Section 31 - Pump Stations

I. Introduction - HRSD owns and operates wet well stations and pressure reducing stations. Wet well stations are sized to receive projected flows from gravity sewers and discharge to force mains. Pressures reducing stations and/or other facilities are sized to maintain the pressure head in force mains within HRSD operating limits. Wet well stations, force mains and pressure reducing stations are all sized and operated in accordance with HRSD's Hydraulic Grade Line (HGL) policy.

A. Wet Well / Dry Well Pump Station - Flows are discharged by gravity sewers or force mains into a wet well from which they are pumped into a force main. The pumps are designed for a flooded suction condition and are in a separate dry well adjacent to the wet well with intake piping leading from the wet well to the pumps.

B. Pressure Reducing Station (PRS) - A pressure reducing station is connected directly to a force main and is used to maintain the pressure on the suction side of the pumps.

C. Submersible Pump Station – The pumps are located in a wet well. These stations are typically for small service areas. Refer to Section 36 - Standard Details, Series 400 in this standards manual for guidance.

II. Description of Operations

A. Wet Well / Dry Well Pump Station

1. Wet well stations typically use variable speed pumps to match flow fluctuations and minimize turbulence in the wet well to reduce odor, corrosion and air entrainment.

2. A proportional integral derivative (PID) level controller shall be configured in the programmable controller to control the sewage level in the wet well. The level controller shall vary the speed of the pumps as required to match the pump discharge flow rate to the wet well influent rate. The desired level to be maintained in the wet well will be programmed in the programmable controller as the set point for the level controller. The level controller will compare the actual wet well level to the set point level and output a 4-20mA speed reference signal to the variable frequency drive (VFD) for operating the sewage pumps to increase or decrease the speed of the pump or pumps as required to maintain the set point level.

3. A standby pump shall be called to operate at the high-water alarm level.

B. Pressure Reducing Station (PRS)

1. Pressure reducing stations typically use variable speed pumps to match flow fluctuations to lower the pressure on the suction side of the station. Pressure reducing stations do not typically run continuously and are not normally required to operate until the force main flow reaches approximately two-thirds of the design flow.

2. Pressure reducing stations operate by starting the lead pump when the force main discharge pressure increases to a preset high limit. The lead pump speeds up and slows down to maintain the force main suction pressure within a preset range. If the lead pump cannot maintain the force main suction pressure within the preset range, an additional pump or pumps are started and operated together to maintain the suction pressure within the preset range. As the force main discharge pressure decreases to preset lower limits, the pumps are stopped in the reverse order as needed until all pumps are stopped.

3. Provide for piping and valves inside of the pump station so that the force main flows can be pumped in either direction as appropriate with the operation of a minimum number of valves.

III. General

A. Pump stations shall meet the requirements of the Virginia Department of Environmental Quality Sewage Collection and Treatment (SCAT) Regulations.

B. Pump stations shall be designed to Hydraulic Institute (HI) Standards to the extent possible. Exceptions to the HI Standards to be discussed with HRSD and approved on a case-by-case basis.

C. Pump station shall be designed in accordance with the HRSD HGL Policy. Pump selection shall be based on the following flow and pressure conditions provided by HRSD and general requirements:

1. Operating range flows and pressures

a. Dry weather minimum

b. Dry weather maximum

c. Wet weather maximum

2. Pump stations shall be designed with provisions to accommodate future growth based on development trends.

3. Under typical operating conditions for variable speed drives (VFDs), pumps shall be capable of maintaining wet well level or pressure set point without cycling on/off.

4. Pumps shall operate within the pump's preferred operating range (POR) in accordance with the HRSD HGL Policy.

5. In the case where a bypass pumping system is required, the design and operation of the pumping system, whether portable pumps or portable pumps in conjunction with permanent station pumps, will not exceed pump station design capacity.

D. Pump station shall be capable of meeting the peak design flow condition with the largest pump out of service.

E. Pump stations shall be designed to comply with locality flood elevation construction requirements. The current locality requirements, available at the time of publication of this manual, that need to be verified for each project, are listed in Section 10 – Flood Elevation Requirements.

F. Provide a separate generator room or building with adequate space for maintenance and heat rejection from the engine block and exhaust system or isolate remaining areas from generator noise and heat.

G. Provide a slope on the pump room floor that will convey seepage from pump packing and drainage from wash down to a sump. Provide Zoeller Model 137D sump pump unless this standard model will not meet the flow or pressure condition and in this case, obtain approval for a deviation from HRSD's Project Manager.

