PUMPING STATION DESIGN GUIDELINES

The Metropolitan Sewer District of Greater Cincinnati

Hamilton County, Ohio

July 2013

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List of Abbreviations

amsl	above mean sea level
ASTM	American Society of Testing and Materials
AASHTO	American Association of State Highway and Transportation Officials
AMWA	Association of Metropolitan Water Agencies
AOR	Allowable Operating Region
AWWA	American Water Works Association
ANSI	American National Standards Institute
BEP	Best Efficiency Point
BHP	Best Hydraulic Point
bgs	below ground surface
CADD	Computer Aided Design and Drafting
CCTV	Closed Circuit Television
CIP	Capital Improvement Program
DPW	Department of Public Works
EDU	Equivalent Dwelling Unit
EPA	Environmental Protection Agency
GIS	Geographic Information System
gpd	gallons per day
gph	gallons per hour
hp	horsepower
ID	inside diameter
I/I	Inflow/Infiltration
IMS	Infrastructure Management System
LEED	Leadership in Energy and Environmental Design
lf	linear feet
LWL	Lowest Water Level
MGD	Million Gallons per Day
MH	Manhole
MSDGC	Metropolitan Sewer District of Greater Cincinnati
NEMA	National Electrical Manufacturers Association
NPSH	Net Positive Suction Head
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency
OPC	Ohio Plumbing Code
OSHA	Federal Occupational Safety and Health Act
POR	Preferred Operating Region
P&ID	Process and Instrument Diagrams
rpm	rotations per minute
RVSS	Reduced Voltage Solid State
SCADA	Supervisory Control and Data Acquisition
TSDF	Transporter Treatment, Storage and/or Disposal Facility
VAC	Volts Alternating Current

Executive Summary

This document is prepared in accordance with Section 702 of the MSD Rule and Regulations, Policy on Privately Constructed Wastewater Lift Stations in Areas Served by the Metropolitan Sewer District of Greater Cincinnati, which reads in part:

> “The Board shall periodically approve the technical requirements for wastewater lift stations within the Metropolitan Sewer District. The Director shall maintain on file and make available to the public upon request the current technical requirements for wastewater lift stations within MSD. ”

Included with this design guideline are guide specifications and engineering detailed drawings for the use of owners, developers, consultants, and MSDGC design engineers to plan for and design wastewater pump stations meeting the requirements of MSDGC.

Introduction

It is the policy of the Metropolitan Sewer District of Greater Cincinnati (MSDGC) to minimize the need for wastewater pump stations and to limit their construction and use within the system. The basis for this policy is that pump stations cause disproportionate expense in order to provide service to a limited customer base and that failure of pump stations poses significant environmental risks.

It is recognized however, that there are situations where pump stations are necessary. All small remote pumping stations with a projected design peak flow at build-out conditions of less than 2 MGD, whether Developer funded or not, shall be designed in accordance with these guidelines. MSDGC provides the large regional pump stations it deems necessary for orderly system development and operation under its Capital Improvement Program (CIP). MSDGC will consider, on a case-by-case basis, requests to accept new, Developer funded, pump stations in the situations described below:

Temporary Pumping Station awaiting Future MSDGC project for a Regional Pumping Station

The pump station proposed will only be necessary on a temporary basis and can be eliminated by a project or combination of projects in the future that are a part of MSDGC’s CIP.

Approved Location within MSDGC and Other Agency’s Long Range Plans

The proposed pump station is at an appropriate location and has adequate capacity or expansion capabilities to serve as a permanent or long term facility and gravity service is cost prohibitive using triple bottom line analysis or not possible due to other circumstances.

The construction of the proposed pump station would facilitate significant progress toward achievement of land use goals and strategies described by current, officially approved, planning documents and no other reasonable options are available for service.

Eliminates Other Existing Pump Stations

The construction of the proposed pump station would include elimination of one or more existing pump stations.

Approved for Consideration

In the event that the Developer believes the development meets one of these criteria, they shall submit a letter requesting consideration for such to MSDGC, including a summary of their development's sanitary sewer service area, its topography, and their planned pumping station design scenario for approval. MSDGC will review such requests and provide either preliminary approval or decline the request requiring a different means of conveying sewage to their regional collection system, or the use of local treatment systems. Preliminary approval shall not be considered design approval. Developers must hire a Professional Engineer licensed in the State of Ohio to design a pump station according to these guidelines and submit such design for MSDGC Board approval according to the stipulations herein.

References

All other work associated with the construction of a pump station including but not limited to earthwork, site improvements, roadways, various materials, excavation support systems, demolition/abandonment of existing features/utilities, manholes, equipment, piping, coatings, etc… shall be in accordance with the latest State of Ohio Department of Transportation, Construction and Materials Specifications, the City of Cincinnati Supplement to the State of Ohio Department of Transportation, Construction and Materials Specifications, all applicable portions of the OEPA Guidelines – "Sewage: Collection, Treatment & Disposal", all OSHA regulations, as well as other applicable MSDGC Standards, Rules, and Regulations, safety, regulatory, and jurisdictional requirements and any amendments and/or addenda thereto.

Equipment

MSDGC has preferences as to which equipment manufacturers provide materials that best meet these guidelines. Such manufacturers are listed within the appropriate sections of the guide specifications (see Section 5 herein for the list of guide specifications). A general table providing a summary of standard equipment for pumping stations and the MSDGC preferred manufacturer for each is provided as Appendix A to these design guidelines. However, in the event of a discrepancy between the table in Appendix A and the manufacturers listed within the guide specifications, the guide specifications shall govern.

Section 1

Design Submittal

After reviewing these design guidelines, including guide specifications and detail drawings, the developer's engineer will prepare a design submittal for review by MSDGC.

1.1 Initial Design Submittal

The submittal must include the following:

- Plan design for pump station layout including:
    - Upstream MH, Wet Well, and Valve Vault
    - Control Cabinet(s) and Electrical Power Utility Lines (including transformers)
    - Backup Generator, fencing, and necessary landscape items
    - Land tract including access to station from public roadway
    - Emergency overflow routing from station's incoming gravity sewer system to final discharge to waters of the U.S. should entire station fail
- Force main plan and profiles including:
    - Plan sheets at a readable scale depicting stationing from point of exit from wet well to connection location with the existing MSDGC sewer system
    - Length, size, and type of piping, including fittings
    - Details and/or description of connection to existing MSDGC sewer system
    - A copy of the entire forcemain profile on a single 8-1/2 x 11 or 11 x 17 sheet with the pump station, discharge point, air release valves, hydraulic grade line (both for pumped system and emergency overflow), and key stations labeled clearly
- Manufacturer's details and specifications for pumps (including controls), generator, and transfer switch
- Sanitary Sewer Pump Station Required Design Data shall be listed on the first page of the submittal including:
    - Service area description (according to section 2 herein) and sewage constituents (according to pump specifications)
    - Calculation of average and peak flows, including in monitoring data and modeling results if utilized for design
    - Pump and system curve plots

Two complete sets of the design shall be submitted for review to MSDGC, allowing at least 2-weeks from the time of submittal for review.

One set of the design submittal shall be returned to the Developer with review comments and any necessary changes required.

1.2 Final Design Submittal

Upon completion of all necessary changes, five complete sets of the revised design shall be submitted to MSDGC for final approval along with a copy of a submitted OEPA Permit-To-Install (PTI) application.

Only upon receipt of final approval of the OEPA PTI will MSDGC approve for the Developer, their Engineer, or any Contractor, to be allowed to proceed with the construction of the station.

Section 2

Sizing Standards

2.1 Extent of Service Area

The extent of the service area and service area characteristics (population and land use) must be determined to adequately develop appropriate design flows.

Owners, Developers, and/or Contractors (hereafter referred to as Developers) must identify the following as part of their proposed pump station design:

- Service area boundary
- Size of watershed drainage area
- Population
- Land use (residential, commercial, industrial)
- Age of development
- Condition of existing sewers tributary to proposed pump station with respect to potential for infiltration/inflow

2.2 Design Flows

Design flows must be identified to appropriately size pumping stations. Once the extent of the service area has been established, the following design flows must be defined:

- Average flow
- Peak wet weather flow

Flow metering data must be used if available, consult with MSDGC.

