Coated hubs when with PVC-Coated rigid steel conduit.
   2. PVC-Coated Fittings and Boxes:
      A) Fittings for use with PVC-Coated RGS shall be PVC-Coated and shall be products of the same manufacturer as the conduit.
      B) Where flex fittings are used where PVC-Coated rigid galvanized steel conduits/raceways are required fittings shall also be PVC-Coated and shall be products of the same manufacturer as the flex.
      C) Stainless steel 304 NEMA 4X boxes shall be used with PVC-Coated rigid galvanized steel conduit and where indicated.
   3. Malleable Iron Fittings and Boxes:
      A) Fittings for use with galvanized steel conduit and EMT shall be of malleable iron or gray-iron alloy with zinc plating.
   4. PVC Fittings and Boxes:
      A) Fittings for use with non-metallic conduit shall be PVC, solvent welded type.

d. Conduit Connections and Transition:
   Instrumentation, and other equipment where flexible connection is required to minimize vibrations:
   1. General: Flexible metal, liquid-tight conduit.
   2. Hazardous Areas: Flexible coupling suitable for Class 1, Division 1 and 2 areas.
   3. Length: 18-inches maximum, sufficient to allow movement or adjustment of equipment.

4. Outdoor areas, process areas exposed to moisture, and areas required to be oil-tight and dust-tight: PVC-Coated flexible metal, liquid-tight conduit.
5. Transition From Underground or Concrete Embedded to Exposed: PVC-Coated galvanized steel conduit to 12 inches below grade.

e. Support:
Application/Type of Conduit Strap:
1. EMT Conduit: Zinc-coated steel, pre-galvanized steel, or malleable iron.
2. PVC-Coated Rigid Galvanized Steel Conduit: PVC-coated metal or stainless steel.

9.03.3.04 Grounding

a. Grounding shall be in compliance with NFPA 70 and as shown.

b. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

c. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

d. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceway and cables, receptacle ground connections, and metal piping systems.

e. Shield Instrumentation Cables:
1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1-inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

f. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.

g. Ground Rods: Install full length with conductor connection at upper end. Install one ground rod in each handhole.

9.03.3.05 Low Voltage Motor Control

a. Install equipment in accordance with NEMA ICS 2.3 and manufacturer's instructions and recommendations.

b. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers. Adjust to approximately 11-times motor rated current.

c. Select and install overload relay heaters or adjust electronic overload protection after the actual nameplate full-load current rating of motor has been determined.

9.03.3.06 Luminaires and Accessories

a. Install in accordance with manufacturer's recommendations.

b. Install plumb and level at mounting height shown.

c. Pole Mounted Fixtures: Provide cast-in-place concrete bases as shown.
   1. Pole Head fixtures shall be Hubble, Beacon style no photo cell.
   2. Part # VPS 60NB-136 5K T4 UNV RA BZT or new model.
   3. Poles shall be of the type which are hinged at the bottom and installed in such a manner as to allow the pole to be lowered to ground level unobstructed.

d. Install symmetrically with suspended ceiling pattern in finished areas.

e. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

9.03.3.07 Conductors and Cables

a. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendation.

b. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

c. Conduit system shall be complete prior to pulling conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.

d. Terminate all conductors and cables, unless otherwise shown.

e. Do not splice conductors, unless specifically indicated or approved by District.

f. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.

g. Wiring within Equipment and Panels: Remove surplus wire, dress, bundle, and secure.

h. Power Conductor Color Coding:
   1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
   2. No. 8 AWG and Smaller: Provide colored conductors:
      A) Neutral wire: White.
      B) Live wires, 120/240 volt, single phase: Black, red.
      C) Live wires, 277/480 volt, three phase: Brown, orange, or yellow.
      D) Ground wire: Green.
      E) Control Wire:
         (i) 120V wire within control panel: Red.
         (ii) 120V wire external to control panel: Yellow.
         (iii) DC positive wire: Blue
         (iv) DC negative wire: White with blue strip
         (v) 480V wire: Brown, Orange, Yellow
         (vi) 277 neutral wire: Gray

9.03.3.08 Operational Readiness Test (ORT) Template

a. Factory Demonstration Test, witness by the District's Representative, for electrical enclosure-01 and 02 shall be per District's standard.

