CHAPTER 17  WASTEWATER LIFT STATIONS

17.01 General

A. The intent of this chapter is to provide guidelines for the design of wastewater lift stations.

B. These guidelines presented in this chapter apply to lift stations with a peak hour pumping capacity up to approximately 2 mgd, with total dynamic head (TDH) of not more than approximately 160 feet. Lift stations, with capacity and/or TDH higher than the flow and TDH limits, are considered special designs not addressed by this chapter.

C. For the flow and TDH limits stated above, this chapter assumes that the proposed lift station will be a submersible lift station with 2 or more pumps installed in a concrete wet well, and a buried valve vault with discharge piping.

D. Factory-Built Systems: The COS accepts that wastewater lift stations in the sizes covered by these guidelines may be factory-built systems. The lift station, valve vault, electrical panels, control panels, and discharge piping may be assembled at the factory and shipped to the site to be installed by the contractor, who assumes responsibility for providing a functional facility with all associated piping, electrical, and controls.

E. The Engineer is responsible to provide materials, linings, and coatings suitable for a corrosive environment in accordance with Chapter 5.

F. In accordance with Chapter 7 of the Surprise EDS, public wastewater lift stations are discouraged and are allowed only under unusual circumstances with the prior written approval of the COS Public Works Director or designee. If a lift station is found to be required, refer to the EDS for project financing requirements and associated responsibilities.

17.02 Concept Design Review (CDR) Phase

A. General: The project shall be summarized and presented in a CDR report. The report will be submitted to the COS for review and acceptance. A CDR is required for any wastewater facility considered in this document, regardless of the project size or complexity. The CDR is the basis for the ensuing design process and must be presented in a fashion that allows the reader to gain a thorough and complete understanding of the necessity of the project. Without an approved CDR, the Engineer will not receive COS approval to proceed with final design.
B. Prepare a CDR with the items below and all design calculations supporting decisions and/or recommendations. The report will be submitted to the COS for review and acceptance. Submit the items below and other applicable items to support the CDR to the COS for review and approval:

1. Executive Summary.

2. Table of Contents.

3. The project background.

4. Existing conditions including, but not limited to, existing utilities and a list of major stakeholders with contact information for each.

5. Summary of utility conflict information, including pothole information or recommendations for utilities proposed to be potholed.

6. Topographic mapping information summary, per Chapter 2.


11. Summary of the applicable drainage and traffic study findings with references to those documents submitted separately.

12. Description of pump selection to include at a minimum:
   a) Summary of wastewater source(s) to be pumped.
   b) Technical selection criteria including operational scenarios of wet well volume, pump cycle time, flow, and TDH for selected pumps.
   c) Expandability features of facility including number of pumps, impeller size to accommodate range of flows for current and throughout all phases of expansion.
   d) Cost considerations including capital costs and operating costs.
   e) Description of operability issues.
   f) Summary of constructability issues.
   g) Recommendation of pump type and configuration, including the motor horsepower and impeller diameter.
   h) Table that summarizes the pump design criteria, including design head, design flow, motor horsepower, and pump design efficiency.
13. Flow monitoring data, if available.

14. Preliminary drawings (30 percent design drawings) illustrating:
   a) Property ownership, right of way, and easement information.
   b) Proposed grading and civil site improvements.
   c) Site access for maintenance.
   d) Electrical single-line diagram.
   e) HVAC schematic.
   f) Preliminary P&IDs.
   g) Proposed offsite improvements where applicable.
   h) Force main plans and profiles.
   i) Plans with dimensions to indicate equipment locations.
   j) Major sections indicating pipe centerline elevations.

15. Alternatives evaluation summary, if required.

16. Identification of appurtenant facilities and spacing criteria, including preliminary design of odor control facilities and noise attenuation.

17. Project considerations such as:
   a) Equipment procurement.
   b) Project schedule, which includes design, bidding, and construction.
   c) Stakeholder impact, which includes public and private entities.

18. Identification of any permanent and temporary ROW/easement constraints and acquisition needs.

19. Matrix summary of permits to be obtained and preliminary schedule for submittals and approval.

20. List of agencies, stakeholders, and utilities to review and sign the drawings.

21. Outline of technical specification sections and list of final design drawings.

22. Preliminary quantities and associated cost estimates.

23. Preliminary construction schedule.

24. Project correspondence file, including meeting minutes.

25. Inventory of existing facilities and improvements.
26. Graphics, detail sketches, tables, and other displays to support analyses and recommendations.

27. List of relevant reports, plans and maps reviewed, and other relevant project information.

28. Work plan for how construction is to be accomplished if connecting into existing facilities (phasing, shutdowns, etc.).

29. “Line of Sight” study for PLC/Radio Control (if requested).

30. Preliminary description of station operational scheme and controls, to include communication with SCADA.

31. Preliminary description of architectural features for structures and perimeter walls.

17.03 Agency and Utility Coordination

A. The Engineer shall initiate contact and coordinate efforts with outside utilities and agencies in accordance with Chapter 1.