The Developer must provide and submit all information necessary to complete the OEPA Permit-to-Install (PTI) application. PTI guidelines and forms can be found on the Ohio EPA website: www.epa.state.oh.us

2.2.1 Estimating Sanitary Sewage Flow from New Developments

Sewer flows for new developments shall be estimated using full build-out conditions for the service area according to the guidelines below. Zoning maps and any available regional planning reports should be used as the basis for future development.

2.2.1.1 Residential

The average flow of sanitary sewage shall be computed on the basis of 400 gallons per household per day.

The peak flow shall be computed as the average flow times a peaking factor. The peaking factor for various situations shall be in accordance with the guidance provided in the publication, *Sewage: Collection, Treatment & Disposal, Ohio EPA, 1993 Edition*.

2.2.1.2 Infiltration

An allowance of 200 gallons per day per inch diameter per mile of sewer shall be provided.

2.2.1.3 Total Peak Flow

The total peak flow shall be the sum of the peak Residential flow plus the Infiltration allowance.

2.2.2 Determining the Amount of Sanitary Sewage for Existing Sanitary Sewer Upgrades

Where upgrades to existing facilities are involved, sewer flows shall be determined both by estimation of flows for full build-out conditions per new development standards above, as well as through the use of monitoring and modeling of current flows within the sanitary sewer system. The greater of the flows determined by such methodologies, or the addition of new development flows to the measured/modeled flows shall be used for appropriate sizing of pump station upgrades. The MSDGC monitoring/modeling group should be consulted to develop a flow monitoring strategy for each proposed project.

2.2.2.1 Monitoring of Existing Flows within the System

Temporary flow meters shall be used to measure dry- and wet-weather flows for a period of at least 3 months during the spring high groundwater period. The monitoring period shall include at least three wet-weather events with rainfalls of 1-inch or more.

2.2.2.2 Modeling Simulations

The design flow shall be based on the model-projected peak sewer flow rate from a design storm with the applicable recurrence interval.

The design flow shall be comprised of three components:

- Base Wastewater Flow (BWF)
- Groundwater Infiltration (GWI)
- Rainfall-derived inflow/infiltration (RDII)

These design flow components will be determined using the following criteria:

- BWF shall be established using data observed during flow monitoring. In areas with primarily residential development, the BWF can be estimated as 90 percent of the minimum flow during a dry day. Alternatively, BWF may be estimated from winter water use records.
- GWI shall be set at the maximum rate observed during the flow monitoring period, or that projected to be the typical annual peak GWI rate (i.e. peak rate expected once per year) if flow monitoring results are considered to be not representative of typical conditions.
- RDII shall be established using the following conditions:
    - The Soil Conservation Service (SCS) Type II rainfall distribution
    - Antecedent soil moisture conditions that correspond to the maximum observed wet-weather flow during the flow monitoring period shall be assumed in estimating the design RDII flow rate. If flow monitoring results are not considered to be representative of typical conditions for this purpose, then the flow monitoring data shall be used to project to the maximum antecedent soil moisture conditions expected to occur once per year, which will be used for establishing the design RDII flow rate.

2.2.3 Special Conditions for Determining Design Flows

In the event that the standard methods for determining design flows herein do not appropriately or completely encompass the anticipated flows for a particular service area, special conditions may be presented to MSDGC for review. Where special conditions are agreed to by MSDGC, determination of the amount of sewage shall be fixed by approval of the Director and the design engineer shall proceed with the pump station design based on such special condition design flows.

Section 3

Station Guidelines

3.1 Station Type

Pumping stations shall be submersible where pumps will be installed in a circular, precast concrete wetwell and operated at constant speed in response to a control system that starts and stops the pumps based upon level in the wet well.

Stations shall be equipped with constant utility power source as well as backup generator power source for when interruptions in utility power source occur. Depending upon the location, backup generators may be designed and installed either above or below ground in accordance with these guidelines. Developer shall contact MSDGC for determination if above ground installation will be permitted.

3.2 Pump Type

Pumps shall be submersible sewage non-clog type pumps designed and manufactured for use in conveying raw, unscreened sewage with up to 3-inch diameter solids. Pump selection and construction shall consider the duty requirements as well as the physical and chemical characteristics of the wastewater.

The pumps shall be capable of meeting the performance requirements according to the calculations determined for the service area by the sizing standards contained herein. The results of hydraulic calculations for the proposed pumping station and force main system shall provide the limits of expected pump operation over the useful life of the facility. Equipment selected shall be fully suitable for continuous operation at any specified condition or any condition lying between the specified operating conditions.

Pump motors shall be capable of handling any load on the pump’s performance curve without using any factor of safety or being overloaded, and shall allow up to 10 starts per hour.

Recommended pump manufacturers are included within the equipment listing of Appendix A. Additional detailed pumping requirements are also included within the guide specifications of Appendix C and the guideline detail drawings of Appendix D.

3.3 Control Philosophy

Typical MSDGC pump stations are two pump systems utilizing a local pump control panel to manage the constant speed pumps based on five level settings using float switches or other means.

Figure 3-1 shows the basic configuration and sequence of operation of the selected level settings.

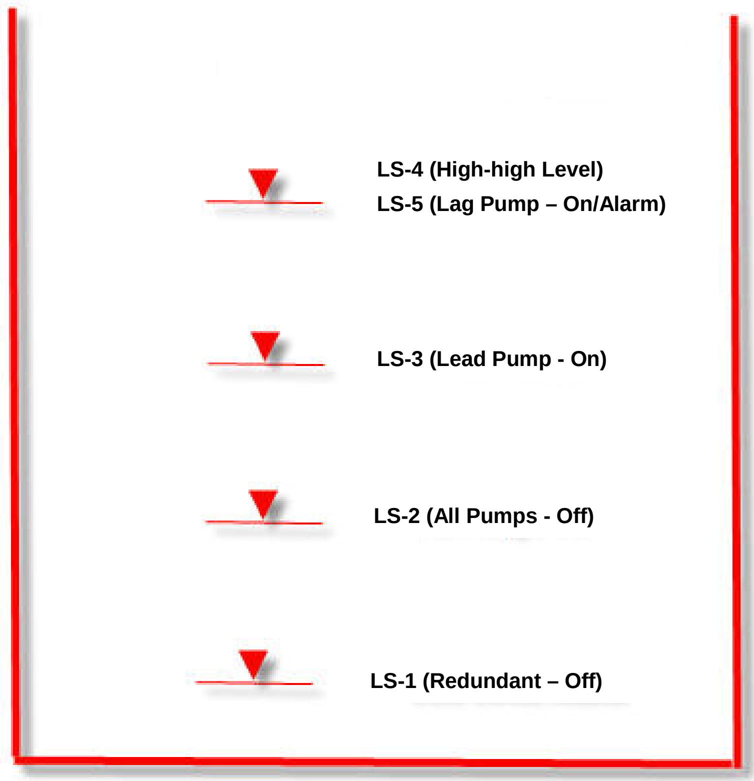

Figure 3-1 - Wet Well Level Setting Configuration

- When the water level in the wet well reaches LS-3, the lead pump turns ON.
- If the water level continues to rise and reaches LS-5, the lag pump turns ON.
- The lead and/or lag pumps shall continue to run until the water level falls to the LS-2 (All Pumps – Off) level setting.
- LS-1 is a Redundant Off level setting, which will turn off the lead and lag pumps in the event of failure of the LS-2 level device. The LS-1 level shall be set at the pump minimum submergence as required by the pump manufacturer and at least 6-inches below the LS-2 level setting.
- LS-4 provides a high-high level alarm to the station's telemetry system. The LS-4 level is typically set at the same level or slightly higher level as the LS-5 (Lag Pump – On/Alarm) level setting For in-system pump stations serving separated sewers, LS-5 is recommended to be configured to send out a nominal high water alarm to through the station's telemetry system.
- Other Lag Pumps, if used, will have their 'Lag Pump – On' level set to a level between LS-3 (Lead Pump On) and LS-4 (High-high Level). The other lag pumps-on elevations are dependent on the field condition to avoid influent pipe surcharging as determined by the design engineer.

Note that the LS-2 (All – Pumps Off) level should be set at a location meeting the following criteria:

- The pump manufacturer's recommended pump off-elevation but no lower than the pump volute.
- The pump manufacturer's recommended level on the smallest pump for different sized pumps.

