CITY OF ST. CHARLES, MISSOURI

STANDARD PUMP STATION

DESIGN AND CONSTRUCTION REQUIREMENTS

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These design and construction requirements were based on the Metropolitan St. Louis Sewer District Standard Pump Station Design and Construction Requirements. They were modified to reflect the specific requirements for pump stations within the City of St. Charles.

INTRODUCTION

The following are general guidelines and standard specifications for regional pump stations to be installed within the City of St. Charles.

The City may, from time to time, revise these guidelines and specifications. It is the responsibility of the design engineer to contact Public Works, prior to beginning the pump station design, to verify that he/she is using the latest version.

To provide efficient, cost effective, reliable service to the customers of the City of St. Charles, regional sanitary sewage pump stations or low pressure sewer systems (LPSS) will only be considered where a thorough study of all alternatives clearly indicate a gravity collection and disposal system is not practical or feasible.

Prior to the project design, it is the responsibility of the design engineer to contact Public Works to determine the following:

1. Will the City 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 designer have the latest specification revision?

The developer/designer shall comply with the most current rules and regulations of the State and Federal Government regarding the design and installation of pump stations. In cases where State or Federal law differs from these design standards, the designer shall be required to comply with the more stringent requirement.

SECTION 1 - PLAN REVIEW SUBMITTAL REQUIREMENTS

Three (3) copies of the following material must be submitted to the Public Works Department for review of any proposed pump station. Plans submitted that do not have the required drawings and/or pump station design report data shall be returned to the design engineer.

Upon completion of the review by Department, the Public Works Department will forward all comments to the design engineer. After the design engineer has had an opportunity to go over these comments, a meeting may be arranged to clarify any questions that may arise.

No construction approval of a portion of a sanitary sewer system, which requires a pump station, shall be given until construction approval of the pump station and force main.

1.1 PUMP STATION DESIGN REPORT

A pump station design report shall be typed and bound in 8-1/2x 11" booklet form in the following format:

A. Title Page
   a. Date
   b. The developer/owner
   c. Engineering firm preparing plans
   d. 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 Sewer System
      - Location and type of gravity system the force main will discharge to.

   3. Future Sanitary Sewer Service
      - 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 4–hour detention (generator backup required on all stations). If the City determines that the requirement of a generator is waived, 8-hour detention will be required.

4. Static Head

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

6. Selected Pump Manufacture'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 is derived from the selected pump manufacturer's performance curve. It is the maximum pump head or shut-off head in PSI, plus 50 PSI. 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 GEOTECHNICAL REPORT

A geotechnical analysis of the soil conditions and foundation recommendations in the area of the pump station shall be required. A minimum of two (2) borings shall be required. At least one of the borings shall be at the proposed location of the wet well with the second being in the area of the detention pipes. The borings shall extend a minimum of five (5) feet below the bottom of the wet well and pipes.

Borings along the alignment of the force main shall be required for restrained joint design.

Additional borings may be required due to the size of the pump station or detention pipes.

1.3 FLOOD PLAIN STUDY

The pump station shall be designed to be accessible and to remain above the 25-year flood elevation. Furthermore, the station shall be protected from damage during a 100-year flood event. A flood plain study may be required to determine these flood elevations.

1.4 DESIGN DRAWINGS

The design drawings shall be individual 2' x 3' design plan sheets. Each sheet must 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 (1" =50' scale)
   1. All buildings and/or residences with top of foundation (TF) and basement floor (BF) elevations noted.
   2. All sanitary sewers and storm sewers with their manholes identified.
   3. All streets.

C. Pump Station Site Plan (1"=5' scale)
   1. All access roads, fencing and pavement surrounding the pump station.
   2. Location and size of all storm and sanitary sewers. Also show water, gas and electric lines running to or through the pump station easement.
   3. Location of wet well, valve chamber and detention tanks.
   4. Location of all pump station appurtenances, such as control panels, antenna poles, boxes, generators, transfer switches, etc.
   5. Details on any proposed landscaping affecting the immediate area surrounding the pump station site.
   6. Property information indicating public ingress, egress, and sewer easements.

7. Adjacent private or common ground property lines.

8. Utility Easements

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

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

2. Locate force main appurtenances, such as clean-outs, combination air/vacuum release valves and block valves. The distance between each appurtenance shall be indicated.

3. Locate mechanically restrained joints at angle points. Also indicate the number of restraining joints required both upstream and downstream from an angle point.

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

5. Show a minimum of two witness posts with tracer wire access box on both the plan and profile. Spacing and location of witness posts to be as shown in section 4.2.

E. Gravity Sewer Profiles (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.

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

3. Provide a profile of each detention tank.

F. Pump Station Structure Sheet

The purpose of this sheet is to provide an accurate, complete, and uncluttered drawing to aid the pre-cast company to fabricate the structure. Only include measurements and information required for this goal.

1. Plan and section view of the wet well and valve chamber to scale.

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

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

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

5. A sectional view of the chamber tie walls detailing each wall as you are facing it from the pump chamber side and 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

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

2. In the Section view show the elevations of the:
   - Top of structure
   - Bottom of structure
   - Sanitary sewer inlet flowline
   - 12" D.I.P. detention pipe flowline
   - Float elevations:
     - All Pumps Off
     - Lead pump On
     - Lag pump On
     - High Level Alarm
     - 75% detention level alarm (HIGH HIGH ALARM)

3. Show the lift 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
   - Antenna

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 electric power source
   - Single phase to three phase power converter

2. When electric plans are required, begin with the Pump Station Site Plan

3. Electrical plans shall present 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

Provide a sheet that will contain details on items such as:

- Force main clean-outs
- Combination air/vacuum release valve chamber
- Valve junction boxes
- Force main taps
- Fencing
- Entrance gates

J. Pump Station Design Requirements

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

Should the designing engineer elect not to use the standard sheets, all design requirements and specifications in Sections 3 through 10 of the Manual must be included on the sheets prepared by the designing engineer.

