Duckett Creek Sanitary District

Pump Station Design Requirements
(PSDR)

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PUMP STATION DESIGN REQUIREMENTS

(PSDR)

INTRODUCTION

To provide efficient, cost effective, reliable service to the customers of Duckett Creek Sanitary District (the "District"), regional sanitary sewage pump station or low-pressure sewer systems (LPSS) shall only be permitted where the District believes that a thorough study of all alternatives indicates a gravity wastewater system is not practical or feasible.

Prior to the project design, it is the responsibility of the design engineer to contact the District's engineering supervisor to determine the following:

1. Will the District allow construction of a pump station or LPSS?
2. Are there additional requirements due to project location, pump station size or force main size?
3. Does the design have the latest specification revision?

The following are general guidelines and standard specifications for regional pump stations to be installed within District's service area. These specifications are to serve as a supplement to the District's Standard Construction Specifications.

The District, may from time to time, revise these guidelines and specifications. It is the responsibility of the design engineer to contact the District's engineering supervisor, prior to beginning the pump station design, to obtain the current version

SECTION 1 - PLAN REVIEW SUBMITTAL REQUIREMENTS

An electronic copy of the following shall be submitted to the District's engineering supervisor for review of any proposed pump station. Incomplete submittals will not be reviewed by the District.

Comments and questions from the District's review will be provided to the design engineer. A construction permit will not be issued by the District for any portion of a wastewater collection system that requires a pump station until a construction permit has been issued for that pump station.

1.1 PUMP STATION DESIGN REPORT

A pump station design report prepared by a professional engineer registered in the State of Missouri shall be electronically submitted to the District in in the following format:

A. Title Page

1. Project Name
2. Date
3. Name and contact information of developer/owner
4. Engineering firm preparing plans and calculations
5. Design engineer's seal

B. Sewer System Information

1. Introduction
   - Type, location and size of development.
   - Number of and range in size of lots or buildings to be serviced.

2. Existing Wastewater Facilities
   - Location and type of wastewater system to which the force main will discharge.

3. Future of Wastewater Facilities
   - Describe in words and map(s) how the proposed wastewater facilities will accommodate any project phasing. State whether the entire development will be serviced by the proposed phase or if several phases will be involved.
   - State the number of lots this phase will encompass initially and finally (if future phases are to be constructed).
   - State whether other areas outside of the development may be tributary to the pump station.

C. Pump Station and Force Main Design Calculations (see Section 2)

D. Detention Pipe Design Calculations
Structural calculations verifying that the minimum pipe materials specified in Section 4 are adequate.

E. Design Summary

1. Average Daily Flow

2. Peak Daily Flow

3. Volume for 12-hour detention or detention volume with generator backup

4. Static Head

5. Total Dynamic Head, GPM and efficiency at the pump's operating point

6. Selected Pump Manufacturer's Information: model number, type, horsepower, RPM, voltage and phase.

7. Average Daily Flow Cycle Times:
   Pump On
   Pump Off

8. Peak Daily Flow Cycle Times:
   Pump On
   Pump Off

9. Force Main Size, Material, Type or Class and Length

10. Force Main Velocity at the pump's operating point

11. Force Main Test Pressure – This test pressure value shall be 1.5 times the pump shut-off pressure. The pressure value shall be clearly indicated on each force main profile sheet as "FORCE MAIN TEST PRESSURE".

F. Manufacturer's Specifications and Cut-Sheets

1. The manufacturer's specifications and cut sheets for the pumps and equipment shall be included in the back of the pump station design report booklet

2. The manufacturer's cut sheets shall be marked to identify the applicable items selected.

3. Specifications and performance curves shall be included for each pump proposed by the design engineer.

4. The pump performance curves included with the pump information shall have the worst case and best case system TDH curves plotted on them. See Section 2.2 for the plotting instructions.

1.2 FLOODPLAIN STUDY

The pump station shall be designed to remain both accessible and operational during a 1-percent-chance flooding event. The pump station shall be protected from damage during a 1-percent-chance flooding event. A flood study shall be required to define physical access, operational capacity, and reasonable protection of the proposed pump station during a 1-percent-chance flooding event.

1.3 DESIGN DRAWINGS

The design drawings shall be individual 24"x36" design plan sheets. Each sheet must indicate the project name and be sealed by a professional engineer registered in the State of Missouri.

A. Cover Sheet (when submittal is separate from site improvement plans).

B. General Site Plan (minimum 1" = 50' scale)

1. U.S.G.S-Referenced Datum

2. All buildings and/or residences with top of foundation (TF) and basement floor (BF) elevations noted.

3. All sanitary sewers and storm sewers with their manholes identified.

4. All street right-of-ways.

C. Pump Station Plan (minimum ¼" = 1' scale)

1. All areas of access, fencing, and pavement surrounding the pump station.

2. Location and size of all storm and sanitary sewers. Also show all existing water, gas, communication, and electric lines located in or near the pump station easement.

3. Location of wet well, valve chamber and detention tanks.

4. Location of all pump station appurtenances (e.g., control panels, generators, transfer switches, phase converters, etc.).

5. Details for proposed landscaping affecting the immediate area surrounding the pump station site including the future expanded driplines of trees and shrubs.

6. Property information indicating pump station ingress, egress, and utility easements.

7. All adjacent property lines and property ownership information.

8. All existing and proposed utility easements.

D. Force Main Plan and Profile (minimum 1"=20' scale horizontal and 1"=10' vertical)

1. Identify the force main size, pipe material and overall length.

2. Locate force main appurtenances (e.g., clean-outs, tracer wire access points, combination air/vacuum release valves, etc.). The distance between each appurtenance shall be indicated.

3. Locate mechanically restrained joints or thrust blocks (if needed) at angle points. Also indicate the number of restraining joints required both upstream and downstream from any angle point.

4. Show the force main test pressure on each profile sheet.

E. Gravity Sewer Profiles (minimum 1" = 20' scale horizontal and 1" = 10' vertical)

1. Provide a profile of each sanitary sewer reach showing the top and flow line elevations at each manhole. Also indicate the lowest finished floor connected to the proposed wastewater system.

2. Indicate the pipe size, length, and slope of each reach.

3. Provide a profile of each detention tank.

F. Pump Station Structure Sheet (minimum ½" = 1' scale)

The purpose of this sheet is to provide an accurate, complete, and uncluttered drawing to aid the fabrication foundry in the manufacture of the structure. As such, only include measurements and information required for this purpose.

1. Plan and section view of the wet well and valve chamber to the scale of the pump station structure sheet.

2. In the section view, show the elevations of the:
   - Top of structure
   - Bottom of structure
   - Sanitary sewer inlet flowline
   - 8" D.I.P. detention pipe flowline

3. Detail of the wet well and valve chamber hatch casting with the exact location of hatches and hatch hinges.

4. One detailed joint section shall be included. The pre-cast manufacturer shall determine actual joint elevations.

5. Two sectional detail views of the chamber tie walls (one from the pump chamber side and one from the valve chamber side).

6. On pre-cast stations, gravity lines must have their angles of entry into the structure included. Also provide a description or detail of the pipe-to-structure joint.

7. Miscellaneous Details:
   - Corbel
   - Valve chamber side wall electric conduit entry
   - Tie wall pump cable opening
   - Tie wall valve chamber drain opening

G. Pump Station Mechanical Sheet (minimum ½" = 1' scale)

1. Plan and Section view of the wet well and valve chamber to the scale shown above.

2. In the section view, show the elevations of the:
   - Top of structure
   - Bottom of structure

- Sanitary sewer inlet flowline
- Detention pipe flowline
- Float elevations
  - Pump off
  - Lead pump on
  - Lag pump on
  - High level alarm

3. Show the pump station piping and force main piping transition outside the structure.

4. Show adjustable cradle jack valve supports.

5. Miscellaneous Details:
   - Control panel plan and profile
   - Valve chamber drain
   - Wet well pipe support

H. Electrical Plans and Details

1. Electrical plans are only necessary when the proposed station requires one or more of the following electrical equipment:
   - Generator
   - Variable frequency drives
   - Dual electrical power source
   - Single phase to three phase power converter

2. When electrical plans are required, begin with the Pump Station Site Plan (minimum 1/4"=1' scale)

3. Electrical plans shall include the following:
   - Conduit and wire sizes
   - One-line schematic
   - Notes referencing documents where detail information is available on each of the major pieces of electrical equipment.

I. Miscellaneous Details

1. Provide a sheet that will contain details on items such as:
   - Force main clean-outs
   - Combination air/vacuum release valve chambers
   - Valve junction boxes
   - Force main taps
   - Fencing
   - Entrance gates

J. Pump Station Design Requirements

The DSCD will provide a computer file of these Pump Station Design Requirements in pdf format upon request. Modifications may be required to this sheet for specific projects. All changes to the Standard Sheet shall be noted in bold.