Also, the Pump-on and Pump-off elevations shall be based on the calculations to:

1. Limit the pump cycle time to less than the specified 10 starts per hour.

2. Limit wetwell fill times under design average flow conditions to 30 minutes or less.

The pumps will operate in a traditional lead-lag sequence with alternation of the lead pump designation. This shall provide similar total run times for the pumps in service allow for even wear on them and help to minimize the amount of solids accumulating in front of the lag pump. The alternation shall occur after the All Pumps – OFF level setting (LS-2) is reached. The alternator is a hard-wired device located in the pump control panel and provided with an OFF-ON selector switch to maintain operation of the "good" pump if the other pump fails or is taken out of service.

HAND-OFF-AUTO selector switches shall be provided for each pump and shall be used to take a pump out of service (OFF position), to start a pump locally (HAND position) or to leave the pump under control of the wet well level detection devices (AUTO position).

If a specific control scheme is established by the design engineer, such scheme must be included as part of the pump station design submittal and the final O&M manual.

Pumping stations shall be designed to perform at both primary and secondary operating conditions.

Primary Operating Condition. This condition represents the normal operating condition for the facility in which a single pump operates under normal daily flow conditions and shall be the rated condition for the pump. This condition shall be calculated to represent the maximum flow, minimum anticipated system head condition for single pump operation. This condition shall be located within the Preferred Operating Region (POR) as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application and shall be to the right of the pump's Best Efficiency Point (BEP). The station shall pump the calculated peak wet weather flow with the largest unit out of service under this operating condition.

Secondary Operating Condition. This condition represents the operating condition for the facility in which the two pumps operate in parallel at a flow in excess of the calculated peak wet weather flow at the station. This condition should only happen under extreme events or pump failure. This condition shall be calculated to represent the maximum anticipated system head condition for parallel pump operation. It is expected that this condition will be less frequent than the Primary Operating Condition and, therefore, may be located in the Allowable Operating Region (AOR) as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and published in the manufacturer's published application data for the specific model proposed for this application. The flow at this head will vary, depending on a given pump's head capacity curve.

3.3.1 Instrumentation and Controls (SCADA)

MSDGC Pumping Stations have a simple monitoring and control scenario. All stations are controlled locally at the facility via hard wired control and are monitored as part of a larger SCADA (Supervisory Control and Data Acquisition) system.

The pump station controller is located at the facility and consists of a Remote Terminal Unit (RTU). The RTU communicates with a Master Terminal Unit (MTU) located at the Central Control Center via telemetry (spread-spectrum radio communication). The SCADA operator remotely monitors the pump station from the Central Control Center. The SCADA operator has no remote control of the pump station from the Central Control Center.

At a minimum the following signals shall be monitored from a typical MSDGC pump station (this list of signals shall be verified with MSDGC's Ken Stith to ensure they align with the most recent PCS guidelines):

- Loss of Control Power
- Wet Well Level
- Wet Well Redundant Off Float Switch (Low Level)

- Wet Well High Level Alarm
- RTU Intrusion (Door Switch)
- Loss of Duke Utility Power
- Transfer Switch in Emergency
- Generator Run
- Generator Common Fault
- Pump #1 Run
- Pump #1 Fail
- Seal Fail Pump #1
- Pump #2 Run
- Pump #2 Fail
- Seal Fail Pump #2
- High Level Alarm at Receiver Manhole (WIB stations only)
- Control Panel Intrusion Switch
- Transfer Switch Fault (if available)
- Station in 'Maintenance Mode'

Most pump stations are equipped with level monitoring devices for monitoring and control.

Some common level monitoring methods include:

- Float switches (mechanical or optical type)
- Submersible pressure transducers
- Radar level sensors

Float switches shall be installed in MSDGC wet wells for pump control. These float switches shall be of the optical type, except where mechanical switches or other devices are specifically approved by MSDGC.

When mechanical float switches are approved by MSDGC, the switches shall be of the mercury-free mechanical type. This switch shall be encased in a float that is leak proof, shockproof and corrosion resistant to sewage. This type of float switch shall be provided with an integral oil-resistant flexible cable to connect the switch to the control panel. The float switch shall operate off of 24 VDC. Continued use of mechanical float switches may be considered at existing facilities, but shall not be used at new installations.

Optical-type float switches shall be used for pump control at all new pumping stations. Optical float switches shall be mercury-free and use a fiber optic cable to transmit a beam of light from a transmitter in the control panel to the float where the beam makes and breaks depending on the tilt of the float. With this type of float switch there are no electrical wires running from the control panel to the float switch and thus inherently intrinsically safe in hazardous locations.

Setting of the level set points for pump operation requires the design engineer to understand the flow into and out of the pump station. The visual representation of the selected levels are typically shown on the P&IDs or on the Mechanical or Electrical drawing that represents the pump station section with the elevations indicated. The selected levels shall be measured from the top of the wet well lid.

Actual wet well level shall be monitored by the control system. MSDGC has employed pulse radar and ultra-sonic transmitters with some success in the past. A third type of transmitter that can be used to monitor level is the submersible pressure transducer. This device contains a pressure port equipped with an elastomeric diaphragm and a piezoresistive pressure sensor and typical measures pressures in the range of 3 to 50 m H_2O. This pressure measurement is then converted to the wet well water level

measurement. All new MSDGC pump stations shall utilize submersible pressure transducers for level monitoring. The use of any other level sensor, such as pulse radar or ultra-sonic shall only be used if granted permission by MSDGC. A local panel meter shall be provided on the interior door of the pump control panel and connected directly to the level measuring device. The panel meter shall be calibrated for level and will provide a local wet well level reading. During well cleaning, the local wet well level reading will allow for maintenance/operations staff to occasionally override the wet well low level setting for pump control and subsequently pump the water level to its lowest possible elevation. Additionally on this interior door shall be a final elevation benchmark listing the wet well rim elevation and subsequent depths or elevations to each level control point represented within figure 3-1 above.

For the classic-float control scheme, the pumps are assigned a level float switch for on-off control for the pump, with the length from the pivot point the adjustment for the level operating range.

- The pivot point may be from:
  - The top of the wet well where all the floats are accessible and adjustable

  OR

  - A pipe, wire or chain running from top to bottom of the wet well.
- The position on the pipe, wire or chain and the length of cable to the float switch provides:
  - On-off pump control adjustment
  - Overlapping pump control adjustment

3.3.2 Valving

Piping systems shall be provided with sufficient valves to effect proper operation and maintenance of the pump station during normal, peak, and future bypass conditions. Valves shall be suitable for use with raw, unscreened wastewater and shall be of a design suitable for its function, its installation location, as well as the normal and maximum operating pressures expected at the pump station. A full-closing eccentric plug shut-off valve shall be provided on the discharge piping of each pump. A swing check valve shall be provided on the discharge piping of each pump, between the pump and the shut-off valve. Check valves shall be placed in the horizontal position. All valves shall be located so that they are readily accessible.

Recommended valve manufacturers are included within the equipment listing of Appendix A. Additional detailed valve requirements are also included within the guide specifications of Appendix C and the guideline detail drawings of Appendix D.

3.3.3 Emergency Pump—out Connection

An emergency pump-out connection shall be provided in the common forcemain, just downstream of the pump isolation valves. This connection shall consist of a tee with a plug valve matching the sizing of the forcemain piping and a blind flange.

3.3.4 Pig Launching and Retrieval

A pig launching port wye connection shall be provided. The pig launching port shall be provided in the forcemain cleanout chamber immediately downstream of the valve vault or within the valve vault just downstream of the emergency pump-out connection.

An appropriately sized pig retrieval basket shall be provided with hanging attachment mounts in the forcemain discharge to gravity sewer manhole.

3.4 Redundancy Criteria

All pumping stations shall be capable of handling the peak flows determined using the Sizing Standards herein with the largest pump out of service.

3.4.1 Mechanical Equipment

The preferred method of establishing redundancy shall be the sizing of duplex pumping systems where pumps are identical and each pump is capable of handling 100% of the design peak flow.

Other methods of redundancy however, will be considered for approval by MSDGC.

3.4.2 Power

MSDGC requires standby power sources at each pump station. This can be accomplished with dual electrical utility feeds or a single utility feed with a standby generator. Dual electrical feeds may not always be the solution since, in the event of an 'area' power outage; it is possible for both feeds to go out at the same time. However, if dual electrical feeds are used, the feeds shall come from separate substations. Pump stations shall be designed with backup generators per section 4.7 herein, unless they receive specific direction or approval by MSDGC for other redundant power source.