H. Provide a toilet and sink in a separate room within the pump station. Provide a wash basin in the pump station.

I. Design shall incorporate measures to facilitate the maintenance and removal of equipment and pumps in both dry well and wet well areas.

J. Provide access to dry well and wet well by stairs.

1. Spiral stairs and ship ladders are not acceptable.

2. Stairs shall be a minimum width of 36 inches and shall include handrails on both sides.

3. Stair riser heights and tread depths shall comply with the International Building Code (IBC), latest addition.

K. Design wet well and influent piping to minimize turbulence and air entrainment in the wet well.

L. Provide minimum submergence required to eliminate vortex at pump suction intake.

M. Evaluate the need for odor control and make provisions as necessary.

N. Locate discharges for sump pump, pump air release and restroom discharge away from pump intakes in the wet well and design to minimize turbulence and air entrainment.

O. Furnish and install a removable bar screen. Channel shall be designed to accommodate a grinder system and a bar screen interchangeably. The electrical system shall be designed with the necessary capacity for the grinder system.

P. Provide wet wells that slope toward the pump suctions and do not create areas where solids can collect and build up.

Q. Concrete in the wet well shall be protected from corrosion using polymer concrete, anti-microbial additive, surface applied coating system or a thermoplastic sheet liner.

1. Thermoplastic sheet liner shall not be used on influent channels.

R. Provide smooth interior wet well surfaces. When installing thermoplastic sheet liner system, ensure that it is anchored into the new concrete and protect all interior concrete surfaces except the surfaces 1’-0” below the lowest water level in the wet well, i.e. the floor and lower walls. Use light-colored thermoplastic only, never black or other dark colors.

1. The approved thermoplastic sheet linings for new pump station wet wells are:

a. T-Lock Amerplate by Ameron International of Brea, California. (PVC Sheet Linings), or

b. GSE Studliner by GSE Lining Technology, Inc. of Houston, Texas. (High Density Polyethylene Liner), or

c. Anchor-Lok by Atlas Minerals and Chemicals, Inc. of Mertztown, Pennsylvania (High Density Polyethylene Liner).

2. The anchored thermoplastic sheet linings shall be installed in strict accordance with the manufacturer's recommendations and shall be installed to ensure a pinhole free lining system. Particular care must be taken to ensure that lining terminations and transitions at changes in direction and at metal pipe penetrations, and leading edges are properly treated.

3. Hot air welding on liners.

   a. PVC liners shall be performed by certified welders trained by the selected manufacturer in strict accordance with the manufacturer's instructions. Welding shall fuse both sheets and weld strips or filler material together to provide a continuous joint equal in corrosion resistance and impermeability to the basic liner sheets.

   b. Joints on HDPE liners shall be filled using extrusion welding performed by personnel trained by the liner manufacturer.

4. Quality Control Testing

   Once the thermoplastic sheet liners have been installed, the concrete forms removed, and all welding performed, the lining shall be inspected and tested by an independent testing firm as follows:

   a. The entire lining shall be carefully visually inspected for pinholes or damage.

   b. All welds shall be probed with a blunt instrument like a putty knife to identify any weld defects.

   c. All surfaces of the sheet linings shall be tested with an approved (by the manufacturer) electrical holiday detector with the instrument set at the voltage range recommended by the manufacturer. This testing should only be performed by a certified technician trained by the manufacturer of the sheet lining or qualified previously to do so.

S. All below grade concrete structures shall have an exterior vapor barrier and /or waterproofing approved by HRSD.

T. Pump Station Substantial Completion Checklist – refer to Attachment A.

U. Physical Modeling shall be considered on all new or full replacement pump stations and a determination shall be documented in the PER regarding the decision to pursue physical modeling on an existing pump station rehabilitation project. The decision related to whether to do physical modeling shall be coordinated with the HRSD Project Manager.

IV. Site Issues and Layout

A. Pumping station building and site shall be designed and configured to be in harmony with the surrounding setting. Architectural and landscaping designs and renderings will be submitted to and approved by HRSD at the PER stage. Refer to Section 2 – Architectural and Landscaping Design and Review Process in this standards manual.

B. Real-estate setbacks: Property shall accommodate existing and future HRSD development requirements, taking into consideration setbacks and zoning restrictions.

1. Minimum property dimensions for a Pump Station is 150 feet x 150 feet.

2. Minimum property dimensions for a Pressure Reducing Station is 200 feet x 200 feet.

C. Evaluate the need for the acquisition of additional property to accommodate future pump station replacement, off-line storage and/or other HRSD facilities.

D. Design must consider potential off-site impacts including noise, odors, excessive light, and other impacts to adjacent property owners.