If the design engineer elects to not to use the District's standard construction drawings, all design requirements and specifications in Sections 3 through 10 of the manual shall be included in the construction plans prepared by the design engineer.

SECTION 2 - PUMP STATION AND FORCE MAIN DESIGN CRITERIA

2.1 METHODOLOGY FOR DETERMING DESIGN FLOWS

A. Residential Development Area

1. Population Equivalent
   Nb = Number of single-family residence specified types of buildings
   Np = Number of persons per unit = 3.7
   PE = Population Equivalent = Nb x Np = 3.7 x Nb

2. Average Domestic Flow
   F = Population Equivalent Flow = PE x 100 (galllons/person/day)

B. Non-Residential Development Area
The average daily flow (excluding infiltration) for non-residential development areas (F) shall be based on one of the following:

1. Actual Water Use Records of like facilities

2. The current Rules and Regulations of the Department of Natural Resources Division 20, Clean Water Commission, Chapter 8. Design Guides (10CSR 20-8.021(11)(B)3).

3. Industry Standards

C. Future Development
In designing all components of the pump station and force main, consideration shall be given to the potential need to expand or modify the facility to accommodate the future development of areas tributary to the station. As a minimum the following items shall be considered.

1. The valve chamber and wet well shall be sized to accommodate the ultimate pump and valve equipment requirements.

2. The ultimate flow shall be considered in selection of the pumps.

3. The ultimate flow shall be considered in sizing the force main.

4. The ultimate storage requirement shall be considered in the configuration of the detention pipes to allow for future expansion. Adequate area adjacent to the detention pipes shall be provided to allow for this expansion.

D. Infiltration
The infiltration flow amount (I) shall be determined for the:

1. Gravity system

2. Detention chambers

3. Piping from detention chambers to wet well
   Where:

   I = Piping diameter (inches) x piping length (miles) x 200 (gallons/inches-diameter./mile/day)

For proposed pump station that will serve areas with existing gravity sewers, the District may require an infiltration rate greater than the 100 gal./dia./mi./day. The design engineer should contact the District prior to submittal to determine if a greater rate is required for the service area of the proposed pump station.

E. Average Daily Flow

ADF (GPD) = F + I
ADF (GPM) = ADF (GPD) / 1440 (minutes/day)

F. Peak Daily Flow

PDF (GPD) = 2.5 x ADF (GPD)
PDF (GPM) = 2.5 x ADF (GPM)

The use of a peak factor of 2.5 is due to the safety factor provided by the 12-hour detention requirement.

2.2 PUMP SELECTION DESIGN

The design engineer shall select from acceptable manufacturers (see Section Five), the most efficient pump capable of accommodating the station's peak daily flow (PDF). Use the following procedure to make these determinations. Operating efficiency shall be the primary consideration when selecting the recommended pump.

A. Total Dynamic Head (TDH)
TDH (feet) = Static head plus friction losses in force main and station piping = HS + Lf + Ls

1. Static Head (Hs)
Eh = Maximum force main elevation
E1 = Wet well low water elevation (Pump Off)
E2 = Wet well absolute highest water elevation
Worst case static head Hsw (feet) = Eh – E1
Best case static head Hsb (feet) = Eh – E2

2. Loss (Lf) from friction in force main
Length = Total equivalent length of force main pipe, valves and fittings (feet)
Lf (feet) = Length x Friction Factor/100

Where Friction Factor = Friction head loss (feet) per 100' pipe = 0.2083 x (100/C)^1.85 x Q^1.85/d^4.8655 (Hazen-Williams)

Where d = inside diameter of pipe (inches), C = C-Factor (see 4. below) and Q = FLOW (GPM)

3. Loss (Ls) from friction in the station piping
Length = Total equivalent length of the station piping, valves and fittings (feet).

4. The following Hazen-Williams C-Factors shall be used for computation of friction losses:

- The worst-case system design shall be used for determining the pump operating point or Constant Speed Rating (see definition of CSR in B. below):

  Plastic and lined DIP (C=120)

- To check the pump motor does not overload after installation, use the best-case system design C-Factor:

  Plastic pipe: (C=150)

5. TDH (feet) = Hs + Lf + Ls

   Plot a worst case TDH curve and a best case TDH curve on a manufacturer's pump performance curve sheet. The worst-case curve begins with the worst-case static head (TDH = Hsw) at Q = 0 and increases with friction losses determined by using the lower C-Factors in 4 above.

   The best-case curve begins with the best-case static head (TDH = Hsb) at Q = 0 and increases with friction losses determined by using the higher C-Factors in 4 above.

   A minimum of four flow rates shall be used to plot each curve.

B. Constant Speed Rating
The Constant Speed Rating (CSR) or the pump's operating point is the point where the worst case TDH and the pump manufacturer's pump performances curves intersect.

C. Pump Motor Overload Check
Find where the best case TDH and the pump manufacturer's pump performance curves intersect and check the pump is not in an overloaded condition.

D. Cycle Times - General
The volume (Vr) of water required to raise the level in the wet well for the primary pump to turn on:

1. Elevation difference (E5) between primary Pump On elevation (E3) and Pump Off elevation (E4), i.e. E5 (feet) = E3 – E4

2. Volume (Vpf) of water per vertical foot in the wet well: A = the inside area of the wet well (sq. ft.)
   Vpf (gal./ft.) = A x 7.481 (gal./cu.ft.)

3. Vr (gal.) = E5 x Vpf

E. Cycle Time for ADF

1. Time (Tf) required for volume in wet well to reach Vr (Pump Off)
   Tf (min.) = Vr/ADF (GPM)

2. Time (Tp) required for pump to return water level to the pump off elevation (Pump On)
   Tp (min.) = Vr/(CSR-ADF)

4. Because the pumps alternate in a duplex station, after a pump turns off it remains off until the wet well fills (Tf), the second pump lowers the wet well level (Tp), and the wet well fills a second time or T off (min.) = 2 x Tf + Tp. Therefore, the Total Cycle Time Tc for one pump is:

   Pump On for Tp plus Pump Off (Toff) or Tc (min.) = 2 x (Tf + Tp)

F. Cycle Time for PDF

1. Tf (min.) = Vr/PDF (GPM)

2. Tp (min.) = Vr/(CSR – PDF)

3. Tp (min.) = 2 x Tf + Tp)

2.3 STORAGE REQUIREMENTS

A minimum detention of 12 hours is required for all pump stations having an Average Daily Flow of 75,000 gpd or less. The District, on a case-by-case basis due to site restrictions or other considerations, may reduce the amount of the detention required for larger pump stations. Requests for variance shall be submitted in writing with justification provided.

A. 12-Hour Storage Volume Requirements:
The volume of the detention Chambers in gallons (Vs) is:
Vs = ADF (GPD) x 1 Day = Cylindrical Volume of detention chamber pipe used.

The volume of the incoming gravity lines or wet well shall not be considered in sizing of the eight-hour storage. Only the volume of the detention chambers shall be used.

B. Less 75,000 GPD Average Daily Flow
A minimum detention of at least 12 hours is required for all pump stations with average daily flows of 75,000 gpd or less. Generators or alternate power sources will not be considered in lieu of 12-hour detention chambers.

C. 75,000 GPD or more Average Daily Flow
For pump stations with average daily flows more than 75,000 gpd, the District will require 12-hour storage plus a secondary power source.

NOTE: The lowest development elevation shall be above the elevation of the highest point of the detention chamber plus two (2) feet.

2.4 BUOYANCY CALCULATIONS

The buoyancy potential of the pump station structure and the detention pipe(s) shall be analyzed to ensure that flotation of the structure and detention chambers will not occur.

Ww = Weight of concrete wet well
Wf = Weight of concrete bottom slab
We = Weight of earth backfill on footing
Wt = Ww + We + Wf (or weight of detention chambers and backfill overburden)
Ws = Weight of displaced water
Wt = Shall be greater than Ws

2.5 FORCE MAIN DESIGN

At design average daily flow, a minimum cleansing velocity of two feet per second shall be maintained with maximum velocity not to exceed eight feet per second.

SECTION 3 - STRUCTURE REQUIREMENTS

3.1 DESIGN CRITERIA

All reinforced concrete structures shall be designed using the Working Stress Method. At a minimum this includes the wet well, valve chamber, and control panel pad. The structures may be either pre-cast or cast-in place as approved by the District.

3.2 JOINING CHAMBERS

The valve chamber shall rest on a haunch poured integral with the wet well walls. Both chambers shall be tied together with a minimum of two (2) threaded tie bolts. The design engineer shall specify the bolt diameter and material strength. Bolts are

to be eighteen inches (18”) down from the top of structure. For top slab thickness greater than 12 inches, place the bolts down six inches (6”) from bottom of top slab.

One-half inch (½”) thick 6” x 6” backing plates shall be used as washers on each end of the tie bolts. Both structure tops shall be at the same elevation separated by a one-inch (1”) square flexible rubber mastic sealant placed along the perimeter of the valve chamber where it meets the wet well. The tie bolts and the 6” x 6”. Backing plates shall be stainless steel.