3.5 Flow Metering

MSDGC standard for determining flows into its system is through the use of in-line flow monitoring generally performed through the installation of temporary meters in the gravity sewer upstream from a pumping station or by draw down testing for stations under 1MGD.

Flow metering with an indicating, totalizing, and recording device shall be provided for pump stations with capacities of 1200 gpm or more. For stations with capacities of less than 1200 gpm, elapsed time meters may be provided in lieu of flow metering, subject to MSDGC approval.

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3.6 Wet Well Configuration

Wet wells shall be configured with the incoming gravity sewer piping at or below the LWL to minimize mixing and possibility of air entrainment. Contact MSDGC for resolution if this is not possible due to existing conditions. Incoming piping shall be as close to perpendicular to the pumps' alignment as possible for best efficiency, as shown in Figure 3-2. Invert elevation of the pipe should be at or just above the top of the pump volute.

Wet wells shall be designed in conjunction with pump manufacturers to ensure proper spacing for installation and maintenance as well as most efficient intake (typically 4" spacing all sides is ideal). Wet wells shall have flat bottoms for pump intakes but shall have fillets of at least 45 degrees (60 degrees preferred) from the horizontal to promote solids to reach the pump intake area. No projections within the wet well or on the well wall which would

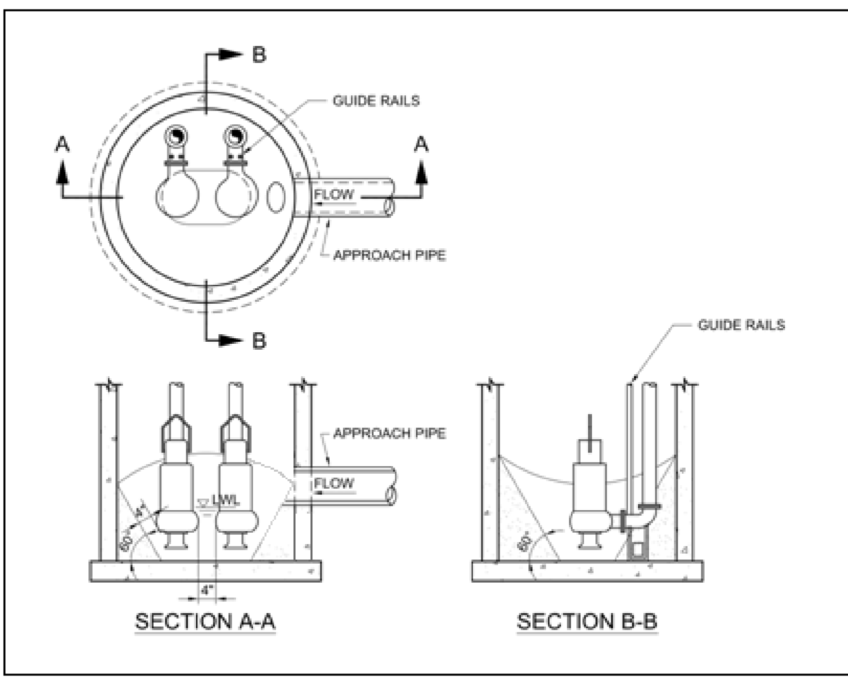

Figure 3-2. Typical Wet Well Plan and Sections

allow deposition of solids under normal operating conditions shall be allowed. Sufficient submergence of the pump or pump suction piping shall be provided to prevent the occurrence of vortexing within the wet well during normal operation.

Electrical conduits within wet wells shall be PVC with seal tight connections. All fasteners, straps, and hardware shall be stainless steel.

3.7 General Pump Station Layout

3.7.1 Mechanical

Pump and motor shaft shall be one piece. Pump volutes shall be single piece centerline discharge design with a large radius on the cut water to prevent clogging and with smooth passages large enough to pass any solids that may enter the impeller.

Impellers shall be radial high head single or dual vane enclosed design, dynamically balanced, and designed for solids handling with a long thrulet and no acute turns. Impeller vanes shall be angled toward the periphery to facilitate release of objects that might clog the pump. Multi-vane (>2 vanes) impellers shall not be permitted unless approved by MSDGC due to their increased possibility of clogging.

Pump motors shall be explosion proof induction type with squirrel cage rotor, shell type design, housed in an air or oil filled, watertight chamber (NEMA B type). Motors must be suitable for operation within the wet well environment and shall utilize solid-state reduced voltage style starters. Motors shall be cooled by the surrounding wet well environment; water jackets are not to be utilized unless approved by MSDGC.

3.7.2 Site (Civil)

Pump stations shall be generally configured in accordance with the MSDGC standard site plans presented in Appendix D. Pumping stations shall be laid out with a lead, inflow manhole within 400 feet of the wet well for sampling and temporary bypass pumping, the wet well sized for both the necessary pumps and storage capacity for pump cycling, and a force main discharge valve manhole with allowable temporary bypass pumping connection. No piping connections are permitted between the lead (inflow) manhole and the wet well, and all service connections must be at an elevation above the invert of the lead (inflow) manhole.

Above ground items shall include electrical control cabinet(s) and transformer. The control cabinet shall be on a minimum 4-inch thick concrete pad where such pad extends a minimum of 6-inches on all sides of the cabinet. 36-inches of clearance will be required where any access doors exist on the cabinet, including the telemetering box if mounted on the side or back of the cabinet. All conduit alignments and sizes to/from the control cabinet(s), transformer(s), generator(s), wet well, etc… shall be shown on the site plans as part of the design submittal.

All pumping stations must have a maintainable drive path to/from them suitable for boom trucks as well as vactor trucks. Hard surfacing of such drive paths is required with longitudinal slopes < 10% and cross-slopes < 5%. Hard surfacing shall be 8” thick class “c” 4,000-psi concrete with a minimum 4” thick type 304 compacted sub base. Drive-thru or interior turn-around (minimum 50-foot diameter cul-de-sac) shall also be provided. Parking for 3 trucks (two standard service trucks plus one large vactor or boom truck) must be provided within a one-block (1,000’) radius of the station. Drive paths and station layout shall provide positive drainage away from the pump station facility without excessive sloping that would be an erosion problem.

Water, electrical, communications, and any other utility services required for support of the station shall be shown on design drawings and shall not be proposed in a manner that would impede future sanitary sewer maintenance of the station, manholes, or piping.

Pump stations shall be located on a tract of land with an assigned address or easement properly deeded to MSDGC and recorded with the Board of County Commissioners. The deeded tract shall include the immediate pump station site, any access drive, any relief structure outfall including the drainage pattern & associated easement from such outfall to the waters of the state and any necessary utility services or piping. The tract shall be large enough to locate the pump station structures, an area suitable to locate an emergency generator, and have enough space to park and maneuver maintenance vehicles. Where determined to be necessary by MSDGC, pump stations shall be fenced.

Pump stations shall be located and designed to minimize the development of nuisance conditions (i.e., noise, odor, relief discharge location, etc.) in the surrounding area. A grading and landscape plan shall be included in all pump station design package submittals. See the guide specifications of Appendix C and the guideline detail drawings of Appendix D for the detailed requirements for grading and landscaping plans.

Pump station structures as well as all associated equipment and appurtenances shall be protected so that the pump station remains fully functional, operational, and free from physical damage during a 100-year flood. The 100 year flood elevation shall be noted on the drawings.

3.7.3 Structural – Architectural

Wet well structures shall be round reinforced precast concrete structures unless otherwise approved by MSDGC. They shall be sized to allow appropriate spacing for pumps as well as maintenance personnel entry with inside diameters ranging from 6-feet up to 12-feet and shall comply with the MSDGC standard design drawings.

Manhole structures for gravity sewers leading into pumping stations shall be round reinforced precast concrete structures. Gravity sewer manholes shall be sized appropriately according to inlet and outlet pipe size and configurations and shall be no smaller than 4-foot ID. They shall have appropriate invert channels for flow matching inlet and outlet piping up to at least one-half the respective pipe's diameter.

Maintenance access structures for force main valve vaults shall be either rectangular or round reinforced concrete structures. They shall be sized to allow appropriate spacing for piping, valves, meters (where used) as well as maintenance personnel entry and shall be located above the emergency bypass connection. All floor and walkway surfaces shall be sloped such that water and wastewater drains to a designated removal area under the influence of gravity. Such removal area shall either be near enough to an access hatch to allow a portable pump to be lowered into the structure for pump it out, or shall drain via valved piped outlet back to the wet well. Any such structure that has a ceiling elevation that is more than 7-feet below grade with a single 4-foot ID or smaller man way (riser) shall have electrical lighting provided. Lighting must meet the fire code rating for the vault space. For below grade valve vaults, physically separated from the wet well with a closed piping system, all electrical work shall be rated for a Class 1, Division 2, Group D environment.