17.04 Final Design Phase

A. General: The Engineer shall provide a Final Design with progress submittals to the COS at 60 percent and 90 percent level of completion in accordance with Chapter 1, which builds upon work completed during the CDR. The Final Design shall include:

1. Final design drawings.

2. Final specifications.

3. Final drawings and specifications shall meet the general requirements presented in Chapter 1.

4. Details of security features in accordance with the current COS Security Master Plan.

5. Final Cost Estimate.

6. Final versions of all studies and reports submitted with the CDR.

17.05 Design Flows

A. Wastewater Generation Rates: The Engineer shall meet with COS personnel to discuss the initial and ultimate hydraulic and organic loading
for the proposed lift station. Sources of flow and land uses must be identified and overall project phasing must be established.

B. Wastewater Flows: For existing areas, coordinate with the COS for flow data. Where flow data are not available, collect flow data or estimate minimum, average, maximum daily, and peak hour flows as described in Chapter 16, Section 16.05.

C. Include flow component if appropriate for infiltration and stormwater as described in Chapter 16, Section 16.05.

17.06 Hydraulic Analysis

A. General: The Engineer is required to develop hydraulic models of the service area as part of the CDR. Hydraulic models must incorporate information from the City regarding the existing wastewater collection system in accordance with Chapter 16, Section 16.07 and as described herein.

B. Hydraulic analysis is required for all new facilities and modified facilities, which includes the following:

1. Pump replacement.
2. Modifications to pumping capacity, pump control, and operation adjustment.
3. Significant changes in total dynamic head (TDH), and check valve/control valve closure time adjustments, etc.

C. Extended Period Simulation (EPS) Analysis: An extended period simulation (EPS) hydraulic model of the service area and proposed service area is required to demonstrate how the proposed facilities respond to daily peaks and minimum flows throughout initial and buildout conditions for the service area.

D. Steady State Analysis: The Engineer shall perform a steady-state hydraulic headloss analysis of the pumping and force main system to determine the TDH requirements of the lift station. TDH calculations shall be made for new facility designs and existing facility modifications. The Engineer shall:

1. Determine pumping head requirements, TDH system curves, flow velocities, and travel times.
2. Establish minimum and maximum static head.
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3. Provide recommended pumping rates.

4. Determine pipe class rating.

5. Establish maximum allowable shutoff head.

6. Use Darcy-Weisbach or Hazen-Williams equations.

7. Provide a list of friction factors for typical pipe materials.

E. Modeling Results Summary: Summarize results of modeling as part of the CDR and include a table that shows the average, peak, and minimum hour flow rates for each proposed project phase. The modeling results will be used by the Engineer to determine the type and size of pump equipment, odor control, wet well, and other facilities necessary for efficient pump operation during the normal starting and stopping of the pumps, and during electrical power failures.

17.07 Pumping Capacity

A. Lift stations will be designed with consideration of the station’s design peak inflow, as well as the design minimum inflow, for both the current and future conditions. The firm capacity of the lift station is the total pumping capacity of the station (design peak inflow), with the largest pump out of service at maximum static differential levels.

B. Minimum requirements (design criteria) for lift stations are included herein. The COS accepts the use of factory-fabricated package lift stations utilizing submersible wastewater pumps for the size ranges noted at the beginning of this chapter. Non-factory fabricated package lift stations will be considered on a case-by-case basis. Main pumping equipment shall be specially selected for individual application/service. At a minimum, all lift stations shall be equipped with two (2) pumps and have the capability of automatically alternating the pumps from lead to standby. With two pumps furnished, each pump shall be capable of pumping the design peak inflow determined for the station as follows:

\[
\text{Design Peak Inflow} = \text{PF} \times \text{Calculated Peak Inflow}
\]

Where:

Design Peak Inflow = Pumping capacity of each pump, gpm

Calculated Peak Inflow = Peak Influent Flow, gpm

PF = Peaking factor per IWMP or current flow data.
17.08 Wet Well Design

A. Flow Data: Establish wastewater flows and pumping capacity per the aforementioned sections. Provide a table of flow data for the wastewater collection system that discharges into the wet well.

B. Wet Well Materials: Provide an FRP or reinforced concrete structure as follows:

1. Rated for anticipated dead and live loads, which include seismic as well as vehicle traffic and soil loads in accordance with Chapter 4.

2. Providing protective lining and coating systems and materials suitable for a corrosive environment as recommended by a corrosion engineer and in accordance with Chapter 5.

3. FRP structures are not allowed in roadways or where vehicle traffic is anticipated.

4. PVC lining of concrete structures is not allowed.

C. Wet Well Inlet: The wet well inlet shall be designed in accordance with ANSI/HI 9.8 Pump Intake Design Standard for Solids-Bearing Liquids. The wet well inlet pipe invert shall be above the high water operating level, and the inlet shall be designed to minimize turbulence and odor generation, with no free fall discharge into the wet well under any operating condition. Wet well inlet shall include an external drop inlet with means to bypass the wet well, and a manhole designed to catch rocks and other debris, generally as shown on Figures 17.1, 17.2, and 17.3.