Clean Water Services

Template Only Change to what is needed

Operational Readiness Test (ORT)

Factory/Field Demonstration Test Template

Provide necessary activities for successful factory demonstration test of Electrical Enclosure-01

Project Name: _____ **Project #:** _____

Demonstration Date: _____ **Witness By:** _____

Integrator: _____

Verified	Item	Description
	1.	**Enclosure 01 Power:**
	a.	Verify receptacles are energized.
	b.	Verify light illuminates when panel door is opened.
	c.	Simulate high temperature and verify fan runs.
	d.	Simulate low temperature and verify heater runs.
	e.	Verify power outlets, connectors, etc. have proper cover.
	2.	**Enclosure 01 Labels:**
	a.	Verify labels on doors, receptacles, cables, conduits, RTU, etc.
	3.	**Enclosure 01 Controls:**
	a.	Verify **Pump Sequence Control Panel Control Power ON** light is illuminated.
	4.	**High Level Beacon Light:**
	a.	Switch Beacon Enable switch to ON, jumper terminals at the wetwell

Verified	Item	Description
		High Level float intrinsically safe relay and verify High Level Beacon Light illuminates.
	b.	Verify High WetWell alarm calls out. (RTU Input # 7)
	c.	Remove jumper and verify High Level Beacon Light stays illuminated for 5 minutes (until TD3 times out).
	d.	Switch Beacon Enable switch to OFF, jumper terminals at the wetwell High Level float intrinsically safe relay and verify High Level Beacon Light does not illuminate.
	e.	Turn sector switch High Level Beacon Light Test switch and verify High Level Beacon Light illuminates.
	f.	Verify Beacon Light is mounted properly and securely.
	5.	**Pump#1 Control:**
	a.	Switch Pump #1 HOA switch to HAND and verify Pump #1 starter is energized.
	b.	Verify Pump #1 Running light is illuminated.
	c.	Switch Pump #1 HOA to OFF and verify Pump #1 starter does not energize regardless if wetwell high level float or level transmitter call for Pump #1 to run is jumpered.
	d.	Switch Pump #1 HOA to AUTO and switch Lead Selector switch to Pump #1. Jumper Lead Pump On level contact at level transmitter and verify Pump #1 starter energizes.
	e.	Remove jumper and verify Pump #1 starter de-energizes.
	f.	Again jumper Lead Pump On level contact at level transmitter and verify Pump #1 starter energizes again (there is no alternation).
	g.	Verify Run-Time meters are working.
	6.	**Pump#2 Control:**
	a.	Switch Pump #2 HOA switch to HAND and verify Pump #2 starter is energized.
	b.	Verify Pump #2 Running light is illuminated.
	c.	Switch Pump #2 HOA to OFF and verify Pump #2 starter does not energize regardless if wetwell high level float or level transmitter call

Verified	Item	Description
		for Pump #2 to run is jumpered.
	d.	Switch Pump #2 HOA to AUTO and switch Lead Selector switch to Pump #2. Jumper Lead Pump On level contact at level transmitter and verify Pump #2 starter energizes.
	e.	Remove jumper and verify Pump #2 starter de-energizes.
	f.	Again jumper Lead Pump On level contact at level transmitter and verify Pump #2 starter energizes again (there is no alternation).
	g.	Verify Run-Time meters are working.
	7.	**Both Pumps Control: (AUTO)**
	a.	Repeat steps **6.**a thru **6.**e for Pump #2.
	b.	Switch both pumps HOA to AUTO and Lead Selector switch to ALT. Jumper Lead Pump On level contact at level transmitter and verify Pump #1 or 2 starter energizes.
	c.	Remove jumper and verify that energized starter de-energizes.
	d.	Jumper Lead Pump On level contact at level transmitter again and verify the other pump starter energizes for Alternator relay function.
	e.	Jumper Lag Pump On level contact at level transmitter and verify both pump starters energize.
	f.	Verify Both Pumps Running alarm calls out. (RTU Input #_____)
	g.	Remove both jumpers and verify both pump starters de-energize.
	h.	Jumper terminals at the wetwell High Level float intrinsically safe relay and verify both pump starters energize.
	i.	Remove jumper and verify both pump starters stay energized for 5 minutes (until TD3 times out).
	8.	**Pump#1 Overtemp and Seal Leak:**
	a.	Switch Pump #1 HOA switch to OFF and remove temporary resistor connected to the Pump #1 Mini Cas to simulate an overtemp condition and verify Pump #1 Overtemp light is illuminated.
	b.	Verify Pump #1 Fail alarm does not call out.