3.3 ACCESS HATCHES

Access hatches shall be cast in the top sections of each chamber. The hinged side of the valve and pump chamber hatches shall be located on the walls opposite from each of their respective common tie walls. For valve chambers requiring double hatch doors, the hinges shall be placed on the common wall and the wall opposite the common wall. Hatch specifications are provided in Section 6.6.

All access hatches shall include an integrated District-approved orange safety grate for open hatch fall protection.

3.4 ACCESS OPENINGS

In addition to the openings for the incoming gravity lines and pump discharge lines, the following accesses are required:

- A six-inch (6”) hole shall be centered in the valve chamber tie wall, 20 inches from the structure top. A four-inch (4”) SCH40 DWV PVC coupler shall be cast in the center of the wet well tie wall and centered on the valve chamber six-inch (6”) hole. After the two chambers have been tied together, a four-inch (4”) PVC stub shall be glued in the coupler on the valve chamber side through the six-inch (6”) hole. The space between the pipe and the chamber walls shall then be filled and sealed with grout. This opening will be used for power and control wire passage between chambers.

- A six-inch (6”) hole shall be centered at the bottom of the valve chamber floor in the tie wall. A four-inch (4”) PVC coupler shall be cast in the wet well tie wall and centered with the valve chamber six-inch (6”) hole. After the two chambers have been tied together, two (2) four inch (4”) PVC stubs shall be glued into the coupler on each side of the tie wall. These stubs will be used for the valve chamber drain piping.

- Two two and one-half inch (2-½”) holes shall be placed on each side of the valve chamber sidewalls, eighteen inches (18”) from the tie wall and eighteen inches (18”) from the top of the structure. For a top slab thickness greater than ten inches (10”), place the two and one-half inch (2-½”) holes down eight inches (8”) from bottom of top slab. A two and one-half inch (2-½”) PVC coupler shall be cast in each hole. One of the openings is to be used for the power and control wires from the panel board. Two openings are provided for flexibility. The opening not used shall be stubbed and capped with a piece of two and one-half inch (2-½”) PVC.

3.5 VALVE CHAMBER FLOOR

The valve chamber floor shall be sloped with a three-sided invert towards the four-inch (4”) drainpipe using a two-inch (2”) fillet. Gravity pipes, detention pipes and electrical conduits may not be run beneath the valve chamber.

3.6 VALVE SUPPORTS

Valve chamber piping shall be supported as follows:

- After discharge piping and valves have been installed in the valve chamber an adjustable pipe cradle jack shall be under the valves and tee, so that they have a ten-inch (10”) clearance between the floor and valve flanges. The supports shall be firmly bolted to the valve chamber floor.

- A second adjustable pipe cradle jack shall be placed against the back of the discharge tee and then bolted to the common chamber tie wall to prevent piping thrust movement. The thrust jack shall be shown on the valve chamber plan drawing.

3.7 ENTRANCE LADDER

Wet well entrance ladder shall be per the District's Standard Construction Specifications. Entrance ladder shall be located as follows:

- Entrance ladder shall not be placed in front of incoming gravity lines.
- Entrance ladder shall not be located under or next to any obstructions.
- Entrance ladder should provide a clear-in-line visible unobstructed access from the top of the chamber to the bottom of the station.
- Entrance ladder shall be placed on the station sidewalls closest to the control panel, approximately in the center of the hatch cover.

3.8 DETENTION CHAMBER(S)

Detention shall be installed below ground with an access manhole(s) located at the upstream end. The connection between the detention chamber(s) and the wet well wall shall be made with an 8" minimum ductile iron pipe. The detention tank shall be a dedicated system; it may not be used as part of the gravity system. The detention tank and connecting line shall be laid with a minimum 1% slope.

3.9 CHAMBER SIZING

The pump station wet well and valve chamber shall each be sized as noted. Access hatches shall be correspondingly sized to the chosen structure size.

VALVE CHAMBER		WET WELL	
Inside Area	Access Hatch Size	Inside Area	Access Hatch Size
5' X 5'	60" X 60"	5' X 5'	48" x 60"
6' x 6'	72" x 72"	6' x 6'	48" x 72"
7' X 7'	84" X 84"	7' X 7'	60" X 84"
8' X 8'	84" X 84"	7' X 7'	60" X 84"

To prevent the possibility of the valve chamber pulling the top section of the wet well off of the joint, a poured counter-weight is required to offset the mechanical level arm tipping force. The counter-weight shall be monolithically poured at the bottom of the upper-most wet well section opposite of the valve chamber tie wall. Size and weight of the counter-weight shall be shown on the plans.

3.10 CONTROL STRUCTURE PAD

The control structure concrete pad shall be a minimum of four inches (4") thick, reinforced with 8 gauge, 6 x 6 welded wire mesh. The concrete shall have a well-compacted 4" stone base (minimum).

The pad shall be poured next to the pump station, parallel to the length of the station structure and centered between the two chambers. Pad dimensions shall be 6' x 11'-4".

3.11 MISCELLANEOUS ITEMS

A. Incoming Manhole Placement
A manhole shall be placed on the gravity line approximately 20 feet from the pump station structure.

B. Detention Chamber Placement
The eight-inch (8") pipe joining the detention chamber(s) and the pump station shall be no less than 20 feet in length.

C. Bulk heading
Bulk heading of the detention chamber shall be completed with a pre-cast bulkhead.

D. Construction Tolerance of Wet Well
The wet well shall be installed so that it is no more than 3 inches per 25 vertical feet out of plumb.

E. Connection of Gravity Pipe to Structures
All incoming gravity lines and discharge piping will have a "Z-lok" or "A-lok" type compression fitting cast-in place where the piping passes through the valve and wet well chamber walls. The maximum angle of deflection allowed for pipe gaskets is as follows:

- "Z-lok" = 25 degree
- "A-lok" = 7 degree

All piping outside diameters shall be located a minimum of one foot above or below structure joints.

F. Top of Wet Well and Valve Chamber
The top elevation shall be six (6") inches higher than the surrounding ground elevation. Surrounding ground shall be sloped away from the structure for proper drainage.

SECTION 4 - PIPING AND VALVES

The following specifications shall be used for installation of the pump station piping and valves. Flanged piping shall be the acceptable means of connecting piping and valving.

All pipes must enter the structure walls with a one-foot minimum clearance from the outside face of the pipe to the face of the adjoining wall to allow for proper pipe gasket alignment.

4.1 DISCHARGE PIPE MATERIAL

A. From the individual pump discharge bases through the header tee to a point a minimum of four feet (4') outside the structural wall, the following materials shall be used:

1. Four Inch (4") Diameter and Above
   - Flanged: Ductile iron pipe Class 53 ANSI A-21.51 (AWWA C-151). All bolts and nuts for flange connections shall be 304 stainless steel (minimum). All flange gaskets shall be full-face 1/8" thick red rubber.

2. Three inch (3") Diameter:
   - Solvent-Weld Installation: ASTM 1785 Schedule 80 PVC.

3. Two Inch (2") and Two and a half (2 ½") Diameter:
   - Solvent-Weld Installation: ASTM 1785 Schedule 80 PVC.

B. The following materials shall be used for the force main from a point four feet (4') outside the chamber wall to the discharge manhole:

1. Four Inch (4") Diameter and Above:

- AWWA C-900 PVC Class 150
- Ductile iron pipe Class 52 ANSI A-21.51 (AWWA C-151)
- AWWA C-909 PVCO (for pipes 4-inch through 12-inch)
- AWWA C-905 PVCO (for pipes 14-inch through 48-inch)

2. Three Inch (3") Diameter:
   - PVC pipe meeting AWWA C-900 PVC Class 150 with integral bell and gasket joint design meeting the requirements of ASTM D3139 and F477, minimum pressure class shall be PC 150.
   - Ductile iron pipe Class 52 ANSI A-21.51 (AWWA C-151).

   All ductile iron pipe and fittings shall have polywrap in accordance with AWWA C-105 and be installed per AWWA C-600.

4.2 FORCE MAIN REQUIREMENTS

The following elements shall be included in the force main system design:

A. Air Relief / Vacuum Valves (ARV)
Automatic combination vacuum/air relief valves shall be placed at high points in the force main as required. Refer to the District's Detail FM-2 for additional information.

1. **Acceptable Manufacturer:** ARI Model D-025 NS (minimum standard).

2. On valves other than A.R.I. model D-025, the body of the ARV shall be supported to the wall of the structure by a 1-¼" x 1-¼"x ⅛" stainless steel angle bracket (or as approved by the District).

B. Connection to Gravity System
Force mains shall discharge to the gravity sewer system at a manhole. The point of connection shall be no more than one foot above the flow line of the receiving manhole.