D. Wet Well Operating Volume: Total wet well operating volume is defined as the volume between the all pumps stop level and the all pumps start level. The wet well operating volume and pump sequencing start/stop levels must:

1. Consider operation at all flows, which includes minimum inflow conditions through design peak inflow conditions.

2. Be small enough to minimize septic conditions and resulting odors at minimum flows.

3. Be large enough to provide a pump cycle time of at least 8 minutes to prevent overheating of the motor.

4. Limit pump starts to maximum of 10 per hour.
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5. Include automatic alternation of lead and lag pumps.

E. Wet Well Sizing: The wet well shall be sized considering the following at a minimum:

1. An appropriate minimum flow factor will be used to size the wet well. The Minimum Flow Factor (the ratio of minimum to average flow for small wastewater service areas) less than 1 mgd average flow is approximately 0.2. The Minimum Flow Factor increases to approximately 0.3 for service areas having a flow greater than 2 mgd.

   \[(\text{Minimum inflow}) = (\text{Average Dry Weather Flow}) \times \text{(Minimum Flow Factor)}\]

2. Therefore, the required wet well operating volume for the first pump to start is as follows:

   \[\text{First Pump Wet Well Operating Volume} = \text{Pump capacity} \times 8 \text{ minutes/4}\]

F. Wet Well Operating/Alarm Levels: The wet well high and low operating levels, pump sizes, impeller sizes, and the high and low alarm levels shall be shown on the design drawings for all phases of expansion, current and future. The pump automatic shutoff level shall allow for sufficient net positive suction head based on the selected pump. Submergence of the pump suction bells shall be in accordance with the Hydraulic Institute Pump Intake Design Standard, and the pump manufacturer’s requirements.

G. Emergency Storage Volume: The emergency storage volume allows operating and maintenance personnel time to respond to a station alarm and/or to perform emergency repairs to correct a failure condition. In addition to the wet well operating volume, the Engineer shall:

1. Demonstrate that the wet well and system upstream of the pumps has a volume that can accommodate 2 hours of storage at design peak inflow.

2. Review electrical utility records, if available, for frequency of power outages in evaluating the emergency storage volume.

3. Define the total storage volume (i.e., the volume of the wet well above the pump “off” level to the lowest wastewater spill point upstream of the wet well) by using any combination of additional storage in the wet well above the operating volume, separate overflow tank, and storage in the inlet pipe up to the lowest spill level.
H. Storage in Influent Wastewater Collection System: Except as noted above for Emergency Storage Volume, the wet well influent pipe shall not be designed to accommodate wastewater storage during normal lift station operation. For example, normal lift station flows shall not require the use of influent lines for wet well storage.

17.09 Force Main Design

A. Capacity of Downstream Wastewater Facilities: The Engineer shall meet with the COS to verify that the wastewater collection system downstream of the force main discharge point has sufficient capacity (both current and future) to handle the increased flows. This investigation should go sufficiently far downstream to a point that the lift station flow component is not a significant factor. If sufficient capacity is not available, the project must include provisions to add the required capacity.

B. Multiple Force Main Considerations: A minimum velocity of 3 ft/s must be maintained at minimum flows. During force main sizing to accommodate both present and future flows, consideration should be given to the installation of multiple force mains as a method to control velocities in the pipe during initial phases of development. Combining smaller force main sizes for smaller flows and larger force mains for larger flows will allow higher velocities in each force main, thereby reducing potential solids deposition in the pipe and reducing the overall retention time.

C. Force Main Retention Time: The Engineer shall prepare calculations to determine the maximum retention time within the force main. The following calculations shall be prepared:

1. Min. Pump Run Time (MPRT) = 5 minutes = (First Pump Wet Well Operating Volume)/(Pump Capacity) – (Minimum Inflow)

2. Number of Cycles (for force main volume) = Force Main Volume / [(Pump Capacity) x MPRT]

3. Max. Wet Well Fill Time = (First Pump Wet Well Operating Volume) / (Minimum Inflow)

4. 1 Cycle Period = Max. Wet Well Fill Time + MPRT

5. Max. Retention Time = [Number of Cycles (for force main volume)] x (1 Cycle Period).
17.10 Site Civil

A. General: Provide a site design that conforms to general requirements for grading, setback, vehicle access, and stormwater management in accordance with Chapter 2.

B. Site Layout: Site grading shall preclude site drainage from gaining access to the lift station building. Adequate setback from property lines shall be provided in accordance with the Surprise Unified Development Code. Sufficient setback shall also be provided to allow for fill, cut, or fill transition to existing contour elevations at property lines. A fill or cut slope of 4:1 or flatter is required, unless specifically approved otherwise. A typical lift station site layout is shown on Figures 17.4 and 17.5.

C. The lift station shall be positioned and the site developed to ensure a uniform soil bearing condition. The footing and floor shall be placed on either native earth material or structural fill. The lift station shall not be situated where a portion of the station is on native material and a portion is on fill material. See Chapter 3 for Geotechnical Requirements.

D. Provide facilities that collect and retain stormwater designed in accordance with ADEQ and EPA requirements.

E. Service vehicle access to major station components shall be incorporated into the site layout. These service vehicles may include pickup trucks, vacuum excavator trucks, cranes, delivery vans, and chemical tanker trucks.

17.11 Signage

A. Each lift station site shall be identified with a sign mounted on the exterior of the masonry perimeter wall adjacent to the site access gates. Exact location will be determined by the site layout on a case-by-case basis.