Protective linings, coatings, or painting shall be required by MSDGC for wet wells and forcemain discharge structures, and all manholes within 400 feet upstream or downstream of the force main discharge point. In such cases MDSGC requires either post-installation epoxy coatings, manufacturer applied epoxy coatings, or FRP/polymer concrete structures.

All points of entry into pump station structures, vaults, panels, etc. shall be lockable. The pump station shall be provided with adequate outdoor and indoor lighting to facilitate normal and emergency operation and maintenance activities during daylight and non-daylight hours. Safety placards for all

pump station structures and equipment, as required by Federal, State, County, and City agencies shall be provided and be readily visible.

3.7.4 Electrical

As indicated in Section 3.7.2, all electrical equipment and devices shall be installed above the 100-year flood elevation to ensure the station remains fully operational under these flood conditions.

Stator windings and leads shall be housed within moisture resistant insulation having leakage sensors and thermal switches embedded for monitoring with connection to the control panel. Each pump will be required to have the necessary length of submersible cable to reach the junction box without splices.

Motors shall have voltage tolerances of +/- 10%, a combined service factor of at least 1.15, and be designed for operation within standard submersible pumping allowable temperature ranges.

All sensing circuits in the pumps shall be low impedance, closed circuit systems. Open circuit, high impedance sensors shall not be acceptable since they are subject to false tripping caused by lightning in the vicinity of the pump station.

MSDGC has standardized on using reduced voltage solid state (RVSS) motor starters for constant speed motor control of the stations pumps.

Features of reduced voltage solid state motor starters include:

- RVSS have a soft-start and soft-stop ability that mitigates water hammer and is easier on the mechanical and electrical components, which allows extended pump station equipment life cycle. It should be noted that the soft stop capability cannot be relied upon to control transients in power failure situations.
- The RVSS operates on its electronic component during the starting phase to bring the pump up to rated speed. The starting duration is adjustable and typically a fraction of 60 second starting time. Then the RVSS controller logic bypasses the electronic component and becomes a FVNR motor controller that operates the pump at the rated speed.
- RVSS are programmable for the start-time duration and the stop-time duration, within limits of the electronic devices and is manufacturer specific. Typically, start ramp may be 0-10 or 15 seconds and the stop ramp is similar and adjustable.
- Long start/stop durations put a burden on the electronic components that must hold the motor current during the transition and may lead to early failures.

Typically, MSDGC does not use the soft-start feature of the RVSS motor starter. Pumps are started at full speed to minimize ragging problems on start-up. The soft-start feature is most commonly used in soft-stop conditions to decelerate the pump on shut down to minimize water hammer.

For MSDGC station pump control, open type RVSS controllers such as the Allen Bradley SMC series or the Cutler Hammer S811 series shall be provided and installed in the pump station control panel.

3.7.5 Odor Control

Sewage odor is caused by any mixture of inorganic gases and organic vapors along with volatile solvents and mineral-oil-based matters that are discharged into the sewer system. MSDGC defines odor as any disagreeable odor that is detectable within the pump station area, force main discharge manhole, or related gravity sewer. The main gases that MSDGC monitors for odor control are oxygen, methane, and hydrogen sulfide.

Pumping stations may be required to have odor control systems if MSDGC determines them to be necessary either through review of the station's layout design or by monitoring of the station's surrounding environment for a period of up to two years after station start-up.

Odor control systems shall be designed by the engineer to mitigate the build-up and release of odorous gases both at the station and at the force main discharge location through the use of a Sodium Hypochlorite drip into the wet well. System design shall include the use of a minimum 1,500 gallon storage tank, dosing pump, and radar level indicator and shall be designed to dose adequate amounts of Sodium Hypochlorite based on time between pump runs.

MSDGC will take air samples in the area of all pump stations with MSDGC gas monitors to review odors. Hydrogen sulfide levels must be maintained below five (5) parts per million at all times. MSDGC shall review a station's odor control performance during the initial two (2) years of operation to evaluate the effectiveness of the installed odor control system and determine if additional odor control measures are necessary.

3.8 Essential Features to Facilitate Maintenance

3.8.1 Wet Well Cleaning

All wet wells, regardless of size, should be easy and quick to clean with minimal (if any) need for personnel to enter the wet well.

Installing a conical bottom that hugs the pump volutes closely, allows sludge to slide down the sides to within the influence of the strong suction currents and be pumped out in each complete pump cycle. Occasionally overriding the LWL switch and pumping the water level to its lowest possible elevation, promotes scum being drawn into the large vortex that is formed beside the pump. The intent would be to engulf floating solids quickly, before the pump loses prime, and then the pump shut off immediately. This cleaning operation is of very short duration and should not adversely affect pump life, provided that the pump is stopped as soon as it breaks suction. The cleaning operation may be observed either visually or by wetwell level monitor and the pump stopped manual as soon as it breaks suction. Alternatively, low current monitors have been used to stop pumps as well. When the pump breaks suction, current draw drops and the pump is stopped. Another alternative is to install a low level shutoff switch for the cleaning operation. The level of this switch for effective wet well cleaning would be determined and set during commissiong of the station.

This is an intermittent operation, with the cleaning frequency based on the nature of the pump station service area. For example, pump stations located in areas with a large number of restaurants may require more frequent draw down to remove floatables than stations located in primarily residential areas. The cleaning operation would typically be done once per week, and the frequency then adjusted based on operator experience.

3.8.2 Pump Removal and Maintenance

Pumps shall be provided with a guide rail system and lifting chains to allow easy removal of the pump without entering the wet well. Lifting chains shall be type 316 stainless steel, capable of lifting at least 3 times the static weight of the pump. A MSDGC boom truck will be utilized to lift each pump into and out of the wet well. Wet wells must have accessible at grade area for boom trucks to reach pumps in accordance with the Site (Civil) section herein. Final design submittals must include pump weights for verification of meeting existing MSDGC boom truck capacities.

3.8.3 Extended Maintenance Bond

A two (2) year maintenance bond is required from the permittee for all pumping stations. Such bond shall be for general maintenance as well as odor control monitoring. If the system has met the requirements, MSDGC will return the bond to the station's construction/installation permittee at the end of the two (2) year period. If the system does not meet the requirements, MSDGC will notify the permittee of the results allowing them to correct the problem without losing their bond money.

If the system has failed due to odor control issues, MSDGC will again review the odor control performance each year until either the system maintains odor control or until the 2 year bond period expires. If the system is found to meet the odor control requirements during any one-year of such additional sampling, the bond money shall be returned to the permittee. If the system does not meet the odor control requirements after the two (2) year bond period, MSDGC will retain the bond money.

Section 4

Detailed Design Criteria

4.1 Pumps

Design Engineers shall preliminarily size pumps utilizing predicted pump performance curves for each condition point in conjunction with the sizing standards herein: showing head, power, efficiency, and NPSH required on the ordinate plotted against capacity (in GPM) on the abscissa. Curves shall clearly display all specified operating conditions and the manufacturer's limits for the POR and AOR.

4.1.1 Initial Pumping Capacity

Multiple pumps shall be used such that the pump station is capable of conveying the peak hourly wastewater flow to its desired outfall location with the largest single pump out of service.

For duplex pumping stations, pumps shall be of equal capacity.

4.1.2 Total Dynamic Head Calculations

Multiple pumps shall also be evaluated for operation during peak flow conditions where all pumps could be running simultaneously to meet inflow conditions greater than that of normal design to ensure continuous operation within the AOR. A system curve, plotting total dynamic head versus capacity, shall be developed for all operating conditions that may be imposed on the system. Two system curves should be developed and evaluated including one for low static head, low friction losses and low minor losses within the system as well as one for high static head, high friction losses and high minor losses. This will allow for the proper representation of all possible operating conditions both as a newly installed system and as a system nearing the end of its life expectancy.

Friction Losses: Friction losses are commonly calculated using either the Hazen-Williams equation or the Darcy-Weisbach equation.