E. Provide concrete entrance and a paved driveway for off-street parking, access to building and provision to turn around a crew truck. During design, use visualization tools to solicit feedback from stakeholders regarding proper access and turnaround space at site.

F. Include a site plan showing property lines, building, piping, existing & proposed utilities, valves, emergency pump connection, physical features, topography, etc. and any other requirements by the local approving authority.

G. Set a new benchmark at each new pump station or PRS and provide a data sheet to include a site map, coordinates, elevations, descriptions at a minimum. Coordinate accuracy should be within 1/100 of a foot.

1. This applies to the following if a benchmark does not exist:

    a. Rehabilitation projects

    b. Acquired assets (PS, PRS)

H. Refer to Section 34 – Miscellaneous in this standards manual for additional site layout information.

I. Provide a separate conditioned space to accommodate sensitive electrical equipment, such as the switchgear, motor control center, and variable frequency drives as applicable with site and space limitations.

J. Underground fuel storage tank replacement should be evaluated at existing stations when the tank age exceeds thirty years and major site work is being performed.

V. Masonry

A. Refer to Section 34 – Miscellaneous in this standards manual for additional information.

B. Building walls shall be concrete block with exterior brick veneer or as otherwise determined by HRSD's Architectural Review Committee and referenced in Section 2 – Architectural and Landscaping Design and Review Process.

C. All lintels shall be stainless steel.

VI. Equipment

A. Pumps shall be centrifugal, non-clog, solids-handling pumps, capable of passing a 3-inch solid.

B. Pump manufacturer shall certify that the pump will meet the design requirements.

C. In typical installations, pumps shall be dry-pit submersible, close-coupled or extended shaft-driven pumps. Pumps will be evaluated and recommended for use by the FIRM.

1. The FIRM shall carefully evaluate the size and dimensions of each manufacturer's product for compatibility with the space where the pump and accessories will be installed. This is especially important for rehabilitation projects where different pumps and motors are required within limited available space. Consideration must be

given by the FIRM for maintenance access and removal of the pump and motor within existing spaces due to varying dimensions between manufacturers for similar products.

2. 3D modeling of the station must be completed and shared with stakeholders during the design phase to confirm maintenance access.

3. If the contractor suggests an “equal” substitution to major equipment during the bid or construction phase, the maintenance access must be reconfirmed through 3D modeling. Major equipment to be defined by Engineer in the bid documents.

D. Pump, motor, and impeller shall be balanced as a unit at the factory prior to shipment.

E. Motor shall be inverter duty rated.

F. For submersible pumps, motor shall be equipped with two (2) moisture detection sensors, one in the mechanical seal oil bath and one in the lower portion of the armature area.

G. Accommodations shall be made to properly cool all electrical equipment and motors to effectively dissipate heat.

H. Pumps shall operate at speeds below 1,000 RPM unless otherwise approved by HRSD’s Project Manager.

I. All pumps shall have a one-inch tap on the volute with a ball valve and flexible hosing so that the employee servicing the pump can monitor the air venting process while also safely directing any air or water away from the work area.

J. Spare parts to be provided by the contractor shall typically include the following. A requirement to furnish a spare volute and/or other major mechanical or electrical parts is project specific and should be discussed with HRSD.

1. For each size pump, provide the following:

a. One spare full-size impeller

b. One spare stainless-steel shaft and sleeve (shaft-driven only)

c. One spare set of wear rings

d. One spare set of mechanical seals

e. One spare set of bearings

2. For close-coupled pumps, provide the following (in addition to above):

a. One spare coupling for each pump.

K. OSHA approved safety rails (load rated):

1. All safety railings shall be load rated, meet OSHA Safety Railing Standards, and support a vertical and horizontal load of 200 pounds.

2. Mounts for safety railings shall be designed and cast in place as part of the station.

3. Handrails, guardrails, and/or safety chains shall be 42 inches in height with a 21-inch mid-rail/chain and 4-inch toe boards.

4. All stairs, safety railings and decking within the wet well shall be fiberglass reinforced plastic (FRP). All mounting brackets and exposed metal shall be stainless steel.

L. Pumps Performance Testing – pumps shall meet all specified requirements and have measured vibrations within the acceptable limits prescribed in the HI standards.

VII. Conveying Systems

A. Provide a load rated monorail or bridge crane, trolley, and hoist with appropriate hatches and doors to directly access and remove the pumps and motors for maintenance. Use removable load rated grating to cover interior openings that are to be used for removal of equipment. Indicate the load ratings on the plans, stencil load ratings on the trolley, hoist, and rail system and provide three copies of certified load testing documentation. The monorail/trolley/hoist shall be load tested in accordance with OSHA requirements during construction by the contractor.