17.12 Access Gates

A. Provide vehicle access gates and pedestrian access gates that meet or exceed security and vehicle access requirements described in Chapter 2, Section 2.10.

B. Provide separate access for utility power to read power meters in accordance with Chapter 7.
17.13 Security

A. At a minimum, an 8-foot tall masonry perimeter wall with locked entrance shall be provided around the site. The perimeter wall will:

1. Be compatible with the surrounding environment, including landscaping.
2. Satisfy all COS architectural and other Community Development requirements for appearance, colors, and coatings.

B. All other security issues shall be addressed by the Engineer, which include items described in the latest version of the most current COS Security Master Plan.

17.14 Mechanical Layout

A. General Station Layout: The Engineer shall work with the COS to establish a preliminary layout of the lift station. The layout shall address general room dimensions and use, including length and arrangement of station piping, location of valves, flowmeters, pumps, tanks, MCC panels, control panels, and major equipment.

B. At a minimum, all lift stations shall be equipped with two (2) pumps and have the capability of automatically alternating the pumps from lead to standby. Station equipment, piping, etc., shall be oriented in the station to provide convenient safe access for operation and maintenance, including the installation and removal of equipment. Typical wet well, valve vault, and building floor plan are presented in Figures 17.1, 17.2, and 17.3.

17.15 Noise Attenuation

A. General: Provide noise production studies and recommended noise attenuation in accordance with Chapter 11, Section 11.24.

17.16 Odor Control Facilities

A. Odor control measures shall be provided for all lift stations. Odor control may also be required for influent wastewater collection lines and discharge force mains.

B. Liquid Phase Odor Control Systems:

1. Liquid sodium hydroxide (caustic), liquid sodium hypochlorite (bleach), and liquid calcium nitrate type system designed to oxidize sulfides and volatile organic in the wastewater to reduce odors.
2. Designed to directly deliver chemical to the wet well and/or a manhole upstream on the influent line.

3. The liquid phase treatment system will be sized for a 30-day on-site supply, and shall consist of storage tanks with secondary containment, along with associated peristaltic type metering pumps (duty + standby), controls, and piping.

C. Solid Phase Odor Control Systems:

1. Granular activated carbon (GAC) that is pelletized and chemically impregnated and formulated to remove the following:
   a) Hydrogen sulfide
   b) Volatile organics
   c) Mercaptans.

2. Utilizes GAC storage tank and centrifugal fan as well as stainless steel or FRP foul air piping or ductwork.

D. Vapor Phase Odor Control systems shall utilize a hydroxyl ion fog odor control system to oxidize the odors in the wet well and adjacent odorous spaces such as pipelines and manholes. Requirements for vapor phase odor control will be determined by the COS on a case-by-case basis at the beginning of design.

E. All storage tanks, equipment, piping, ductwork, and materials shall be suitable for anticipated service and corrosive conditions in accordance with Chapters 5 and 6.

F. Metering pumps and piping shall be in accordance with Chapter 6.

17.17 **Vault Standards for Wastewater Lift Stations**

A. General: The Engineer shall locate vaults in non-traffic areas whenever feasible. Structural design of vaults shall conform to the requirements of Chapter 4.

B. For access and maintenance, the COS requires the use of vaults for all buried valves used for wastewater service.

C. Vaults shall incorporate heavy-duty aluminum hatches with Type 316 stainless steel hardware, capable of withstanding H-20 loads imposed by traffic, heavy maintenance equipment, chemical delivery trucks, etc.

D. Vault entrance hatches shall provide a minimum clear opening of 36 inches in diameter complete with access ladder.
E. Drainage: Vaults shall be designed to drain to a sump equipped with an 18-inch deep sump with an exterior 120 VAC/60 Hz/1 Ph ground fault circuit interrupter receptacle to be used for a portable sump pump.

F. If the design will result in “confined space” regulations and associated safety issues, the Engineer shall obtain concept approval prior to completing the design.

G. Flowmeter Considerations: Vaults equipped with flowmeters shall be:

1. Sized with sufficient upstream and downstream straight runs of pipe to maximize meter accuracy.

2. Provided with manual isolation valves that can be operated without the need to enter the vault.

3. Equipped with exterior aboveground panel adjacent to the vault with visual reading of flowmeter in units of gallons per minute or million gallons per day as determined by the COS.

17.18 Wastewater Pumping Systems Design

A. System Responsibility: In general, the Engineer shall include in its project design, specifications requirements for the pump, drive motor, supports, Type 316 stainless steel rails, constant speed equipment, and specific controls and appurtenances to be provided by a single manufacturer/supplier who shall take unit responsibility for the entire system.

B. Pump Inlet Configuration: The pump inlet shall be designed in accordance with the ANSI/HI Standards to minimize turbulence.

C. Equipment Access: In general, pumps, lifting chains, level controls, access hatches, etc., shall be arranged to provide safe and convenient access for operation, maintenance, equipment installation, and equipment removal.

D. Expandability: Lift station expandability will be evaluated on a case-by-case basis. If a lift station is planned to be expanded in the future, the Engineer shall ensure that adequate space is provided to accommodate future equipment. The discharge piping manifold shall be sized for future flows. Pumps shall be selected to provide stable and efficient operation throughout the range of both current and future operating conditions provided by the wet well.