The Hazen Williams equation may be presented as follows:

$h_f = 4.72LQ^{1.85}/C^{1.85}D^{4.87}$, where:

h_f = Friction loss in piping, feet

L = Pipe length, feet

Q = Flow, cubic feet per second

C = Hazen-Williams coefficient

D = Pipe Diameter, feet

The Hazen-Williams equation was developed empirically and values for the Hazen-Williams coefficient can vary widely depending on items such as the age of the pipe, the size of the pipe and the material of construction. The equation is easy to use, but is only applicable to water at about room temperature and is not suitable for use under laminar flow conditions. In order to bracket the range of operating conditions that might be expected, a C value of no higher than 110 should be used for the high head condition and a C value of no less than 140 for the low head condition. These values should be confirmed for the specific pipe material being used.

The Darcy-Weisbach Equation may be presented as follows:

$h_f = f(L/D)(v^2/2g)$, where:

h_f = Friction loss in piping, feet

f = the coefficient of friction

L = Pipe length, feet

v = velocity, feet per second

D = Pipe Diameter, feet

g = 32.2 ft/sec^2 (acceleration due to gravity)

The Darcy-Weisbach Equation is applicable to laminar as well as turbulent conditions. It can also be used for fluids other than water. One disadvantage is the need to determine the coefficient of friction, f. This is based on the Reynolds number, determined by:

$R = vD/\boldsymbol{\nu}$, where:

R = Reynolds number (dimensionless)

v = velocity, feet per second

D = Pipe Diameter, feet

$\boldsymbol{\nu}$ = kinematic viscosity, square feet per second

Once the Reynolds number has been calculated, the coefficient of friction can be determined using a Moody Diagram. Note that the pipe diameter and absolute roughness (Є) for the pipe material are required to determine the roughness coefficient from a Moody Diagram. Similar to the Hazen-Williams C value, the absolute roughness will vary with pipe material and age. Hydraulic calculations should consider both high and low absolute roughness values.

The Moody Diagram was developed from Colebrook's equation:

$$\frac{1}{\sqrt{f}} = -2log_{10}\left(\frac{\frac{\epsilon}{D}}{3.7} + \frac{2.51}{R\sqrt{f}}\right)$$

Where: f = the coefficient of friction

D = Pipe Diameter, feet

R = Reynolds number (dimensionless)

Є = absolute roughness, feet

Colebrook's equation could be used to iteratively calculate the value for f.

Another alternative to determine f is an equation developed by Swamee Jain, as follows:

$$f = 0.25/(log_{10}(\frac{\epsilon/D}{3.7} + \frac{5.74}{R^{0.9}}))^2$$

Where: f = the coefficient of friction

D = Pipe Diameter, feet

R = Reynolds number (dimensionless)

Є = absolute roughness, feet

For more details on the use of the Darcy-Weisbach equation and the determination of the coefficient of friction, f, consult a reference book such as *Handbook of Hydraulics, Brater and King, 1976*, or *Pumping Station Design, Revised Third Edition, 2008.*

Minor Losses: Losses due to turbulence at fittings and valves are commonly referred to as minor losses. These losses are calculated using the following equation:

$h_m = Kv^2/2g$, where:

h_m = Minor loss at valve or fitting, feet

K = Headloss Coefficient

v = velocity, ft/second

g = 32.2 ft/sec^2

There are numerous references for K values. Tables B-6 and B-7 in *Pumping Station Design, Revised Third Edition, 2008,* provide headloss coefficients for fittings and fully open valves. *Crane Technical Paper No. 410 (TP-410)* is another reference for minor losses in piping system.

4.1.3 Pump Selection

Proposed pumps must operate at the design flows always within their POR and AOR for all possible operating conditions as specified in paragraph 3.3 herein.

Proposed pumps must have a service center that stocks parts within the Greater Cincinnati Area. A five-year Municipal Warranty shall be provided for the pumps. No vortex type pumps will be allowed.

Grinder pumps will be allowed only with prior MSDGC approval. If approved for use, grinder pumps must be supplied with a spare set of grinder wheels for each pump.

Pumps shall be capable of handling a 3-inch solid and any trash or stringy material that can pass through a four-inch hose. Pump suction and discharge openings shall be no less than 4-inches in diameter.

4.1.4 Power Requirements

Pumps shall be specified for 480-VAC power unless it is determined by Duke Energy that such is not available within a particular service area. If a 480-VAC power supply is not available, the design engineer shall show power sizing calculations in conjunction with available Duke Energy electrical power amounts, including pump motor specifications to match.

4.2 Wet Well Sizing and Connections

Wet wells for constant speed pumping stations shall be sized to limit pump starts to no more than 10 per hour and shall incorporate an approach pipe as shown in Figure 3-2 above and further described in *Pumping Station Design, Revised Third Edition, 2008 (see* Chapter 12, Example 12-2). This design incorporates an approach pipe and an upstream manhole, in addition to the wet well. The upstream manhole should not be impacted by pump operation; however, the approach pipe provides a portion of the wet well volume for cycling the pumps and is critical to the wet well cleaning operation.

The approach pipe design can be checked using either Table B-10 or B-11 from *Pumping Station Design* (valid only for slope of 2% and LWL set at 0.6D of approach pipe) or the spreadsheet, *Approach*. The *Approach* spreadsheet is available for download at www.coe.montana.edu/ce/joelc/wetwell/ .

The inlet pipe should be located coplanar (in line) with the pumps, with the pipe invert set at or just above the pump volute. This configuration eliminates a cascade inlet, reducing air entrainment and odor release. By locating the inlet in line with the pumps, the motor of the near pump serves as a baffle to

decrease the inlet jet velocity. Under normal operation, the low water level should be set at 0.6 inlet pipe diameters (0.6 D) above the inlet pipe invert. The approach pipe should have a slope of approximately 2 percent and a diameter one or two pipe sizes larger than the upstream sewer. This approach pipe should be included in the required wet well volume calculated to cycle the pumps. With the lower level in the wet well set at 0.6 D, a hydraulic jump will form in the approach pipe every time a pump runs, entraining floatables so that this material is pumped out of the wet well. The approach pipe should be designed so that the pipe provides roughly half the volume required to regulate the pump between low level and high level.

This design guideline does not address the design of significant equalization storage to minimize the peaking of flows for the downstream sanitary collector systems or treatment plants. In the event that MSDGC feels that the proposed pumping station will be detrimental to the existing downstream systems, or cannot handle the planned demand, equalization basins and/or sewage storage tanks will be required.

Solid sleeve type pipe joints shall be used for closed pumping system pipes entering and exiting pump station structures. A minimum of two 4-foot pipe sections shall be provided between pump station structures to allow for differential settlement without compromising the integrity of the overall pump station. Gravity pipe inlets and outlets of pump station structures (MHs) shall be made watertight with flexible boots according to ASTM C-923 and grouted.

Pump stations shall be adequately vented in accordance with local and state building codes as well as OSHA and NFPA standards. At a minimum, pump station wet wells shall be provided with a 3-inch mushroom-type vent with a stainless steel insect / bird screen. Vent elevations shall be a minimum of four feet above the 100-year flood elevation.

If the lowest interior elevation of any tapped structure in the service area is within 2 feet of the top of the slab of the wet well (or other controlling system relief point) a constructed relief structure from the pump station wet well, or first upstream manhole, must be considered as part of the system’s design. The evaluation of risk and the routing of such release mechanisms shall be considered on a case by case basis with the involvement of MSDGC and OEPA. If such is not feasible, then at a minimum, backflow preventers shall be provided for those sanitary service lines within such elevation range.

4.3 Operation Set Points

Pumps shall operate at speeds of 1800 rpm or less, except if prior approval by MSDGC is received. In certain cases motors speeds up to 3600 rpm may be approved by MSDGC.

Pumps shall operate with a pump suction specific speed as near to 8,000 as possible and always below 10,000. Suction specific speed is calculated as follows in accordance with the Standards of the Hydraulic Institute.

$$S = \frac{n(Q_{BEP})^{0.5}}{NPSHR^{0.75}}$$

Where:

n = speed, rpm

Q_{BEP} = flow rate, gpm at the BEP

$NPSHR$ = net positive suction head required (ft) at the BEP

Constant speed pumps shall be cycled such that the number of starts is minimized and resting times are maximized to avoid overheating and overstressing of the pump motor. Pumps shall be designed for

automatic pump alternation with operation at no more than 10 times per hour under the worst case condition (influent flow equals half of pump capacity).