Verified	Item	Description
	c.	Switch Pump #1 HOA switch to AUTO and verify that the Pump #1 Fail alarm calls out. (RTU Input # 3)
	d.	Switch Pump #1 HOA switch to HAND and verify that the Pump #1 Fail alarm calls out. (RTU Input # 3)
	e.	Verify Pump #1 starter does not energize until the simulated overtemp condition is removed and the reset pushbutton is pressed.
	f.	Jumper the temporary resistor to the Pump #1 Mini Cas to simulate a seal leak condition and verify Pump #1 starter can be energized.
	g.	Verify Pump #1 Seal Leak light is illuminated and stays on until the simulated seal leak condition is removed and the reset pushbutton is pressed.
	9.	**Pump#2 Overtemp and Seal Leak:**
	a.	Switch Pump #2 HOA switch to OFF and remove temporary resistor connected to the Pump #2 Mini Cas to simulate an overtemp condition and verify Pump #2 Overtemp light is illuminated.
	b.	Verify Pump #2 Fail alarm does not dial out.
	c.	Switch Pump #2 HOA switch to AUTO and verify that the Pump #2 Fail alarm calls out. (RTU Input # 4)
	d.	Switch Pump #2 HOA switch to HAND and verify that the Pump #2 Fail alarm calls out. (RTU Input # 4)
	e.	Verify Pump #2 starter does not energize until the simulated overtemp condition is removed and the reset pushbutton is pressed.
	f.	Jumper the temporary resistor to the Pump #2 Mini Cas to simulate a seal leak condition and verify Pump #2 starter can be energized.
	g.	Verify Pump #2 Seal Leak light is illuminated and stays on until the simulated seal leak condition is removed and the reset pushbutton is pressed.
	10.	**RTU:**
	a.	Turn off power to Pump Sequence Control Panel and verify PSCP Control Power Fail calls out. This may have a 30 second delay.
	b.	Jumper terminals at the wetwell Overflow Level float intrinsically safe

Verified	Item	Description
		relay and verify WetWell Overflow alarm calls out. RTU Input # 8).
	c.	Jumper the wetwell High Level On level contact at level transmitter and verify High WetWell alarm calls out. RTU Input # 7).
	d.	With Pump #1 HOA switch in AUTO, jumper Pump #1 overload and verify Pump #1 Fail alarm calls out. RTU Input # 3).
	e.	Switch Pump #1 HOA switch to OFF, jumper Pump #1 overload and verify Pump #1 Fail alarm does not dial out.
	f.	Switch Pump #1 HOA switch to HAND, jumper Pump #1 overload and verify Pump #1 Fail alarm calls out. RTU Input # 3).
	g.	With Pump #2 HOA switch in AUTO, jumper Pump #2 overload and verify Pump #2 Fail alarm calls out. RTU Input # 4).
	h.	Switch Pump #2 HOA switch to OFF, jumper Pump #2 overload and verify Pump #2 Fail alarm does not dial out.
	i.	Switch Pump #2 HOA switch to HAND, jumper Pump #2 overload and verify Pump #2 Fail alarm calls out. RTU Input # 4).
	j.	Jumper terminals at the Valve Vault Flood switch intrinsically safe relay and verify Valve Vault Flood alarm calls out. RTU Input # .
	k.	Jumper terminals at the Meter Vault Flood switch intrinsically safe relay and verify Meter Vault Flood alarm calls out. RTU Input # .
	l.	Run generator and verify Standby Generator ON calls out. This may have a 90 minute delay. RTU Input # .
	m.	Verify alarms are calling out correct to Pump Crew and coming into Mission web site
	11.	**Flow Meter Transmitter & Indicator: (If applicable)**
	a.	Verify settings such as scale & range.
	b.	Verify display settings units for GPM or MGD.
	c.	Verify display for current gallons (GPM) and Totalized gallons (GPM) * 1000) pumped.
	d.	Was this instrument factory certified for installation? (data sheet)
	12.	**Level Transmitter & Indicator:**