E. Bypass Pumping Feature: Provide vertical suction piping that extends from the bottom of the wetwell to the top of the lift station with quick disconnect or blind flange as well as wye connection with isolation plug valve on
discharge header (Figures 17.1, 17.2, and 17.3) to allow bypass pumping via a diesel-engine, self-priming pump in the event of a power outage, or if pumps are otherwise not operational. Size piping for anticipated peak flow at buildout.

17.19 Piping Systems

A. On-Site Piping: Lift station piping shall be arranged in accordance with the following requirements:

1. Engineer shall specify accessories and manufacturers as provided in the current COS Preferred Equipment List.

2. Individual pump discharge, header, and force main piping shall be designed to ensure a velocity of between 4 and 10 fps.

3. Check Valves: Flanged swing check valves with outside lever, suitable for use in raw wastewater equipped with the following:
   a) Mechanical disc position indicator, which has continuous contact with the disc under all flow conditions.
   b) Screw type backflow actuator to allow opening of valve during no-flow conditions.
   c) Epoxy coating and polyurethane lining.


5. Flowmeter: Flanged magnetic flowmeter In accordance with Chapter 8.

6. Air Vacuum/Air Release Combination Valves: Shall be in accordance with latest approved materials list.

7. Provide pipe, valves, and fittings for an alternative pump discharge header and pig launching station above the valve vault. General configuration shall be as shown on Figures 17.1, 17.2, and 17.3.

8. Onsite wastewater piping shall be epoxy-lined ductile iron pipe with flanged joints in the wet well and valve vault, and mechanical joints for buried piping.

9. Pipe Lining Repairs: The Engineer shall include in project specifications a detailed procedure for field repair of epoxy linings that are damaged during the construction process. The COS or designee shall be given at least 2 working days advance notice that repairs are complete and the piping is ready for inspection. Piping cannot be closed up until inspection is completed.
10. Joint restraint shall be accomplished by the use of flanged or restrained mechanical joints, or harnesses for flexible couplings. Patented joint restraint methods may be considered by the COS if the application fits the recommended use and design data from the joint restraint manufacturer.

11. Odor Control and Chemical Piping shall be furnished and installed in accordance with equipment manufacturer’s recommendations, and the requirements of Chapter 6. Allowable materials include PVC, CPVC, and polyethylene tubing inside a PVC sleeve for chemical feed piping, and CPVC or FRP ducts for odor control.

17.20 Force Mains

A. Materials: Force mains shall be polyurethane-lined ductile iron pipe designed in accordance with AWWA M41 or DIPRA’s Design of Ductile Iron Pipe for all force main sizes.

B. Pipe Lining Repairs: The Engineer shall include in project specifications a detailed procedure for field repair of polyurethane linings in ductile iron pipe that are damaged during the construction process. The COS or designee shall be given at least 2 working days advance notice that repairs are complete and the piping is ready for inspection. Piping cannot be closed up until inspection is completed.

C. Marking tape shall be provided for location of buried force mains in accordance with Chapter 7 of the EDS.

D. Joints: Joints for force main pipe and fittings shall be mechanical joints or restrained push-on joints for all underground piping. Aboveground piping shall be flanged.

E. Joint Restraint: Provide joint restraint at all tees, bends, valves, and pipe terminations. The Engineer shall provide calculations for restraint length, using formulas approved by the DIPRA. Approved methods of joint restraint include restrained mechanical joints and restrained push-on joints as manufactured by US Pipe (TR-Flex), Pacific States (Perma-Lock), and American (Flex Ring or Lok Ring).

F. Minimum Depth: The minimum depth of bury for force mains shall be 5 feet, subject to profile design as described below.

G. Profile Design: The Engineer shall design the profile of the force main to specific slopes to keep the number of high and low points to an absolute minimum, and to provide the required clearances from other utilities as
specified by the ADEQ, MCESD, COS, and other utility owners. High points shall be equipped with automatic combination air vacuum/air release valves, as noted above. Low points shall be equipped with manually operated pump-out connections. Since high and low points in force mains represent potential locations of odor release, the Engineer shall designate their locations as a part of the CDR for review and concurrence by the COS.

H. Force Main Discharge Design: Except where specifically approved otherwise, force mains shall terminate in a dedicated manhole before wastewater flows into the gravity wastewater collection system. The force main shall be brought into the manhole and piped to a shaped manhole invert that directs the flow in the direction of the wastewater flow. Design of the manhole and force main connection shall keep turbulence in the incoming and outgoing wastewater stream to a minimum to avoid release of odors from the manhole. Preliminary details of the discharge manhole shall be included in the CDR.

17.21 Pumps

A. General: The Engineer shall specify submersible pumps suitable for pumping raw, untreated, unscreened municipal wastewater in a corrosive environment capable of passing a 3-inch sphere without clogging.

B. Pump construction shall be two-piece pump and motor casing as follows:

1. Motor case and seals watertight to submerged depths of up to 65 feet.

2. Constructed from ASTM A48, minimum Class 35 cast iron.

C. Impellers shall be multi-vane, non-clog design constructed of ASTM A48 cast iron with hardened impeller vane leading edges.