In no case shall the all pumps-off activation level be less than the minimum level required for successful pump operation, as recommended by the pump manufacturer. Submersible pumps, including lifting brackets, shall be fully submerged for all normal operating set points. During station maintenance operations, pumps shall be controlled by pressure transducers/transmitters located at the bottom of the wet well and wet well draw down shall be permitted, exposing the pumps. This will provide for appropriate wet well cleaning including the removal of grease, oil, and floatables that may normally reside on top of the wet well water surface, above the pumps.

4.4 Valve and Meter Vaults

Valve and meter vaults shall be pre-cast or cast in place structures as described under Section 3.

Valves and piping shall have sufficient room for a nut/bolt fastener.

4.5 Force Main Design

Wastewater velocity occurring in a force main shall be calculated using the continuity equation. Where the flow (Q) at all points in the force main is considered equal and the velocity (v) varies with the cross-sectional area (A). Thus $Q = v_1A_1 = v_2A_2$. A self-cleansing velocity of at least two feet per second shall be provided throughout the length of the force main. The ability to provide velocities of between three and eight feet per second is necessary to re-suspend any solids that may have settled out.

Force mains shall be adequately anchored to resist thrusts that may develop at bends, tees, plugs, end-of-line valves, and at any other location where a change in flow direction occurs. Such anchoring shall be provided through thrust blocks or the use of original manufacture restrained joint pipe as desired by MSDGC. Retrofit restraining devices are not allowed. Anchoring devices shall be designed to withstand force main pressures of at least 25 percent greater than the maximum pump shut-off head plus an allowance for water hammer and an appropriate factor of safety or to test pressure.

Force main routing shall be such that the number of air release and vacuum relief valves is minimized. An automatic air release valve shall be provided at all high points to prevent air locking of the force main. An automatic combination air release and vacuum relief valve will be located at the ultimate high point and when necessary for surge control where sub-atmospheric pressures or column separation may occur. Automatic air release valves shall be used at other local high points. Air release valves are required when the difference between the low point and high point exceeds one pipe diameter. These valves shall be of the quick-opening, slow-closing type and may be standard height or short body design with a minimum 2-inch diameter screw-threaded inlet.

A maximum 400 foot spacing between manholes (regardless of type) is required, unless otherwise approved by MSDGC. Forcemain piping shall be PVC or DIP unless otherwise approved by MSDGC in accordance with standard specification 33 90 36 FORCEMAINS. In the event that steel or other ferrous metal piping (other than DIP) is approved, the system designer must evaluate if cathodic protection will be necessary to keep such piping from deteriorating.

4.6 Buoyancy

Below-ground pump station structures shall be water-tight and protected from the buoyant forces of groundwater with a factor of safety greater than 1.5.

Flotation calculations shall be performed on below-ground pump station structures using the assumption that the elevation of the groundwater table is equivalent to the ground elevation. Calculations shall not

add the weight of the pumps, internal piping and appurtenances, or wastewater present in the pump station, including the wastewater below the all pumps-off activation level, into the downward forces used to counteract buoyancy. The saturated weight of any soil above the extended footing of the pump station structure shall be allowed in flotation calculations.

4.7 Backup Power – Generator

Pump stations are required to have continuous standby power. A backup power system in the form of a fuel operated generator system shall be designed as part of all pumping stations to supply the same amount of electrical power to the station (including all pumps, controls, alarms, and support systems) as supplied by the utility company. Such system shall be provided complete with all necessary automatic starting equipment, transfer switch, fuel tank, supply and return fuel oil piping, exhaust system/silencer, generator output circuit breaker, and all other necessary appurtenances for complete and operable system.

Recommended generator & switch-gear manufacturers are included within the equipment listing of Appendix A. Additional detailed requirements are also included within the guide specifications of Appendix C and the guideline detail drawings of Appendix D.

4.7.1 Siting Location

The generator shall be housed in a weatherproof enclosure. Such enclosure shall be provided as part of the unit by the manufacturer for all above-ground locations. Such enclosures shall have venting with screens for radiator cooling and otherwise be fully enclosed without gaps or holes to protect the generator from rodents, birds, and swarming insects. For under-ground locations the generator shall be installed within a leak proof underground vault designed to protect the unit from outside elements. Such vault shall be reinforced concrete (pre-cast or cast-in-place) with watertight access hatches, appropriate ventilation, and the generator shall be installed on a housekeeping pad with the vault's floor sloped for drainage the same as valve vaults.

Generator engines shall be diesel powered unless otherwise approved by MSDGC; natural gas may be considered suitable for certain situations. They shall be liquid cooled by means of a unit mounted radiator and engine driven fan. Engine exhaust systems shall be provided with mufflers and must meet local noise ordinance levels for outdoor equipment. The engine shall have a 12 volt DC negative ground battery powered electrical system, a 60 ampere or larger alternator driven by belts from the engine to charge the battery when the engine is running. They shall be equipped with engine block heaters and battery chargers both powered by the main pump station control panel.

Generators shall be sited with a minimum 3-foot clearance on all sides for maintenance access including assurance that all access panels can be fully opened. They shall also be sited so the radiator and engine exhaust are pointed away from the station wet well and control panel. Generators shall be set on a reinforced concrete pad of no less than 6-inch thickness and the pad shall be designed to support five times the weight of the generator and extend at least 6-inches beyond the generator on all sides.

Generators shall include a fuel tank with sufficient fuel storage capacity to run the generator for at least 36 hours at 100% load.

4.7.2 Transfer Switch

An automatic transfer switch shall be furnished and installed in the pump control panel to switch the power supply from the normal power lines to the standby electric generator. Transfer switches incorporating circuit breakers or off time transition shall not be acceptable. The automatic transfer control shall be listed by Underwriters Laboratories to Standard 1008 and to the applicable sections of the National Electrical Code.

The complete automatic load transfer control shall be rated for continuous duty and for all classes of load. The ampere rating of the transfer switch shall be sufficient to handle the capacity of the loads being transferred. The controls and components shall be compatible with the electrical requirements of the standby system. The transfer switch shall be mechanically interlocked so that it shall not be possible for the load circuits to be connected to the normal and emergency sources simultaneously.

A local instrument and control panel shall be furnished and installed on the engine generator set to monitor and control the generator system. This panel shall be a microcomputer type and shall be mounted on the generator by means of vibration isolators.

4.7.3 Generator Type

The generator shall be four pole, brushless revolving field, 12-lead reconnectable, self ventilated of drop proof construction with full amortisseur windings, including brushless rotating exciter and temperature compensated solid-state voltage regulator including under frequency protection.

Voltage regulation shall be within plus or minus two percent of rated voltage, from no load to full load. Upon application of full rated continuous load in one step, transient voltage dip shall be less than 20 percent with recovery to stable voltage within 2 seconds. Stable or steady state operation is defined as operation with terminal voltage remaining constant within plus or minus 1 percent of rated voltage. Manual voltage adjustment range shall be within plus or minus 5 percent of rated voltage. Temperature rise shall be within ratings as defined by NEMA, IEEE, and ANSI standards.

4.8 Materials, Installation, and Testing

4.8.1 Piping

Each pump shall be provided with separate suction and discharge piping systems. The pipe and fittings shall have a minimum of 12-inches clearance from any wall or floor and there shall be a minimum 30-inch clearance between the piping of each pump. All fittings inside pump station and through the emergency pump connection shall be flange joint ductile iron fittings. Station designers must provide appropriate restraining joints for all piping.

Detailed piping material requirements are included within the guide specifications of Appendix C and the guideline detail drawings of Appendix D.

4.8.2 Testing

Testing shall comply with the requirements of the technical specifications, MSDGC Rules and Regulations, and the Ohio Plumbing Code.

Section 5

Standard Specifications

Specifications listed are provided for both above ground and below ground pumping stations. Both stations use submersible pumps. The primary difference between the two station types is that the Standby Diesel-Engine Generator for the above ground station is located on a slab at grade and for the below ground pumping station the Packaged Engine Generator System is located below grade, in a concrete vault. The designer will need to select and edit the appropriate specifications. A given project may require specification sections in addition to those listed.