B. Consider the provision for electric trolley and/or hoist.

C. Provide direct access to monorail and hoist (or install separate lifting devices) for removal of sump/submersible pumps, as needed.

D. Provide rated lifting eyes to assist with equipment removal.

VIII. Mechanical

A. Interior Piping

1. Provide ductile iron flanged joint.

2. Provide a valve on the suction and discharge sides of each pump.

3. Provide a shut off valve or sluice gate on the gravity influent pipe. Preferred means of isolation is a 316 stainless steel, fabricated, heavy-duty sluice gate.

4. Gate valves shall be OS&Y or have a visual indicator, open left, and be coated with fusion- b o n d e d epoxy.

    a. Chain wheel actuators shall not be permitted.

5. All valves shall be easily and safely accessible for maintenance and operation. Provide OSHA approved fixed platform sufficient for a 2-person maintenance crew, as needed.

6. Provide a check valve on the discharge side of each pump between the discharge valve and the pump.

    a. Check valves shall not be installed in the vertical position.

    b. Sizing Check Valve: To reduce O&M requirements, the valve shall preferably be sized to match the pump discharge nozzle size. Engineer shall confirm the selected check valve and size are in accordance with the check valve manufacturer’s recommendations for use and flow ranges and evaluate impact on pump selection and performance.

7. Provide check valves with iron body, bronze seat check and bronze ring on disc.

8. Check valves shall be provided with packing glands or o-rings and external lever and spring in accordance with AWWA C508.

9. Provide adequate pipe support and thrust restraint with base elbows, base pads or hangers as required. Metallic pipe supports and hardware shall be stainless steel.

10. Use eccentric reducers (match elevations at top of pipe) on the suction and discharge piping to prevent the entrapment of air.

11. Provide a manual air release on the discharge of each pump. Reduce from tap on pump volute to ½-inch pipe and ½-inch ball valve. Provide a union to transition to ¾ -inch HDPE air release piping to wet well. All pipe valves and fittings except HDPE shall be stainless steel.

12. Exterior wall penetrations shall be accomplished with a wall sleeve. Seal between sleeve and carrier pipe with a “Link Seal” type seal with stainless steel hardware. Bolts on the link seal shall be oriented so that they are tightened from inside the station. Penetrations between the pump room and wet well for pump suction piping shall utilize wall pipe with a cast integral seep ring.

13. Provide an eyewash station near the generator batteries in accordance with the current safety requirements.

14. Provide flexible connections on suction and discharge of pump to ensure motion and vibration is absorbed.

B. Exterior Piping (Force Main)

1. Refer to Section 24 – Pipelines and Appurtenances in this standards manual for additional requirements for force mains.

2. All pump stations shall have a mainline valve on both sides of the emergency pump connection.

3. Wet Well / Dry Well Pump Station - Provide an emergency pump connection with valves and blind flange(s). Also, provide an HDPE suction leg into the well. The connection or transition from HDPE to ductile shall be outside the wet well. Size pipe for emergency connection based on pump station design flow rate.

C. Provide for space heating to prevent freezing of pump station facilities, as appropriate.

D. Ventilation of the wet well shall meet SCAT regulations. Provide for 12 air changes per hour for continuous ventilation and 30 air changes per hour for intermittent ventilation. The ventilation system shall be designed to ventilate all areas of the wet well and prevent "short circuiting" of the air.

E. Provide potable water for the restroom and hose bibs from the municipal water system or from a well if municipal water system is not available. Signage shall be placed where well water is being used.

F. Provide a Virginia Department of Health (VDH) approved reduced pressure principal backflow preventer to be installed on the main potable water line where it enters the pump station and prior to any outlets in the pump station. Backflow preventer shall be tested and certified after installation.

G. Provide for the discharge of restroom drainage and the sump pump.

1. Pressure Reducing Station - Discharge restroom drainage to the municipal sanitary sewer system, if available or pump discharge into the pump station suction leg utilizing a small package grinder pump. Grinder pump shall meet the maximum inlet head conditions.

2. Wet Well / Dry Well Pump Station - Discharge restroom drainage to the pump station wet well.

IX. Electrical & Instrumentation

A. Refer to Section 32 - Electrical and Instrumentation in this standards manual for additional information regarding electrical and instrumentation systems.

B. Provide a standby generator to meet Class I reliability. The generator shall be designed to meet the firm design capacity of the pump station with the primary power off.

C. Install electrical equipment and motors above the 100-year flood elevation or otherwise protect from the 100-year flood. Refer to Section 10 – Flood Elevation Requirements in this standards manual.