D. Pump shafts shall be Type 431 stainless steel, designed to withstand 1.5 times the maximum operating torque.

E. Bearings shall be permanently sealed, grease lubricated, anti-friction type that meet the ABMA standards and shall be designed as follows:

1. Lubrication system designed to absorb heat energy generated in bearing under maximum ambient temperature.

2. Bearing life shall be not less than 24,000 hours at bearing design load imposed by pump shutoff at rated speed or L10 life of
50,000 hours in accordance with ABMA standards at rated design point.

F. Shaft seals shall be positively driven, rotating tungsten carbide rings with the following features:
   1. Oil chamber lubrication with air volume to mitigate oil expansion due to temperature variations with standard drain and inspection plug.
   2. Will not require pressure differential to affect sealing.
   3. Will not rely on pumped media for lubrication.
   4. Capable of dry (unsubmerged) pump operation for extended periods.
   5. Springs and other hardware shall be Type 316 stainless steel.

G. Discharge base and elbow shall be constructed of same material as pump casing and shall be:
   1. Able to firmly support guide rails, discharge piping, and pumping unit.
   2. Equipped with integral support legs with anchors to floor.
   3. Provided with discharge interface that is self-aligning without entering the wet well and also provides a watertight seal by means of machined metal-to-metal contact.

H. Guide rails, brackets, and lifting chain shall be constructed of Type 316 stainless steel with the following features:
   1. Dual pipes or rails that extend from discharge base to upper bracket.
   2. Sized to fit discharge base and sliding bracket of pump.
   3. Integral, self-aligning, guide rail sliding brackets that seal pump to discharge base.

I. All bolts and associated hardware shall be Type 316 stainless steel.

J. Drive Equipment: Lift stations that pump to a gravity wastewater collection system via force mains shall be provided with constant speed motors with across the line starters for motor sizes under 20 horsepower, and soft start/soft stop starters for motor sizes 20 horsepower and larger.
K. Acceptable manufacturers are as provided in the COS Preferred Equipment List.

L. Provide the following spare parts:
   1. Thrust bearing set.
   2. Radial bearing set.
   3. Upper and lower mechanical seal set.
   4. Casing seal gaskets or O-rings.

17.22 Pump Motor

A. General: Motors shall comply with requirements of Chapter 7.

B. Pump motor shall be dielectric oil filled or liquid cooled single phase, Class F, NEMA L design and shall be:
   1. Suitable for 230 V or 460 V, 3 Phase, 60 Hertz.
   2. Mounted in a sealed submersible housing with stator, rotor, and bearings.
   3. Suitable for continuous operation at ambient temperature for the project at site altitude.
   4. Capable of continuous operation under load with the motor submerged, partially submerged, or exposed without derating the motor.
   5. Equipped with cooling system with jacket that encircles the stator housing for dissipation of motor heat in a closed loop system.
   6. Equipped with stators securely held in place with a removable end ring and threaded fastener to be easily removed in the field and must be capable of being repaired or rewound by a local motor service. No special tools shall be required for pump or motor. Stator windings shall have Class F insulation (suitable for 155 degrees Celsius or 311 degrees Fahrenheit).
   7. Enclosed in a housing with rotor, stator separated and protected from the pumped liquid by an oil-filled seal housing, which incorporates two sets of carbon ceramic mechanical seals mounted in tandem.
8. The mechanical seal housing shall be equipped with two moisture-sensing probes, which shall be automatic and continuous.

9. The sensor probes shall be electrically isolated with a resistor between each probe to eliminate grounding to the casing.

10. Equipped with thermal protection, which shall be low resistance, bimetal disc that is temperature sensitive that annunciates to SCADA, designed as follows:
   a) Sensor shall be mounted directly in the stator and sized to open when stator temperature exceeds 120 or 130 degrees Celsius and automatically reset at 30 or 35 degrees Celsius differential.
   b) Sensor shall be connected in series with the motor starter coil such that the starter is tripped if a heat sensor opens. The motor starter shall be equipped with overload heaters so all normal overloads are protected by external heater block.

11. Equipped with moisture detection, which shall be a sensor in the seal chamber or motor housing that annunciates to SCADA.

17.23 Heating, Ventilation, Air Conditioning (HVAC)

A. General: Provide HVAC systems for all electrical rooms, occupied spaces, and mechanical rooms, which meet requirements of Chapter 9.

17.24 Standby Power

A. General: Each lift station shall be furnished with an emergency standby power generator with fuel capacity and an automatic transfer switch in accordance with Chapter 7. Coordinate location, layout, and enclosures with site design per Chapter 17, Section 17.10.

B. The generator and switch shall be sized to operate the lift station facility including the pumping units at the station’s maximum rated or firm capacity. In addition, for lift stations with two installed pumps the generator shall be sized to operate both pumps simultaneously.

C. The generator shall be pad-mounted and located inside a soundproof enclosure suitable for outdoor service. Access requirements for the generator shall be in accordance with the generator manufacturer’s requirements.
D. The automatic transfer switch shall be provided by the generator manufacturer and designed to work in conjunction with the generator to provide relays for all modes of operation and alarms.