5.1 Pumping Station Specifications

DIVISION 1 – GENERAL REQUIREMENTS [see Div I Template for specifications]

- 01 11 00 Summary of Project
- 01 12 16 Construction Sequence
- 01 14 00 Control of Work
- 01 20 00 Measurement and Payment
- 01 26 00 Contract Considerations
- 01 31 19 Project Meetings
- 01 31 21 Site Safety Plan
- 01 32 16 Construction Progress Schedule
- 01 33 00 Submittals
- 01 33 19 Reference Forms
- 01 42 19 Applicable Codes
- 01 45 29 Testing Laboratory Services
- 01 60 00 Delivery Storage and Handling
- 01 66 00 Material and Equipment
- 01 71 23 Field Engineering
- 01 71 33 Restoration of Improvements
- 01 73 29 Cutting and Patching
- 01 74 00 Cleaning
- 01 75 00 Commissioning Requirements and Sequence
- 01 75 01 Equipment Factory Acceptance Testing
- 01 75 02 Equipment Startup and Checkout

01 75 03 System Functional Testing

01 75 04 Process Performance Testing

01 75 05 Operational Testing

01 75 06 30-Day Commissioning Reliability Test

01 77 00 Contract Closeout

01 77 19 Substantial Completion

01 78 23 Equipment Operating and Maintenance Manual Information

01 78 36 Manufacturer Product Warranties

01 78 39 Record Documents

01 78 43 Spare Parts and Maintenance Materials

01 79 00 Training

DIVISION 2 – EXISTING CONDITIONS [see Pump Station CSI Template for Div. 2 thru 43 specifications]

02 41 13 Pump Station Demolition and Abandonment

DIVISION 3 – CONCRETE

03 10 00 Concrete Formwork

03 20 00 Concrete Reinforcement

03 30 00 Cast-In-Place Concrete

03 40 00 Precast Concrete

DIVISION 5 – METALS

05 05 00 Welding

05 05 13 Hot-Dip Zinc Coating

05 05 23 Anchor Bolts and Anchors

05 50 00 Metal Fabrications

05 53 00 Grating and Ladders

DIVISION 9 – FINISHES

09 91 00 Painting

DIVISION 10 – SPECIALTIES

10 14 00 Signage

DIVISION 23 – HVAC

Section 6

Standard Details

6.1 Standard Drawings

The Developer's design engineer shall utilize the following drawings as a sample for the development of their design drawings for submittal to MSDGC.

1 COVER

2 MATERIALS LIST

3 ABOVE GROUND PUMP STATION WITH BACKUP GENERATOR

4 BELOW GROUND PUMP STATION WITH BACKUP GENERATOR

5 CHAMBERS

5A CHAMBERS WITH DUAL FORCE MAIN

6 FLUSHING STATION

7 DETAILS - 1

8 DETAILS - 2

9 PUMP CONTROL PANEL WIRING SCHEMATIC

10 PUMP CONTROL PANEL LAYOUT AND INTERCONNECT DIAGRAM

11 GRINDER CONTROL PANEL WIRING SCHEMATIC

12 GRINDER CONTROL PANEL LAYOUT AND INTERCONNECT DIAGRAM

Appendix A: Equipment Manufacturers List

A-1. Equipment Manufacturers List

Table A-1 identifies viable equipment manufacturers. A manufacturers listing in this table does not guarantee that a given manufacturer's standard products are suitable for all applications. Design Engineers shall edit the project specifications to only list those with products suitable for a given application. In case of conflict between this list and the manufacturers named in the technical specifications, the specifications shall prevail.

Table A-1. Equipment Manufacturers List

Specification Section	Title	Manufacturers
33 32 19	Access Hatch	Halliday H2W or Bilco JD-2ALH20
33 32 19	Check Valves	American AVK
05 53 00	Access Hatch Ladder	Bilco LU-3 Stainless or LU-4 Aluminum
26 27 16	Electrical Cabinets & Enclosures	Hoffman NEMA 4X SS compliant cabinets
26 32 13	Packaged Engine Generator System	Caterpillar, Cummins/Onan, Kohler
26 36 24	Transfer Switch	Kohler, ASCO, Caterpillar, or Cummins
33 90 36	Force Main Air Release Valves	Vent-O-Mat
40 91 19	Submerged Level Transmitter	GE Druck PTX 1290
40 91 42	Optic Float Level Detection System	Cox Research & Tech Inc – Model TR2 dual transceiver & model F1 Opti-float
43 21 39	Submersible Pumps	Ebara, Fairbanks Morse, Flowserve, KSB, or ITT Flygt
43 21 39	Submersible Pump Motors	Same as pump manufacturers

Appendix B: Pump Station Design Checklists

Section 7

B-1. Design Flow

Design Engineers shall size pumping stations, per Sizing Standards.

Table B-1. Design Flows

STATUS	REQUIREMENT	COMMENTS
	Service Area	
	Planning (build-out) period	
	City Approval	
	New Development Flow Tributary area Number of households Estimated inch-miles of tributary sewer Residential Average Flow Peak Factor Peak Flow	
	Existing (metered/modeled) Flow Average Flow Peak Factor Peak Flow	
	Total Flow Average Flow Peak Factor Peak Flow	
	Special sewage constituents	
	Emergency Protection and Relief Lowest MH rim elevation Lowest building sanitary sewer service Relief structure discharge elevation	

B-2. Pump Station Design

Design Engineers shall specify pumping stations parts per Station Guidelines.

Table B-2. Station Design

STATUS	REQUIREMENT	COMMENTS
	Submersible style pumping station with redundancy	
	Above vs. Below ground generator & controls	
	Wet Well sizing Dimensions Volume Rim Invert Influent Pipe – size & invert – submerged Fillet grouting Coating(s)	
	Pump Selection – pump & system curves included No. 1: __________gpm @ _______ft. TDH; _______ HP No. 2: __________gpm @ _______ft. TDH; _______ HP No. 3: __________gpm @ _______ft. TDH; _______ HP Pump manufacturer & model(s) for basis of design Pump & motor Weight Disconnect method RPM Power – 480 VAC Starter (soft-start & reduced hammer stop) Other features Submerged intake	
	Control Elevations High wet well alarm EL__________ Depth _______ ft All pumps on EL__________ Depth _______ ft Lag pump on EL__________ Depth _______ ft Lead pump on EL__________ Depth _______ ft All pumps off EL__________ Depth _______ ft Low wet well alarm EL__________ Depth _______ ft	
	Detention Time Between “Lead pump on” and “All pumps off” at ADF ____________ min; starts per hour PHF ____________ min; starts per hour Between “All pumps off” and “High Wetwell Alarm” at PHF _____________min; starts per hour	

Table B-2. Station Design		
STATUS	REQUIREMENT	COMMENTS
	Station Piping & Valves Pipe material & size Valve material & size Surge relief valves Check valves (in the horizontal)	
	Electrical Control Equipment Level Monitoring Device(s) Levels Monitored with SCADA Telemetry Device(s) Control Switchgear Alteration of lead-lag pumps	

B-3. Station Site Design

Design Engineers shall ensure sufficient space on-site for all required MSDGC items.

Table B-3. Station Site Design

STATUS	REQUIREMENT	COMMENTS
	Sanitary Sewer Pumping Station Configuration Influent MH Wet Well FM Discharge Valve Vault	
	Bypass pumping connectivity	
	Wet Well pump hoist Hoist type Load rating Reach (horizontally & vertically) away from wet well	
	Main power source & controls Transformer size & location Control Cabinet Transfer Switch Housekeeping pads & clearance(s)	
	Generator & controls Manufacturer & model for basis of design Physical size – dimensions Power rating Fuel source & tank size Housekeeping pad(s) Above ground – housing, color, exhaust, & clearance(s) Below ground – exhaust, clearances, & vault structure including watertight hatch & sloped floor	
	Fencing & Security Lockable gate sufficient for vehicle access Lockable structures & cabinets where no fencing	
	Drive-able Access	
	Land/easement acquisition identified	
	Odor Control	
	Flow Measuring/Metering	
	Force Main Design Single vs. Double barrel Pipe size, type, & profile Isolation Valving & emergency pump-out availability Air Release & Vacuum Relief	
	Underground Structure Design Watertight including hatches Ventilation Buoyancy	

Table B-3. Station Site Design		
STATUS	REQUIREMENT	COMMENTS
	Sloped floors and/or sumps for drainage	
	Identification of Space Classifications NFPA, OSHA, Explosion Proof, etc…	
	Electrical Conduit and Cable material type & size Routing Diagrams Electrical Site Plan Lighting – exterior and below ground deep structures Receptacles	

Appendix C: MSDGC Guide Specifications

(SEPARATE COVER)

Appendix D: MSDGC Standard Details

(SEPARATE COVER)