C. Existing Gravity Manhole Rehabilitation
The sides and bottom of the force main discharge manhole and a minimum of five (5) downstream manholes from the point of connection shall be lined with a solventless, 100% solids, corrosion resistant epoxy coating or a lining having multiple, structural fiberglass layers with a non-porous diaphragm bonded between layers of fiberglass and molded to the existing structure. See acceptable manufacturers below.

D. New Manhole Construction
When a new manhole is to be constructed at the point of connection to the gravity system, the new manhole shall be treated with the epoxy coating specified above.

Acceptable Manufacturer: Raven Lining Systems AquataPoxy A-6, Terre Hill Composites Multiplex Liner THC-610-SL-68, Ameron Protective Lining Division, Amer-Plat T-Lock, (or District-approved equal).

E. Mechanically Restrained Joints
The force main shall be fitted at all angle points with mechanically restrained joints designed to withstand the thrust developed under the test pressure plus 50 psi. The required number of mechanically restrained joints from the angle point shall be determined by the design engineer and shown in plan and profile (see Section One).

F. Tracer Wire
On all force mains there shall be installed a tracer wire which shall be a single insulated No. 12 AWG copper wire. The insulated wire shall be furnished in rolls of not less than 500 feet. Where splices are required, splices shall be made with 3M splice kits or approved equal. The Contractor shall furnish all materials. The No. 12 wire shall be placed along the top of the force main and taped in place with duct tape or electrical tape at a maximum of 6 feet intervals. Permanent access points shall be provided through manholes, access vaults, valve boxes or other approved

means at the ends of the tracer wire. The wire shall be extended into the access points a minimum of 5feet from each direction. The wire shall be neatly rolled and placed so that it does not interfere with normal operation. The two wires shall be spliced inside the access point with a standard plastic or rubberized wire connector. After testing for continuity, the splices inside the access point shall be made with a 3M splice kit or approved equal. Where splices become necessary outside of access points, the splices shall be made with a 3m splice kit or approved equal. All tracer wire shall be tested for continuity as called for in Section 4.2 I below.

G. Utility Marking Tape
A detectable underground utility marking tape shall be installed the entire length of the force main as per the District's Detail FM-1. The material to be installed for this purpose shall consist of three (3) inch wide tape made of bonded layer plastic with a metallic foil core. Tape splices shall be knotted to prevent tensile pressure on the splice. The metallic tape shall be colored green and shall bear an imprint identifying the line below as, "Caution Buried Sewer Main Below". The Contractor shall furnish all materials. The three (3) inch wide tape shall be installed 12" below finished grade. The tape material shall be installed in accordance with the manufacturer's recommendations. The tape shall be placed in a manner such that trench backfill settlement will not cause an excessive stress on the material.

H. Testing
Testing of force mains shall include:

1. Force mains shall be pressure tested at the highest point in the project. The Contractor shall fill and pressure test the force main. The minimum required test pressure shall be the force main test pressure for a period of 2 hours with a maximum of not more than 2 PSI drop in pressure.
2. The tracer wire on all force mains shall be tested by the Contractor for continuity in the presence of a District construction inspector. If the test is satisfactory, all splices shall be made permanent by means of 3M splice kits or approved equal. If test fails in a section, the Contractor shall find and repair any failure in the locator wires.

4.3 TRANSITION PIPING

When PVC pipe (See Section 4.1) is used for force main outside the structural walls, a transition pipe shall be used to make the transition between the discharge tee inside the valve chamber and the force main outside the station structure. The following methods shall be used:

A. Four Inch (4") Diameter and Larger
Both pump discharge lines shall be joined to a flanged or grooved ductile iron tee. A flanged DIP stub shall be bolted to the tee then passed through the "A-lok" that is installed in the valve chamber discharge wall. The PVC force main shall be attached to the D.I.P. stub outside of the valve chamber by a long pattern sleeve mechanical joint with Mega-Lug retainer glands.

B. Three Inch (3") Diameter
Both pump discharge lines shall be joined to a Schedule 80 PVC flanged tee. From the tee, a Schedule 80 PVC stub shall pass through the "A-lok" or "Z-lok" gasket installed in the valve chamber discharge wall. Transition the stub to the C-900 PVC force main with a PVC coupling outside of the valve chamber.

4.4 DISCHARGE RISERS

When plastic pipe is utilized for the pump discharge riser and the riser exceeds 12 feet in length, a stainless steel support brace shall be installed between the riser and wet well wall. The brace shall be placed approximately in the middle of the riser but kept above the normal operating level of the well. A minimum of two (2) braces shall be used on lengths in excess of 20 feet.

4.5 SHUT-OFF AND CHECK VALVES

Approved shut-off and check valves shall be placed on the discharge line of each pump. The check valves shall be located between the shut-off valve and the pump. All valves shall be rated so as to withstand normal working pressure plus allowances for the water hammer. No pump discharge valve shall be vertically mounted or located in the wet well area.

A. Shut-Off Valves

1. Shut-off Valves Four Inch (4") and Larger
Shut-off valves shall be plug type valves. The valves shall be located so that each pump may be isolated from the common discharge header. Plug valves shall be of cast iron body, ASTM A126 Class B, or ductile iron ASTM A536. Valve plugs shall be cast iron ASTM A126 Class B, or ductile iron meeting ASTM A536, Grade 65-45-12, covered with a Buna-N Rubber compound. The seats are to be a corrosion resistant alloy either 304 stainless steel or nickel.

   a. Valves shall be able to pass a sphere not less than 80% of the diameter of the valve size.

   b. Valve Operations
   - Six-Inch (6") and smaller valves shall be provided with a two-inch (2") square operating nut and wrench head.
   - Valves larger than six inches (6") shall be provided with a Manual Gear Operator sized so that the maximum rim pull required is not more than 80 pounds.
   - Valves three inches (3") through twelve inches (12") shall be rated at 175 pounds.
   - Valves fourteen inches (14") and larger shall be rated at 150 pounds when pressure is applied from the preferred direction. These valves have a preferred direction of shut-off, and it is the responsibility of the contractor to see that they are properly installed.

      Acceptable Manufacturers: Valves are to be DeZurik, Milliken or GA Industries (or District-approved equal).

2. Shut-off Valves Two Inch (2") and Two and a half (2 ½")
All thermoplastic ball valves shall be True Union type constructed from PVC Type 1, ASTM D 1784 Cell Classification 12454 or CPVC Type IV, ASTM D 1784 Cell Classification 23447. All O-rings shall be EPDM or FKM. All valves shall have Safe-T-Shear stem an double-stop Polypropylene handle. All union nuts shall have Buttress threads. All seal carriers shall be Safe-T-Blocked. All valve components shall be replaceable. All valves shall be certified by NSF International for use in potable water service. All two inch (2") valves shall be pressure rated at 235 psi and all two and a half inch (2 ½") valves and all flanged valves shall be pressure rated at 150 psi for water at 73 degrees F.

   Acceptable Manufacturers: Spears Manufacturing Company (or District-approved equal).

B. Check Valves

1. Check Valves Four Inch (4") and Larger
Check valves shall be rubber flapper swing check type with epoxy coated iron body. Check valves shall be flanged end type.

   Acceptable Manufacturers: Check valves shall Valmatic, APCO, Milliken or GA Industries.

2. Check Valves Two Inch (2") and Two and a half (2 ½")
All thermoplastic check valves shall be True Union type constructed from PVC Type 1, ASTM D 1784 Cell Classification 12454 or CPVC Type IV, ASTM D 1784 Cell Classification 23447. All O-rings shall be EPDM or FKM. All union nuts shall have Buttress threads. All seal carriers shall be Safe-T-Blocked. All valve components shall be replaceable. All valves shall be certified by NSF International for use in potable water service. All two inch (2") valves shall be pressure rated at 235 psi and all two and a half inch (2 ½") valves and all flanged valves shall be pressure rated at 150 psi for water at 73 degrees F.

   Acceptable Manufacturers: Spears Manufacturing Company (or District-approved equal).

4.6 VALVE CHAMBER DRAIN VALVE

A backwater check valve shall be installed on the valve chamber drain line. The valve shall be installed as follows:

A four-inch (4") diameter PVC stub shall be glued into the 4-inch diameter coupler cast into the wet well wall at the valve chamber floor line. A 90-degree elbow shall be glued to this stub and directed toward the wet well floor. A (4"x3') PVC stub shall be glued into the other end of the elbow. The check valve shall then be slipped on to the stub and attached with two (2) stainless steel clamps to be supplied by the vendor.

Acceptable Manufacturer: The valve shall be a "Tide-Flex" series TF-2, 4-inch (slip on) check valve, by Red Valve Co., EVR Type CPO-4 (or District-approved equal).

4.7 GRAVITY LINES ENTERING THE STATION

Ductile iron pipe shall be used on sections of gravity lines running from:

- The last manhole preceding the station up to the station.
- The outfall of the detention pipes up to the station. This outfall line shall be a minimum of 8-inches in diameter.

Concrete or PVC gravity lines shall not be used in these areas.