E. Fuel source for the generator shall be natural gas, if available, or diesel connected directly to the utility service main.

F. The generator shall meet the noise requirements of Surprise Unified Development Code.

G. The generator control panel shall report the run status to the SCADA system.

17.25 Support Systems

A. Backflow Prevention: Provide approved backflow protection devices to avoid potential contamination. If the backflow prevention device is mounted adjacent to a wall, it shall be mounted a minimum of 24 inches away and no greater than 3 feet high to allow for maintenance. Provide backflow prevention for the following water sources:

1. Potable Water
2. Reclaimed Water.

B. Service Water: Provide for housekeeping and landscaping in accordance with the following:

1. Supply from potable water or approved reclaimed water source.
2. Provide an approved backflow prevention device.
3. Provide 3/4-inch hose bibs with vacuum breaker, galvanized or epoxy-coated steel hose rack with 50 feet of 3/4-inch rubber hose.
4. Provide a turbine meter located on the exterior of the site perimeter wall.

C. Drain System: Provide floor drains, hub drains, and floor sinks for drainage of air relief valves, seal water, condensate, and housekeeping as follows:

1. Sanitary sewers shall be gravity type with minimum slope of 0.007 ft/ft.
2. Drain piping shall be PVC or cast iron.
3. Provide cleanouts and vents in accordance with currently adopted plumbing code.

4. Discharge to sanitary sewer in a manner that is compliant with currently adopted codes.

5. Sump pumps, where required, shall be duplex type submersible and equipped with the following:
   a) Ductile iron or PVC discharge piping.
   b) Type 316 stainless steel lifting chain.
   c) Discharge check valve.
   d) Float level controls.
   e) High water level alarm will annunciate to SCADA.
   f) Aluminum grating or treadplate cover.

D. Telephones and Communications: Provide telephone board and appropriate size and number of conduit for telephone and security wiring in accordance with the following:

1. Conduits shall be extended to suitable junction box outside the pump station facility.

2. Submit approved telephone company drawings as part of project as-built drawings.

3. Coordinate design with current COS Security Master Plan.

E. Freeze Protection: Provide heat tracing and insulation for water piping less than 4 inches in diameter and/or chemical piping located outdoors that is subject to freezing temperatures in accordance with the following:


2. Pipe Insulation: Closed cell, elastomeric foam insulation suitable for temperatures of 0 degrees Fahrenheit to 220 degrees Fahrenheit. Provide UV resistant.

F. Other Support Systems: Systems not specifically addressed herein may be required and will be evaluated by the COS on a project-specific basis.
17.26 Fire Protection

A. Fire protection measures for lift stations shall be designed in accordance with COS, IBC, and IFC requirements.

B. Fire hydrant(s) shall be provided for fire protection in accordance with requirements of the COS EDS.

C. Fire sprinkler systems may be required for facilities with areas that exceed 5,000 square feet.

D. Fire alarm systems, which annunciate to SCADA are required for facilities with occupied spaces such as offices and control rooms.

E. Provide documentation of any fire sprinkler system waivers for electrical rooms as approved by the COS Fire Department.

17.27 Electrical and Instrumentation

A. General: All electrical equipment, instrumentation, control panels, and associated conduit and wiring shall be in accordance with Chapter 7 and shall be properly grounded with ring tongue terminals. Where appropriate, electrical facilities shall be intrinsically safe per NFPA 70 for arcflash and NFPA 820 Class 1, Division 1.

B. Provide arcflash labeling in accordance with NFPA 70.

C. Lockout Safety: Disconnects and circuit breakers shall be provided to safely de energize the panel and equipment using "lockout/tagout" procedures.

17.28 Controls

A. General: All control voltage shall be in accordance with Chapter 8 and accomplished by means of a power supply with a control fuse and on/off switch to protect and isolate control voltage from the line.

B. Control Strategy: The Engineer shall include a written control strategy as part of the design documents. The control strategy shall address anticipated operating and alarm scenarios, which include but are not limited to the following:

1. Pump operation in Hand, Off, Automatic.

2. Lead, Lag, and Standby pump operation.

3. Low wet well level alarm, which shuts off all pumps.
4. High wet well level alarm.

5. High high wet well level alarm, which also starts an available lag or standby pump.


7. Power failure.

8. Generator.

C. Control Floats: Shall be provided for high high level alarm annunciation.

D. Level Measurement: Provide ultrasonic, non-contact type level measurement in accordance with Chapter 8. High-High float switch as described above.

E. Control Panel: A steel, NEMA 4X enclosure located inside the lift station building electrical room shall be provided for each control panel. In addition, control panels shall be:

1. Completely assembled at the factory and tested by the supplier.

2. Identified by a nameplate permanently affixed, which includes model number, voltage, phase, hertz, ampere rating, and horsepower rating.

3. Provided with red run light mounted in the exterior of the panel, with run light having an electrical life of 50,000 hours. One light per pump.

4. Provided with green lights for all alarms with an electrical life of 50,000 hours.

5. Equipped with hand-off-auto switch for each pump on the exterior of the panel. H-O-A switch shall be rocker type with an electrical life of 50,000 operations.