Verified	Item	Description
	a.	Verify settings such as scale & range.
	b.	Verify display settings for units for FEET.
	c.	Double check Transducer head in stilling well.
	d.	Have the factory installer input levels to watch controller respond.
	e.	Was this instrument factory certified for installation? (data sheet)
	f.	Verify pump operation elevation set points: • Bottom wetwell = xxx ft • Both pumps stop = xxx ft. • Lead pump on = xxx ft. • Lag pump on = xxx ft. • Hi level alarm clear/reset = xxx ft. • Hi level = xxx ft. • Hi Float = xxx ft • Overflow Float = xxx ft • Top of Wetwell = xxx ft
	g.	**Engine Generator –** • Field testing generator per specifications • E-Stop. Shutdown engine only without tripping the generator main breaker. • Generator Run • Generator Trouble • Generator Failed
	13.	**ATS Testing** • Field testing ATS per specification
	a.	Record actual ATS time delay settings for Transfer to Emergency and Transfer to Normal power.
	b.	Test ATS manual transfer function.
	c.	Check Alarm, Control and Equipment Test per specification.
	d.	Provide Operational Tests per specification.
	e.	Provide Endurance Tests per specification.

Template Forms:

CWS Pump Station Panel Factory/Field Test – Template		
Project#:		
Date:		
Verified	Item	Description
	1. Enclosure 01 Power:	
	a.	Verify receptacles are energized.
	b.	Verify light illuminates when panel door is opened.
	c.	Simulate high temperature and verify fan runs.
	d.	Simulate low temperature and verify heater runs.
	e.	Verify power outlets, connectors, etc have proper covers.
	2. Enclosure 01 Labels:	
	a.	Verify labels on doors, receptacles, cables, conduits, Auto-Dialer, etc…
	3. Enclosure 01 Controls:	
	a.	Verify **Pump Sequence Control Panel Control Power ON** light is illuminated.
	4. High Level Beacon Light:	
	a.	Switch Beacon Enable switch to ON, jumper terminals at the wetwell High Level float intrinsically safe relay and verify High Level Beacon Light illuminates.
	b.	Verify High WetWell alarm dials out. (Mission Input #_____)
	c.	Remove jumper and verify High Level Beacon Light stays illuminated for 5 minutes (until TD3 times out).
	d.	Switch Beacon Enable switch to OFF, jumper terminals at the wetwell High Level float intrinsically safe relay and verify High Level Beacon Light does not illuminate.
	e.	Press High Level Beacon Light Test switch and verify High Level Beacon Light illuminates.
	f.	Verify Beacon Light is mounted properly and securely.
	5. Pump#1 Control:	
	a.	Switch Pump #1 HOA switch to HAND and verify Pump #1 starter is energized.