4.8 DETENTION PIPE

Detention pipe(s) shall be ADS SaniTite HP triple wall pipe. Engineer to contact local ADS representative for the design of the detention pipe system.

A vacuum test of all detention pipe shall be performed. The test shall be for a period of 1 minute and the vacuum shall be 10" of mercury and may not drop below 9" of mercury at the end of the 1-minute test.

SECTION 5 - SUBMERSIBLE WASTEWATER PUMPS

5.1 MINIMUM STANDARDS

Pump selection shall be based on the following minimum standards:

- Single-phase pumps shall not be used.
- Pumps less than three horsepower (3 Hp) shall not be used.
- Non-clog pumps are the preferred type pumps.
- Grinder pumps shall only be used only upon both acceptable justification and after receipt of a written variance from the District.
- All pumps, with the exception of grinder pumps, shall be capable of passing spheres of at least three inches (7.6 cm) in diameter, pump suction and discharge piping shall be at least four inches (10.2 cm) in diameter.

5.2 PUMP SPECIFICATIONS

The pump(s) shall be non-clog solids handling, submersible, capable of handling raw, unscreened sewage. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump(s) shall be automatically connected to the discharge connection elbow when lowered into place, and shall be easily removed for

inspection of service. There shall be no need for personnel to enter the pump well. A simple linear downward motion of the pump shall accomplish sealing of the pumping unit to the discharge connection elbow. A sliding guide bracket shall be an integral part of the pump unit. No portion of the pump shall bear directly on the floor of the sump. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

A. Major Components
Major pump components shall be of gray cast iron, Class 30, with smooth surfaces devoid of blowholes and other irregularities. Where watertight sealing is required, O-rings made of nitrile rubber shall be used. All exposed nuts and bolts shall be of ASTM A 167 304 stainless steel.

B. Watertight Seals
All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile O-rings. Fittings shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces resulting in controlled compression of nitrile rubber O-rings without requirement of a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.

The cable entry water seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable.

The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the motor interior from foreign materials gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression seal (O-rings). Where a sealed junction chamber is not used, the motor chamber shall be fitted with a moisture detection probe. The probe shall be connected to and activate a warning light in the control panel.

Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board and thus perfectly leak proof.

C. Cooling System
Each system shall be provided with an adequately designed cooling system. When thermal radiators (cooling fins) are used, they shall be integral to the stator housing and shall be adequate to provide the cooling required by the motor. When water jackets are used, the water jacket shall encircle the stator housing. The water jacket shall be provided with a separate, self-contained liquid cooling system. Regardless of the cooling system used, the motor shall be capable of pumping under full load continuously with the water level only to the top of the volute. Motors with intermittent full load ratings or motors requiring oil for cooling shall not be allowed.

D. Impellers
The impeller shall be of gray cast iron, Class 30, dynamically balanced, single or double shrouded non-clogging design having a long thrulet without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications. The pump manufacturer shall, upon request, furnish mass movement of inertia data for the proposed impeller. The impeller shall be capable of passing a minimum 3-inch solid sphere. The fit between the impeller and shaft shall be a sliding fit with one key.

When double shrouded impellers are used, a wear ring system shall be installed to provide efficient sealing between the volute and impeller. The wear ring shall consist of a stationary ring made of nitrile rubber molded with a steel ring insert which is drive fitted to the volute inlet and rotating stainless steel ring which is drive-fitted to the impeller eye.

When single shrouded impellers are used, the volute shall be fitted with an adjustable replaceable front plate. The front plate shall be designed with a wave shaped inlet and an outward spiraling V-shaped groove on the side forcing the impeller to shred and force stringy solids outward from the impeller and through the pump discharge.

The volute shall be of single piece design and shall have smooth fluid passages large enough at all points to pass any size solid with can pass through the impeller.

E. Pump Motor
The pump motor shall be squirrel-cage, induction, and shell type design, housed in an air-filled watertight chamber. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation that will resist a temperature of 155 degrees Celsius (F). The stator shall be dipped and baked three times in Class F varnish. The motor shall be designed for continuous duty, capable of sustaining a minimum of ten (10) starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

The pump motor cable, installed, shall be suitable for submersible pump application. Cable sizing shall conform to NEC specifications for pump motors.

F. Thermal Sensors
Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal switches, embedded in the end coils of the stator winding (one switch in each stator phase). These shall be used in conjunction with and supplemental to external motor overload protection and wired to the control panel.

G. Pump Shaft
Each pump shall be provided with an oil chamber for the shaft sealing system. The drain and inspection plug, with positive anti-leak seal, shall be accessible from the outside.

The pump shaft shall rotate on two (2) permanently lubricated bearings. The upper bearing shall be a single row deep groove ball bearing and the lower bearing a two row angular contact ball bearing. The pump shaft shall be stainless steel or hard chrome plated carbon steel.

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. Seals shall run in an oil reservoir. Lapped seal faces shall be hydro-dynamically lubricated at a constant rate. The lower seal unit, between the pump and oil chamber, shall contain one stationary and one positively driven rotating silicon carbide or tungsten carbide ring. The upper seal unit, between the oil sump and motor housing, shall contain one hard metal ring and one carbon ring, or angled to the shaft lip type seal in grinder pump applications. Each interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable. The following mechanical seal types shall not be considered acceptable.

- Shaft seals without positively driven rotating members.
- Conventional double mechanical seals containing either a common single or double spring acting between the upper and lower units. This conventional system requires a pressure differential to offset external pressure and to affect sealing.

Acceptable Manufacturer: Sewage pumps are to be manufactured by the Flygt Company, ABS Company, Ebara, Barnes or approved equal.

SECTION 6 - PUMP STATION APPURTENANCES

6.1 SLIDE RAILS

All pump-lifting slide rails shall be made of 316 Schedule 40 stainless steel pipe. Slide rails shall be installed and sized per manufacturer's instructions. The slide rails shall be firmly braced to the wet pit wall with stainless steel support brackets. Maximum spacing between brackets shall be every 15 feet.

6.2 LIFTING CHAIN

Pump lifting chain, clevis, and shackles shall be made of 316 stainless steel. The chain shall be sized to accommodate the installed pump weight, but shall not be sized small than 3/16" stainless steel diameter links.

6.3 BOLTS

All field-installed bolts, nuts, and washers used inside either the pump or valve chamber shall be made of 316 stainless steel.

6.4 FASTENERS

All concrete fasteners used for installation of braces, brackets or boxes shall be stainless steel wedge type stud anchors. Anchor holes shall be drilled to the manufacturer's recommended depth. Pump base anchor studs shall be sized as follows:

- 4" pumps and smaller = ⅝" minimum
- 6" and 8" pumps = 1" minimum
- Pumps larger than 8" shall be installed with stainless steel anchors sized per the pump manufacturer instructions

6.5 FLOATS AND SETTINGS

A. General
Floats shall be located near the flow of incoming sanitary lines. All floats shall be located away from the turbulence of the incoming flow. Sewage shall not rise to the level of the incoming gravity lines or the detention pipes during normal pump operation.

B. Float Levels
The following levels shall guide the setting of float levels.

Off Float	The Entire Pump Shall be Covered at the Off level
First Pump	No Less than 1-½ feet above the Top of Pump Motor
Second Pump	No Less than 2 feet above the Top of Pump Motor
High Level Alarm	No Less than 2-½ feet above Top of Pump Motor and No More than 1-inch Below the Detention Tank Pipe

C. Float Leads
Float leads shall be hung with stainless-steel Kellems (or District-approved equal) wire mesh grips from a stainless-steel bracket supplied by Halliday (or District-approved equal). The bracket shall be attached to the wet well hatch cover or firmly bolted to the concrete immediately below the hatch cover.

D. Float Wires
Float wires shall be neatly routed from the wet well to the valve through the access sleeve, without excessive wire strain or pull. Wire length on all float wires shall be such that each float may be adjusted to the bottom of the station wet well.

Acceptable Manufacturer: Pump level floats are to be either Flygt model EH-10 or Anchor Scientific type S-Roto floats.

6.6 ACCESS HATCHES

The pump and valve chambers access hatches shall be aluminum, rated for a 300 lb load. Door size and orientation shall be as indicated on the drawings. The access frame and cover shall be flush with the top of the concrete, complete with hinges and locking mechanism, upper guide holder and level sensor cable holder. Frame shall be securely placed, mounted above

the pumps. Hatches shall be equipped with form skirts, sized for the slab top thickness. Doors shall be provided with padlock lugs.

All access hatches shall include an integrated District-approved orange safety grate for open hatch fall protection.

Acceptable Manufacturer: Hatches shall be Halliday Model S1S or S2S (or District-approved equal) with protective grating option.

6.7 SAFETY POST

On the top two ladder rungs under the access provide stainless steel or aluminum safety extension post manufactured by Halliday (or District-approved equal). All bolts and hardware shall be stainless steel. The safety post shall be manufactured so that the safety post can be attached to top two rungs. Contractor shall verify required spacing.