D. Require Contractor to install wiring for the intrusion alarm system from all required doors and their associated monitoring devices, back to the pump station control panel. The OIT on the control panel will display door entry information. Alarm points to be determined by HRSD.

E. Provide variable frequency drive controllers to control pump speed.

1. Pressure Reducing Station

a. Pump shall be controlled in response to suction pressure.

b. Provide two pressure sensors (one 0 – XX.XX psi and one 0-XX.XX psi) on the suction piping and one pressure sensor (0-XX.XX psi), on the discharge piping. Transmitter span will be provided by HRSD for the location. All transmitters to be mounted on 4- inch Red Valve Annular Seal. Refer to Section 36 – Standard Details, Series 300 in this standards manual.

2. Wet Well / Dry Well Pump Station

a. Pump speed shall be controlled in response to wet well level.

b. On the pump discharge header, provide a 4” Red Valve Annular Seal and pressure sensor or approved equal. Provide a tee with a 4” branch and install a 4” gate valve on the branch prior to the pressure sensor and install a blind flange on the outside of the pressure sensor. Provide two ¾” pipe nipples with valves for flushing and calibration purposes.

c. Wet well levels to be monitored by means of level sensors or bubbler system. If a bubbler system is used, a differential pressure transmitter should be installed. A bypass manifold around the transmitter and maintenance ports on both the low and high side of the transmitter should be incorporated into the pressure assembly.

F. Consider the inclusion of contacts to operate the pumps across the line if the variable frequency drives fail. The alarm system will notify the operators of a variable frequency drive failure and the drives must be switched to the across the line contacts manually. The pumps can be started sequentially in the across the line mode of operation. Evaluate other means of providing variable frequency drive backup when motor horsepower exceeds 200 HP. In all cases, investigate the capacity of the local power grid to accommodate the across the line motor starting.

G. Include a flow meter and pressure sensor sized based on the design flow rate for the pump station. Location of the flow meter shall be downstream of the emergency pump connection. Flow meters must be installed per manufacturers specifications or as directed by HRSD in any case where the manufacturers specifications cannot be met. For all pressure sensors installed, an elevation measurement must be taken and provided to the Project Manager prior to start-up of the facility.

H. Provide a high-level float ball and a low-level float ball in the wet well and a float ball in the pump room.

I. Provide a single four-gang lockable 20-amp, 120-volt GFCI outlet outside the station near the wet well for a portable light or other use. The need for permanent lighting in the wet well should be discussed in the preliminary engineering phase.

J. Arc Flash Requirements - refer to Section 32 - Electrical and Instrumentation in this s t a n d a r d s manual for details.

K. Load Bank Testing Requirements - refer to Section 32 - Electrical and Instrumentation in this standards manual for details.

L. All new pump stations and PRS's shall include an electrical interface located at the pump station to integrate the Advanced Prime Guard Controller used on Xylem (Godwin) pumps with the existing HRSD SCADA system. Refer to the Temporary Pump Enclosure detail in Section 36 - Standard Details, Series 700 in this standards manual for guidance.

M. Temporary Portable Pump Alarms and Setup Standards – refer to Attachment B.

N. When developing a new or modifying an existing functional description, Engineer shall follow the format of an existing and similar functional description provided by the Project Manager. The draft functional description shall be provided to the HRSD team for review in tracked changes.

O. HRSD’s sole source vendor, Emerson, shall be used for the following on new or replacement stations:

1. Furnish a new PLC control panel for installation by the General Contractor. General Contractor shall terminate wires at control cabinet and conduct loop checks.

2. Configure the existing SCADA software to operate the station remotely.

3. Configure the existing data historian, graphics, alarm screens, trend screens and reports on the SCADA system.

4. Lead site acceptance test with support from the General Contractor. General Contractor shall be responsible for testing all

systems and equipment to be controlled by the PLC control panel ahead of the final site acceptance test.

5. Provide information regarding SCADA equipment that has been allocated to the project site.

P. HRSD's preferred vendor shall conduct a Cellular Performance Survey of new property, provide instructions regarding the placement and type of cellular antenna (i.e. unidirectional or omnidirectional), and configure the wireless router and system switch. HRSD Project Manager to coordinate vendor activity through the Electrical and Instrumentation Division. General Contractor shall provide and install antenna and may be responsible for installing router and switch.

Q. Engineer to provide details in the contract documents regarding SCADA Antenna Installation and Radio Communication System Grounding. Refer to Section 36 - Standard Details, Series 700 in this standards manual for guidance.

X. Attachments:

A. PS Substantial Completion Checklist

B. Temporary Portable Pump Alarms

End of Section