Verified	Item	Description
	b.	Verify Pump #1 Running light is illuminated.
	c.	Switch Pump #1 HOA to OFF and verify Pump #1 starter does not energize regardless if wetwell high level float or level transmitter call for Pump #1 to run is jumpered.
	d.	Switch Pump #1 HOA to AUTO and switch Lead Selector switch to Pump #1. Jumper Lead Pump On level contact at level transmitter and verify Pump #1 starter energizes.
	e.	Remove jumper and verify Pump #1 starter de-energizes.
	f.	Again jumper Lead Pump On level contact at level transmitter and verify Pump #1 starter energizes again (there is no alternation).
	h.	Verify Run-Time meters are working.
	6. Pump#2 Control:	
	a.	Switch Pump #2 HOA switch to HAND and verify Pump #2 starter is energized.
	b.	Verify Pump #2 Running light is illuminated.
	c.	Switch Pump #2 HOA to OFF and verify Pump #2 starter does not energize regardless if wetwell high level float or level transmitter call for Pump #2 to run is jumpered.
	d.	Switch Pump #2 HOA to AUTO and switch Lead Selector switch to Pump #2. Jumper Lead Pump On level contact at level transmitter and verify Pump #2 starter energizes.
	e.	Remove jumper and verify Pump #2 starter de-energizes.
	f.	Again jumper Lead Pump On level contact at level transmitter and verify Pump #2 starter energizes again (there is no alternation).
	h.	Verify Run-Time meters are working.
	7. Both Pumps Control: (AUTO)	
	a.	Repeat steps **6.**a thru **6.**e for Pump #2.
	b.	Switch both pumps HOA to AUTO and Lead Selector switch to ALT. Jumper Lead Pump On level contact at level transmitter and verify Pump #1 or 2 starter energizes.
	c.	Remove jumper and verify that energized starter de-energizes.
	d.	Jumper Lead Pump On level contact at level transmitter again and verify the other pump starter energizes for Alternator relay function.
	e.	Jumper Lag Pump On level contact at level transmitter and verify both pump starters energize.
	f.	Verify Both Pumps Running alarm dials out. (Missions Input #_____)
	g.	Remove both jumpers and verify both pump starters de-energize.
	h.	Jumper terminals at the wetwell High Level float intrinsically safe relay and verify both pump starters energize.
	i.	Remove jumper and verify both pump starters stay energized for 5 minutes (until TD3 times out).

Verified	Item	Description
	8. Pump#1 Overtemp and Seal Leak:	
	a.	Switch Pump #1 HOA switch to OFF and remove temporary resistor connected to the Pump #1 Mini Cas to simulate an overtemp condition and verify Pump #1 Overtemp light is illuminated.
	b.	Verify Pump #1 Fail alarm does not dial out.
	c.	Switch Pump #1 HOA switch to AUTO and verify that the Pump #1 Fail alarm dials out. (Auto-Dialer Input #_____)
	d.	Switch Pump #1 HOA switch to HAND and verify that the Pump #1 Fail alarm dials out. (Auto-Dialer Input #_____)
	e.	Verify Pump #1 starter does not energize until the simulated overtemp condition is removed and the reset pushbutton is pressed.
	f.	Jumper the temporary resistor to the Pump #1 Mini Cas to simulate a seal leak condition and verify Pump #1 starter can be energized.
	g.	Verify Pump #1 Seal Leak light is illuminated and stays on until the simulated seal leak condition is removed and the reset pushbutton is pressed.
	9. Pump#2 Overtemp and Seal Leak:	
	a.	Switch Pump #2 HOA switch to OFF and remove temporary resistor connected to the Pump #2 Mini Cas to simulate an overtemp condition and verify Pump #2 Overtemp light is illuminated.
	b.	Verify Pump #2 Fail alarm does not dial out.
	c.	Switch Pump #2 HOA switch to AUTO and verify that the Pump #2 Fail alarm dials out. (Auto-Dialer Input #_____)
	d.	Switch Pump #2 HOA switch to HAND and verify that the Pump #2 Fail alarm dials out. (Auto-Dialer Input #_____)
	e.	Verify Pump #2 starter does not energize until the simulated overtemp condition is removed and the reset pushbutton is pressed.
	f.	Jumper the temporary resistor to the Pump #2 Mini Cas to simulate a seal leak condition and verify Pump #2 starter can be energized.
	g.	Verify Pump #2 Seal Leak light is illuminated and stays on until the simulated seal leak condition is removed and the reset pushbutton is pressed.
	10. Missions:	
	a.	Unplug dialer and verify internal power fail alarm dials out. Missionsr Input #_____).
	b.	Turn off power to Pump Sequence Control Panel and verify PSCP Control Power Fail dials out. This may have a 30 second delay. Missions Input #_____).