6.8 INTRINSIC BARRIERS

The wet well area of the pump station is considered by the NFPA to be a hazardous area. Therefore, intrinsic barriers shall be installed where the level floats terminate in the control panel to prevent explosions from occurring due to electrical arcing in the wet well area.

Acceptable Manufacturer: Sym Com Model ISS-105 or approved equal.

SECTION 7 - ELECTRICAL

7.1 ELECTRICAL

The selected pump supplier shall be directly responsible for all panel fabrication and component installation. The pump control panel shall meet the following specifications:

A. Panel Configuration
The pump controls shall be housed within a NEMA-3R, enclosure, constructed from 12-gauge grade 304 stainless steel, with a #4 finish. The enclosure shall consist of three sections in an “H” shape cabinet, with a total overall dimension of 64” high by 70” wide by 24” deep. Each section shall be joined together at the exterior seams with a continuous weld, so that a weather-tight seal exists between the three sections. With the exception of inside corner seams, all exterior seams shall be “Mig” welded, ground smooth, and brush finished. The cabinet’s exterior inside corner seams, shall be “tig” welded.

Section #1 and Section #3 shall form the two outer legs of the cabinet, with Section #2 forming the bridge between each leg. Section 2 shall be flush with the sides of Sections #1 and #3 closest to the wet well and valve chamber, to allow Section 2 outer panel door to open wider than 90 degrees. The interior of Section #1 shall be sub-divided into two smaller compartments, #1a and #1b. The bottom of sub-compartment #1b and the bottom of Section #3 shall be of open base construction, with an angle iron support frame welded to the inside bottom of the two sections. The base angle iron shall be 2” x 2” x ¼” grade 304 stainless steel. Two removable solid ring ⅝” – 11 tpi. lifting eyes shall be mounted over the top of Sections #1 and #3. Gasketed stainless steel ⅝” bolts shall be provided for eye replacement following cabinet installation.

All compartment exterior doors shall be mounted to the enclosure with stainless steel full-length continuous hinges. Hinges shall be welded to the enclosure. All compartment exterior doors shall be protected with stainless steel drip shields. Self-gripping flange mounted EDPM gasket material with a wire-reinforced base, shall be used to form the seal between the outer doors and the surrounding enclosure flanges. Gasket material shall be EMKA #1011-05. All outer compartment doors shall be secured with three-point interior stainless steel latching mechanism attached to stainless steel exterior mounted handles. The handles shall be capable of accepting padlocks. Latching mechanisms shall be Austin #48-5655XSS.

Full sub-panels shall be mounted within each compartment interior. The sub-panels shall be formed from mild steel. Panel edges shall be turned down to form a ¾" lip. All panels shall be painted white and mounted on ⅜"-16 standoff studs per NEC and UL 508.

All hardware on the panel exterior shall be stainless steel with the exception of the temporary lifting eyes.

B. Section #1 Panels
Section #1 shall be a one door NEMA 3R enclosure with a full inner barrier between Sections #1a and #1b. An opening shall be cut from the back of the Section #1 compartment to provide access into Section #2 when the Section #1 sub-panels are removed. The cut-out opening shall be 38" x 10", to provide a 1" stiffening perimeter around the sides of Section #1a and #1b.

Section #1a shall be accessed through the Section #1 exterior door. This compartment shall be used for installation of the Mission MyDro Cellular Dialer.

Section #1b shall be accessed through the Section #1 exterior door. This section shall have an open bottom with a 2" x 2" x ¼", grade 304 stainless steel angle iron support frame surrounding the bottom interior opening. This compartment shall be used as an entrance point for the following conduits stubbed through the panel's concrete mounting pad:

- Conduit from the valve chamber control junction box shall be minimum two inch (2").

C. Section #2 Panel
Section #2 shall be accessed throughan exterior door, which shall be hinged from the left-hand side. The compartment interior shall include a 12-gauge mild steel continuous hinged inner door painted white unless using converter option (Section 7.5). The inner door shall be set back 2" from the outer door, hinged from the left side and secured with a single point latch knob. Door screws shall not be used. All control switches, hour and event meters, GFI receptacles, indicator lights and circuit breaker toggles, shall be mounted on the hinged inner door. An opening shall be cut from each side of Section #2 to provide access into Sections #1a, #1b and #3 when the adjacent corresponding sub-panels are removed. The size of the cut outs shall be 38"x10", to provide a 1" stiffening perimeter around the sides of Section #2. This compartment shall be performed per NFPDA, NEC and UL-508A specifications. N.E.C. gutter spacing shall be observed. A minimum of 6" additional D.I.N. rail shall be provided for future mounting expansion. All component mounting and wiring shall be completed per the given specifications.

D. Section #3 Panel
Section #3 shall be accessed through it's own exterior door, which shall be hinged from the right hand side. Both the electric meter and the service disconnect shall be mounted inside this compartment. The exterior door shall have a Lexan (or District-approved equal) plastic window to allow the electric meter to be read from outside the cabinet. The window shall be a Hoffman #A-PNK95NFSS. An opening shall be cut from the back of the Section #3 compartment to provide access into Section #2 when the Section #3 sub-panels are removed. The cut-out opening shall be 38"x10" to provide a 1" stiffening perimeter around the sides of Section #3. This section shall have an open bottom with a 2" x 2" x ¼" (304) stainless steel angle iron frame surrounding the bottom inside opening. This compartment shall be used as an entrance point for the following conduits stubbed through the panel's concrete mounting pad:

- Power service conduit shall be two-inch (2") diameter as approved by electric service provider.
- Pump motor conduit from power junction box in valve chamber shall be two-inch (2") diameter.

E. Thermal Magnetic Breakers
Individual thermal magnetic circuit breakers shall be provided for branch disconnecting service and short circuit protection of all motor and auxiliary circuits. Combination circuit breaker and overload mechanism shall not be allowed.

F. Mercury Level Sensors (Float Switches)
Four (or 2 if using level transducer) mercury level sensors or floats shall be provided with sufficient length cord to extend uninterrupted to the valve chamber control junction box. The four float levels shall be: Pump Off, Lead Pump On, Lag Pump On, and Wet Well High-Water Alarm. All floats shall be connected to an intrinsic safety barrier located in the pump control panel.

G. Fluorescent Work Light and Panel Heaters
A 12-inch fluorescent work light with a safety lens shall be mounted inside the top of the control panel without penetrating the panel outer skin with screws or fasteners. The light shall be operable with an on/off switch mounted on the inner door. Low wattage strip heaters shall be installed on the inner compartment doors 1a, 2 and 3 to prevent the accumulation of condensation.

Acceptable Manufacturer: Cabinet heaters shall be Watlow #02012096A-40 (or District-approved equal).

H. Wiring
All wires in the pump control panel shall be numbered with either clip sleeve or heat shrink markers. Wrap on or adhesive type wire markers shall not be allowed. Control panel schematic shall show wire and terminal numbers. All rungs shall be numbered with relay contacts referenced by these numbers. Relay contacts shall have socket terminals noted on drawing.

I. Lightning Arrestor
A silicon oxide varistor type lightning arrestor shall protect the pump station. The arrestor shall be sized for the incoming power service. This arrestor shall be located in the pump control panel externally mounted to the service entrance disconnect switch enclosure.

J. Phase Sequence and Loss Monitor
A phase sequence and loss monitor shall protect all stations supplied with three-phase power. This monitor/relay shall be a single pole, plug-in-type with automatic reset. The relay shall interrupt the control circuit immediately after the control fuse.

Acceptable Manufacturer: The relay shall be a Macromatic PMPU series or approved equivalent.

K. Relays
For pump stations supplied with three-phase power, all control and time delays shall be at a minimum DPDT 8 or 11 pin octal base D.I.N. rail mounted.

Acceptable Manufacturer:

Control Relays	IDEC	RR2-ULAC120
Time Delay Relays	IDEC	RTE-P11-120VAC
	Diversified	TBC-120-ABA

L. Main Terminal Strip
The main terminal strip at the lowest portion of the sub panel shall have a minimum clearance of six inches to the bottom of the Section 2 enclosure.

M. Control Power
The control power shall be 120 volts. If a 120-volt, single-phase power source is not available, a minimum 3 KVA transformer shall be supplied with primary and secondary protection. Individual 120-volt circuit breakers shall be provided for each separate power requirement. A 5-ampere fuse shall be provided on the load side of the control circuit breaker. Three (3) spare control fuses shall be provided in a separately mounted three-pole fuse-block. The Mission MyDro Cellular Dialer shall be powered from a separate dedicated 15-amp circuit breaker, fed from the control circuit. A 15-ampere ground fault interrupter receptacle shall be mounted on the inner door of the control panel.