6. PLC in accordance with Chapter 8.

F. Duplex Pump Controller: An ultrasonic level sensor shall be used for pump control and alarm and shall:

1. Indicate level circuit operations utilizing red LED indicator lights with the LED light function shown on a permanent label on the pump controller.

2. Function to start/stop and alternate pumps.
3. Include a back-up start/stop circuit that is relay controlled and float actuated.

4. Include connectors and terminal blocks with box type lug connectors made of polyamide thermoplastic. Phenolic terminal blocks are not acceptable.

5. Include alternating circuit of the low voltage type and be operational from the transformer mounted on the pump controller board.

6. Utilize wiring with male header assemblies constructed of a corrosion-resistant thermoplastic material having a temperature range of -55 deg Celsius to 105 deg Celsius and copper alloy, bright acid tin over nickel-plating contacts.

7. Incorporate plug connectors for wiring of H-O-A switches, run lights, contactors, and overloads to the pump controller.

G. Power and Control Cords shall be water resistant 600 V, 60 deg Celsius, UL and/or CSA approved and applied dependent on amp draw for sizes. Additional requirements for the power cord are as follows:

1. Each individual lead shall be stripped down to bare wire, at staggered intervals, and each strand shall be individually separated.

2. Power cord entry into the cord gap assembly shall first be made with a compression fitting.

3. The cord gap shall be sealed with Buna N Rubber O-ring on a beveled edge to assure proper sealing where bolted to the connection box assembly.

4. Strain relief shall be provided, to keep the cord from being pulled out.

H. Surge protection shall be provided, which complies with ANSI C62.4-1, Category B and shall be installed in accordance with the manufacturer’s instructions.

I. Circuit breaker shall be used to protect from line faults and to disconnect the pump from the incoming power. The circuit breaker shall be thermal magnetic air-type and sized to meet NEC requirements for motor controls.

J. Starter: Shall be solid state, reduced voltage type for all pumps 20 horsepower and larger, and across the line for pumps less than 20 horsepower. Magnetic starter shall include a contactor with a minimum mechanical life of 3,000,000 operations and a minimum contact life of
1,000,000 operations. The magnetic starter shall include an overload relay, which is ambient temperature compensated and bimetallic.

K. SCADA, alarms, and monitors shall be provided in accordance with Chapter 8 and include the following at a minimum:

1. When a high-level or low-level condition occurs, the alarm system shall activate the light and alarm horn located on the exterior of the building. The high-high float switch shall send an alarm signal to SCADA, as well as starting the pumps for a selectable length of time determined by wet well size and pump down time.

2. A push-to-test and push-to-silence button shall be provided.

3. A pump failure contact circuit shall be provided to activate the alarm and close dry contacts.

4. An overhead tripped indicator light shall be mounted on the enclosure door.

5. A heat sensor tripped light shall be mounted on the enclosure door.

L. Telemetry contacts shall be provided for additional high or low level as well as for motor overload, which shall indicate a visible alarm at the control panel.

M. Elapsed time meters shall be provided for each pump.

N. Seal Failure Indicators shall be provided for each pump, which shall indicate a visible alarm at the control panel and shall report to SCADA.
LIFT STATION TOP PLAN

KEY NOTES
1. PIPE PENETRATION
2. ALL FORCE MAIN PIPING SHALL BE FLANGED. GROOVED JOINT OR RESTRAINED MECHANICAL JOINT WITHIN BOUNDS OF THE LIFT STATION
3. NEENAH HEAVY DUTY (DESIGNED FOR LL-H20) R-666301H W/ TYPE G HANDLE OR EQUAL
4. H20 RATING, SIZED TO ALLOW PUMP REMOVAL
5. PRESSURE GAUGE (0-150psi)
6. ULTRA SONIC LEVEL INSTRUMENT
7. ALL FORCE MAIN AND GRAVITY PIPING WITHIN THE BOUNDS OF THE LIFT STATION SHALL BE DIP POLYBOND LINED OR EQUAL.
8. REDUCER
9. 45° ELBOW UP
10. 45° ELBOW DOWN
11. REDUCER
12. WYE
13. PRESSURE SWITCH
14. MAGNETIC FLOW METER
**KEY NOTES**

1. PIPE PENETRATION
2. ALL FORCE MAIN PIPING SHALL BE FLANGED, GROOVED JOINT OR RESTRAINED MECHANICAL JOINT WITHIN BOUNDS OF THE LIFT STATION
3. NEENAH HEAVY DUTY (DESIGNED FOR LL-H20) R-666301H W/ TYPE G HANDLE OR EQUAL
4. H2O RATING, SIZED TO ALLOW PUMP REMOVAL
5. PRESSURE GAUGE (0-150psi)
6. ULTRA SONIC LEVEL INSTRUMENT
7. ALL FORCE MAIN AND GRAVITY PIPING WITHIN THE BOUNDS OF THE LIFT STATION SHALL BE DIP POLYBOND LINED OR EQUAL.
8. REDUCER
9. 45° ELBOW UP
10. 45° ELBOW DOWN
11. REDUCER
12. WYE
13. PRESSURE SWITCH
14. MAGNETIC FLOW METER

**LIFT STATION BOTTOM PLAN**