Verified	Item	Description
	c.	Jumper terminals at the wetwell Overflow Level float intrinsically safe relay and verify WetWell Overflow alarm dials out. Missions Input #_____).
	d.	Jumper the wetwell High Level On level contact at level transmitter and verify High WetWell alarm dials out. Missions Input #_____).
	e.	With Pump #1 HOA switch in AUTO, jumper Pump #1 overload and verify Pump #1 Fail alarm dials out. Missions Input #_____).
	f.	Switch Pump #1 HOA switch to OFF, jumper Pump #1 overload and verify Pump #1 Fail alarm does not dial out.
	g.	Switch Pump #1 HOA switch to HAND, jumper Pump #1 overload and verify Pump #1 Fail alarm dials out. Missions Input #_____).
	h.	With Pump #2 HOA switch in AUTO, jumper Pump #2 overload and verify Pump #2 Fail alarm dials out. Missions Input #_____).
	i.	Switch Pump #2 HOA switch to OFF, jumper Pump #2 overload and verify Pump #2 Fail alarm does not dial out.
	j.	Switch Pump #2 HOA switch to HAND, jumper Pump #2 overload and verify Pump #2 Fail alarm dials out. Missions Input #_____).
	k.	Jumper both pumps running and verify Both Pump Running alarm dials out. Missions Input #_____).
	l.	Jumper terminals at the Valve Vault Flood switch intrinsically safe relay and verify Valve Vault Flood alarm dials out. Missions Input #_____).
	m.	Jumper terminals at the Meter Vault Flood switch intrinsically safe relay and verify Meter Vault Flood alarm dials out. Missions Input #_____).
	n.	Jumper bubbler system fail (Low Air) and verify Bubbler System Fail alarm dials out. Missions Input #_____).
	o.	Run generator and verify Standby Generator ON dials out. This may have a 60 minute delay. Missions Input #_____).
		Note: Are all voice messages clear and understandable locally at the Missions **and through the phone?**
	11. Bubbler Panel/Compressor Cabinet: (If applicable)	
	a.	Verify compressor #1 run and check for excessive vibrations.
	b.	Verify compressor #2 run and check for excessive vibrations.
	c.	Verify compressors #1 & #2 alternate every cycle.
	d.	Verify LEAD compressor starts at 40 (?) psi.
	e.	Verify LEAD compressor stops at 50 (?) psi.
	f.	Verify both LEAD/LAG compressors start at 30 (?) psi.
	g.	Verify compressor high pressure pop-off is tested at 60 (?) psi.
	h.	Check for access to nuts and bolts for maintenance of equipment.
	i.	Check all air line fittings for leaks.
	J.	Verify purge valve and purge cycle are functioning.
		FOR GASTON STARTUP: BOTTOM wetwell = 152.03’

Verified	Item	Description
		Ramp Down Complete (120 sec) = 155.5' Both Pumps Stop = 156.8' – (PS-2 = 1.3') – (0.56 psi) Lead Pump On = 158.3' – (PS-3 = 2.8') – (1.21 psi) Lag Pump On = 159.4' – (PS-4 = 3.9') – (1.69 psi) Hi Level = 160.5' – (PS-5 = 5.0') – (2.16 psi) Hi Float = 160.5' Overflow Float = 175.6' TOP wetwell = 178.0' Existing Influent Sewage IE =158.28
	12. Flow Meter Transmitter & Indicator: (If applicable)	
	a.	Verify settings such as scale & range.
	b.	Verify display settings units for GPM or MGD.
	c.	Verify display for current gallons (GPM) and Totalized gallons (GPM) * 1000) pumped.
	d.	Was this instrument factory certified for installation? (data sheet)
	13. Level Transmitter & Indicator: (If applicable)	
	a.	Verify settings such as scale & range.
	b.	Verity display settings for units for INCHES or FEET.
	c.	Was this instrument factory certified for installation? (data sheet)
	14. Engine Generator:	
	a.	Record actual ATS time delay settings for Transfer to Emergency and Transfer to Normal power.
	b.	Test ATS manual transfer function.
	c.	Check Alarm, Control and Equipment Test per Spec Section 13101-3.02.C.
	d.	Provide Operational Tests per spec section 13101-3.02.D.
	e.	Provide Endurance Tests per spec section 13101-3.02.E