N. Control Panel Name Plate
All pump control panels shall have a 4”x6” phenolic name plate firmly fastened to the lower right front side of the cabinet inner door or the back panel in the converter option and pursuant to requirements of the electrical supplier. The nameplate shall include the following:

- Manufacturer’s job number
- Manufacturer’s name, location, phone number

- Site name
- Pump model, pump serial numbers, horsepower, voltage, amperage

7.2 THREE PHASE MOTORS

- All pumps shall operate using 240 or 480 VAC three-phase power.
- Any station requiring pumps greater than 15 horsepower shall be powered from a three-phase public power system.
- Any station requiring pumps 15 horsepower or less may use the single-phase power source option upon District approval and based upon a cost analysis presented by the designer/owner. District approval shall be determined on a case-by-case basis and upon a review of a cost analysis provided by the design engineer. Three-phase power is the District-preferred power source.

7.3 ELECTRICAL POWER SUPPLY

Electrical power for pump stations shall be 3-phase unless special approval is granted by the District.

7.4 THREE-PHASE SUPPLY CONTROL

Three-phase electrical supply installations shall meet the following requirements:

A. Magnetic Motor Starters
Magnetic across the line horsepower rated motor starters shall be supplied for each pump under 30 horsepower. Pumps 30 horsepower and larger shall be supplied with soft starters with bypass contactors.

Acceptable Manufacturer: Cutler Hammer series CE-15 with series C-316 overloads and 120-volt coils (or District-approved equal).

B. Soft Starters
The solid-state reduced voltage starter shall be UL and CSA listed and consist of an SCR based power section, logic board and paralleling bypass contactor.

The SCR based power section shall consist of six (6) back-to-back SCR's and shall be rated for a minimum peak inverse voltage rating of 1,500 PIV. Units using triacs or SCR/diode combinations shall not be accepted. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt characteristics of the electrical system.

The logic board shall be mounted for ease of testing, service and replacement. It shall have a quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits. The logic board shall be identical through all ampere ratings and voltage classes and shall be conformally coated to protect from environmental conditions.

The paralleling bypass contactor shall energize when the motor reaches full speed and close/open under 1x motor current. If across the line starting duty is desired, the contactor shall be fully rated for such.. The contactor shall utilize an energy balanced contact closure to limit contact bounce and an intelligent coil controller which optimizes coil voltage during varying system conditions. The coil shall have a lifetime warranty.

The overload protection shall be electronic and be based on an inverse time/current algorithm. Overload protection shall be adjustable and Class 10/20 shall be selectable. Units using bimetal overload relays are not acceptable. Over temperature protection (on heat sink) shall be standard.

The solid-state logic shall be phase sensitive, and shall inhibit starting on incorrect rotation. Improper phase rotation shall be indicated on the starter.

Starters shall protect against a phase loss/unbalance condition shutting down if a 35% current differential between any two phases is encountered.

A normally open (NO) contact shall annunciate fault conditions, with contact ratings of 60 VA resistive load and 20 VA inductive load. In addition, an LED display shall indicate type of fault (current trip, phase loss, phase rotation).

The following adjustments are required:

1. Ramp time: 1-45 seconds
2. Initial torque: 100-200% current
3. Current limit: 100-500% current
4. FLA of motor: 4-1 range of starter

Smooth stopping shall be available to provide a linear voltage deceleration. It is to be adjustable from 1-45 seconds.

Acceptable Manufacturers: ABB or Square D

C. Pump Control Circuits and Indicator Lights
Individual pump control circuits shall be provided with HOA (Hand-Off-Auto) switches, elapsed time meters and re-settable event counters for monitoring pump cycles. Also provide amber pump running lights, green power available light and individual red indicator lights to alarm seal leaks and pump failures. Indicator lights shall be 30 mm full-voltage type (or District-approved equal). LED lights or LCD-type counters shall not be accepted.

The above switches, lights, meters and counters shall be mounted on the inner door of Section #2 of the control panel.

7.5 SINGLE PHASE CONTROL OPTION (AS APPROVED)

Because of the higher probability of electrical failure from using a phase converter, this type of system shall only be considered after investigating the feasibility of having three-phase power brought onto the job site. Three-phase power shall be used unless special approval is granted by the District upon review of a cost analysis provided by the design engineer. All phase converter installations shall meet the following requirements:

A. Single Phase 240 Volt Power Source
The single-phase 240-volt source shall be stepped up to single phase 480 volts to operate the pump motors that are above 15 horsepower. The power transformer shall be shielded, isolated, and sized to handle 1.5 times the total pump load requirement.

7.6 STATION INTERIOR WIRING

Wet well level control float leads shall be hung with stainless-steel Kellems (or District-approved equal) wire mesh grips from a series J Halliday (or District-approved equal) stainless steel cable holder. The holder shall be bolted to the inside of the wet well hatch, immediately below the hatch cover and shall be located to not interfere with the wet well entrance steps. The pump power cables shall be hung with stainless-steel Kellems (or District approved equal) wire mesh grips from the upper pump guide rail brackets. Power and control wiring shall be routed with adequate separation. All excess wires shall be rolled up inside the valve chamber.

Passage of the pump and float wires from the pump chamber to the valve chamber shall be made through two open ended lengths of 4-inch PVC conduit installed between the valve and pump chamber. A minimum of 12” separation shall be maintained between the control and power wiring.

There shall be no electrical connections made in the pump chamber. All wiring shall run unbroken from the pump chamber to the valve chamber through the 4-inch PVC conduits and terminated inside a 12”x10”x6” plastic hinged, watertight junction box. There shall be two junction boxes. One for control wiring and one for power cables. Wire connection shall be DryConn or approved equal waterproof connector.

Acceptable Manufacturer: Carlon #CS12106 or District-approved equal.

Valve chamber junction box cord connections are to be made with liquid tight nylon cord connectors T&B or approved equal.

All wiring in the valve chamber shall be routed and fastened securely along the chamber walls with non-corrosive wire straps and fasteners.

7.7 FIELD WIRING SPECIFICATIONS

Control panel wiring shall be as follows:

- All wiring installed on the line and load side of the electric meter shall be THHN copper wire.
- Electric service to the station shall be sized to provide the maximum total station amperage with all installed pumps running under a fully loaded condition.
- All pump station control panels shall be provided with a minimum 100-amp service.

7.8 CONDUIT SPECIFICATIONS

The following conduit sizes are to be used on any combination of pumps with a total station HP of less than 60 HP. For larger HP stations, contact the District's maintenance supervisor for specific conduit sizes.

- A 2-1/2" conduit shall be used to run from a public electrical system (as approved by electric service provider) to an electric meter mounted in a control panel section #3. The meter and disconnect switch are to be connected together with a rigid steel conduit nipple within section #3 of the panel.
- A 2-1/2" conduit shall be used to run all power wires from the bottom of section #3 in the control panel, to the back of the 12"x10"x6" power junction box in the valve chamber.
- A 2-1/2" conduit shall be used to run all control wires from the bottom of section #1 in the control panel, to the back of the 12"x10"x6" control junction box in the valve chamber.
- If a step-up transformer is required, conduit shall be sized in accordance with current National Electrical Code requirements.
- All conduits running to or from the control panel shall be run underground at a minimum depth of 18 inches below finished grade.
- All below ground conduit shall be PVC schedule 80, unless a phase converter is utilized. For that option, PVC coated rigid steel conduit shall be used including all fittings and transition points.

7.9 CONTROL PANEL MOUNTING

The station pump control panel shall incorporate the pump controls, alarm system and incoming utility power into one pre-fabricated stainless-steel structure. The panel shall be placed as follows:

- The control structure shall be set on a 4-inch concrete pad (see Section 3.10). The concrete pad shall have a well-compacted 4" stone base (minimum).
- Conduits shall be run into the power supply cabinet from beneath the structure per the detail drawing.
- The panel shall be centered on the concrete pad and set 4-inches in from the rear edge of the pad.
- Prior to setting and securing the panel to the concrete mounting pad, a strip of 2"x1/4" solid rubber gasket material shall be placed against the bottom angle iron frame to create a seal between the concrete mounting pad and the bottom panel bottom.
- The control panel shall be firmly anchored to the concrete mounting pad with six, 3/8-inch stainless steel Wej-It stud anchors. Anchor holes in the concrete pad shall be drilled to the manufacturer's recommended depth.

Acceptable Manufacturer: Anchors shall be Hilti Quick Bolt Two (or District approved equal).

SECTION 8 - ALARM SYSTEM

8.1 SYSTEM REQUIREMENTS

Each pump station shall have a Mission MyDro Cellular Remote Alarm System.

SECTION 9 - SITE REQUIREMENTS

9.1 SITE AND ACCESS ROAD PAVEMENT

Pavement is required around all pumping stations unless otherwise approved by the District. All pavement materials and construction shall be in accordance with the current edition of the *St. Charles County Standard Specifications for Subdivision Street Construction* and the following:

A. Station Area
All pump and valve chambers shall have a minimum 6 feet of paved apron placed around the pumping structures. The pavement shall be sloped to cause surface water to drain away from the station.

When fencing is installed around the pump station, the pavement shall be extended an additional 1 foot beyond the fencing perimeter.

B. Station Access Road
The access road shall be:

- A minimum of 12 feet wide
- Be designed to limit the access road grade to a 10% maximum.
- Have a turnaround area at the station end of the access road large enough to accommodate the turning radius of a 16-foot District service van.
- The centerline of the entrance road shall bisect the station gate entrance, security fence, and the valve and wet well structures. If this type entry is not feasible for a particular site, the closest structure to the gate and road shall be the wet well.

C. Pavement Specifications for Access Road and Other Pump Station Pavement Areas

1. Asphaltic Cement Concrete:
Asphaltic cement concrete pavement shall be paved with 2” of Type C (BP-1) asphaltic cement concrete wearing surface with a 6” of Type X asphaltic cement concrete base course and a 6” of well-compacted Type 1 or Type 5 aggregate base (3/4” minus).

2. Portland Cement Concrete:
Portland cement concrete pavement shall be Class B or Pavement Concrete, 6” thick, air entrained (5% minimum) 0.50 water/cement ratio, with a 4” slump. Pavement shall be reinforced with 8 gauge, 6x6 welded wire mesh. All subgrade shall consist of 6” of well-compacted Type 1 or Type 5 aggregate base (3/4” minus).

Concrete Delivery Tickets. The Developer shall furnish to the District for each truck load of concrete delivered the site, a delivery ticket, stamped by a bonded weighmaster on which is shown information concerning the concrete as follows:
(a) Name of concrete plant.
(b) Serial number of ticket.
(c) Date and truck number.
(d) Name of contractor.
(e) Specific project name.
(f) Specific class of concrete.
(g) Quantity of concrete in cubic meters (cubic yards).

(h) Time when batch was loaded, or of first mixing of cement and aggregates.
(I) Arrival time on project.
(j) Time when truck has finished discharging load.
(k) Any additional water added at jobsite to attain pouring consistency.

Failure to provide concrete material tickets may result in the District requiring the removal and reconstruction of the completed work.

D. Entrance Road Barriers
Stations requiring entrance roads shall have 6-inch high barrier posts installed at the road entrance. Post shall be constructed of 6" concrete filled steel or iron pipe, or 6"x 6" cedar posts. Posts shall be set 30" below ground in an 18"x36" poured concrete base. A 5/16" diameter galvanized chain locked on one end and firmly fastened to the other, shall be run between the poles. For safety purposes, a 4"x12" reflective plate shall be attached to the chain at the span center.

9.2 FENCING

Fencing shall be required around all pump station sites unless otherwise approved by the District. Fencing shall be included on the pump station site plan. Elimination or alterations to the approved fencing plans shall only be considered for compliance with municipal requirements.

A. Fencing Specifications
Wire fabric for the fence shall be brown or green vinyl clad 6' high chain link fabric. Wire shall be No. 11 gauge woven in a 2" mesh. Top and bottom salvages shall be barbed.

All posts and other appurtenances used in the construction of the fence shall be brown or green vinyl clad schedule 40 pipe. All posts shall be equipped with tops. Fiberglass or other material fencing components shall not be accepted.

An entrance gate that is at least 12 feet wide is required at the entrance of the pump station grounds.

Posts shall be sized and set as follows:

TYPE	SIZE	PULL
Top Rails & Brace	1-1/4" Nominal (1.66" O.D.)	2.27 lbs./ft.
Line Post & Gate Frame	1-1/2" Nominal (1.9% O.D.)	2.72 lbs./ft.
End Corner or Pull Post	2" Nominal (2.375 O.D.)	5.79 lbs./ft.
Gate Post	3-1/2" Nominal (4" O.D.)	9.11 lbs./ft.

Posts shall be set in the concrete bases so that the pole bottom rests 6" higher than the concrete base bottom.

Horizontal support bars shall be installed half way between the top rail and the ground.

A #7 tension wire shall be installed at the bottom of the fencing fabric and stretched taught enough so as to not allow the bottom of the fencing fabric to be lifted away from the fencing poles and/or ground.

B. Fencing Placement
Fencing shall be located so that:

- There is a 4' space between all auxiliary pump station equipment, panels, generators, etc. and the fence perimeter.
- The access gate shall be located so that hoisting or cleaning equipment can easily access the valve and wet well chambers.

9.3 SITE MAINTENANCE

Temporary erosion control shall be provided in accordance with state and local requirements. Surface water shall be directed away from the pump station paved area to prevent debris from washing over the paved area.

9.4 RESTORATION

Restoration shall be in accordance with the District's standard specification. Final acceptance of the public dedication of the pump station shall be withheld until the site is restored to the District's satisfaction.

SECTION 10 - INSPECTION AND ACCEPTANCE OF PUBLIC DEDICATION

In addition to the inspections by District construction inspectors, District maintenance personnel shall also make inspections of the pump station construction. **Contact the District's maintenance supervisor at 636-441-1244 to schedule inspections. Forty-eight (48) hours advance notice is required for scheduling inspections.** Failure to have the inspection performed at the proper time during the construction process may result in the District requiring the removal and reconstruction of the completed work. The contractor responsible for construction of the pump station shall notify the District when the facility is ready for the following two types of inspections.

10.1 INITIAL CONSTRUCTION INSPECTIONS

Initial construction inspections shall be performed following the completion of the wet well floor, the installation of the pump bases, and prior to allowing water or sewage into the pump station. The contractor shall be responsible for ensuring that the floor is clean and dry for these inspections.

10.2 FINAL DEDICATION INSPECTIONS

Final dedication inspections shall be performed when one hundred percent (100%) of the pump station structure, storage tank, and force main have been completed and all electrical and mechanical equipment and appurtenances, access road, and other pavements have been installed and are in operable condition. Representatives from the pump equipment manufacturer and the installing electrical contractor shall be present at the pump station for these inspections.

A. Submittal Requirements
   Prior to requesting inspections, the following items shall be electronically mailed to the District's engineering supervisor:
   - As-built electrical schematics.
   - As-built plans of the pump station and related appurtenances prepared in a NAD83, MO East Zone, US Foot (MO83-EF) state plane coordinate system (SPCS), by a Missouri-licensed engineer or a Missouri-licensed land surveyor, certifying that all structures, sewers, roads and other pavement were built in accordance with the approved plans and located within existing easements.
   - A comma-separated values (CSV) file containing points for all pump station and related appurtenances as-built points in SPCS represented in a "Point Number, Northing, Easting, Elevation, Description" format.
   - Manufacturer's pump start-up test procedures; the recorded factory test readings for voltage, current and other significant parameters documented on standard forms; and blank forms for the field test.
   - Letter of completion from paving contractor, guaranteeing that all pavement and pavement subsurface has been installed per the District-approved plans and specifications.
   - Control panel schematics, 11"x17" in size, laminated to the inside of the control panel exterior door.
   - Operating manuals and specification literature.
   - Copy of electric, gas, and water bills to facilitate the transfer of these accounts to the District at the time of dedication.
   - As-built drawings prepared by a Missouri-licensed engineer or land surveyor shall be in State Plan Coordinates and shall indicate the physical location of the pump station, retention, access road force main, locator markers and other related structures. GPS survey of all force mains is required, and District approval of such shall be coordinated by the Developer with District's engineering supervisor.

B. Pump Tests
In the presence of District maintenance personnel, the contractor shall subject the pump equipment to such operating tests as may be required by the District to demonstrate that the equipment performs in accordance with the design requirements. At a minimum, the following two tests shall be performed:

- The insulation resistance of the pump's windings and cables shall be tested. The installed pumps shall not register less than 100 megohms resistance per winding on a megohm meter.
- The pumps shall be subjected to start-up tests with the voltage, current and other significant parameters being recorded on the standard forms provided by the manufacturer. The contractor shall arrange for an adequate supply of water for the tests. The minimum quantity of water to be provided shall be equivalent to 1.5 minutes of continuous pumping at the rated pump capacity for each pump operating alone. Each pump shall be tested a minimum of two times.

10.3 CONSTRUCTION, OPERATION AND MAINTENANCE

It is the responsibility of the Developer to ensure that the pump station is constructed in according with the District-approved construction plans. Public dedications of pump stations and related appurtenances shall only be accepted by the District after all electronic copies of associated as-built plans, point coordinate files, operation manuals, specification literature, and electrical diagrams have been received by the District and all inspection deficiencies have been addressed to the satisfaction of the District.

10.4 WARRANTY

In addition to the equipment manufacturers' general warranties, the Developer shall warrant the pump station and related appurtenances to be free from defects in materials and workmanship for a period not less than one year from the date of the District's final written acceptance of Developer's public dedication of said pump station.

10.5 FINAL ACCEPTANCE OF THE PUBLIC DEDICATION

Final acceptance of the public dedication of the pump station shall be subject to the completion of all items stated above as well as the installation of fencing and satisfactory completion of all site restoration as required.