SECTION 2 - PUMP STATION AND FORCE MAIN DESIGN CRITERIA

2.1 METHODOLOGY FOR DETERMINING 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 (gal. /person/day)

B. Non-Residential Development Area and Multi-Family Residences

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 of the Department of Natural Resources Division 20, Clean Water Commission, Chapter 8. Design Guides (10CSR 20-8.021, 1.E.1).

3. Industry Standards

C. Future Development

In designing all components of the pump station and force main, consideration must 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 should 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 should be considered in selection of the pumps.

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

4. The ultimate storage requirement for the service area should be provided. The City, at its sole discretion, may allow installation of storage for less than the ultimate storage required, however, provisions for expansion and adequate area on-site shall be provided for future expansion.

D. Infiltration

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

1. Gravity system
2. Detention Chambers

3. 12" piping from detention chamber to wet well

Where: I= Piping diameter (in.) x piping length (miles) x 200 (gal. /in. dia./mi./day)

For proposed pump station that will serve areas with existing gravity sewers, the City may require an infiltration rate greater than the 200 gal/dia/mi/day. The design engineer should contact the City prior to submittal to determine if a greater rate will be required.

E. Average Daily Flow

ADF (GPD) = F + I

ADF (GPM) = ADF (GPD)/1440 (min./day)

F. Peak Daily Flow:

PDF (GPO) = 4 x ADF (GPD)

PDF (GPM) = 4 x ADF (GPM)

2.2 PUMP SELECTION DESIGN

The design engineer shall select from the approved manufacturers (see Section Five), a 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 (75% Detention Chamber Alarm)

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 = $0.2083 \times (100/C)^{1.85} \times Q^{1.85}/d^{4.8655}$ (Hazen and 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)
Ls (feet)= Length x Friction Factor/100

4. The following Hazen and 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):

Unlined iron or steel pipe:	C=100
All other pipe (including 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
All other pipe (including steel and lined DIP)	C=140

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 performance 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 at the runout of the pump curve.

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

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

2.3 STORAGE REQUIREMENTS

Eight hour detention is required for all pump stations. For pump stations over 250,000 GPD, an on-site generator with four hour storage may be supplied in lieu of the eight hour detention. The City, at its discretion may require additional storage, and/or an on-site generator due to site specific circumstances such as, but not limited to flood-prone areas. The City, 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 must be submitted in writing with justification provided.

A. Eight Hour Storage Volume Requirements:
The volume of the detention Chambers in gallons (Vs) is:
Vs = ADF (GPD) x 0.33 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 storage. Only the volume of the detention chambers shall be used.

NOTE: The lowest development elevation must 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 floatation 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 = Should 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 City.

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 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 (1/2) 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.

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.

- One two and one-half inch (2-1/2”) hole 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 (2-1/2") holes down eight inches (8") from bottom of top slab. A two and one-half inch (2-1/2") 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 (2-1/2") 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 flowmeter, 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 STEPS

Valve vault entrance steps shall be per MSD Standard Construction Specifications (Detail Sheets 57 or 58). They shall be located as follows:

- They shall not be located under or next to any obstructions

- Entry steps should provide a clear-in-line visible unobstructed access from the top of the chamber to the bottom of the vault

- Steps should be placed on the sidewalls closest to the control panel, approximately in the center of the hatch cover.

3.8 DETENTION CHAMBER

Detention shall be installed below ground with an access manhole located at the upstream end. The connection between the detention chamber and the wet well wall shall be made with a 12" ductile iron pipe. The detention tank must 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 will be correspondingly sized to the chosen structure size.

VALVE CHAMBER		WET WELL	
Inside Area	Access Hatch Size	Inside Area	Access Hatch Size
4'x4'	48" X 48"	4' x4'	30" X 48"
6' x6'	72" X 72"	6' x6'	48" X 72"
7'x7'	84" X 84"	7'x7'	60" X 84"
8' x8'	84"x 84"	7' x7'	60" x8.4"

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 lever 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 13'.

3.11 MISCELLANEOUS ITEMS

A. Incoming Manhole Placement
A manhole shall be placed on the gravity line a minimum of 20 feet and a maximum of 26 feet from the pump station structure.

B. Detention Chamber Placement
The twelve-inch (12") pipe joining the detention chamber and the pump station shall be no less than 20 feet in length.

C. Bulkheading
Bulkheading 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 will be located a minimum of one foot above or below structure joints.

Where required by the City, a double ball expansion joint shall be installed at the connection of the discharge pipes to the wetwell. Expansion joint shall be Flex-tend or equivalent.

F. Top of Wet Well and Valve Chamber

The top elevation shall be one inch (1") higher than the surrounding ground elevation. Surrounding ground shall be sloped away from the structure for proper drainage.

G. All joints and connections shall be watertight.

H. The exterior of the lift station and wet well shall be waterproof. Method shall be approved by City.

SECTION 4 - PIPING AND VALVES

The following specifications shall be used for installation of the pump station piping and valves. Flanged and grooved end piping shall be 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 placement.

Ductile iron pipe shall be epoxy coated. Epoxy coating shall be suitable for wastewater systems. Pipe shall be ordered and supplied with the coating applied. All hardware in the lift station shall be stainless steel or coated with armor coat by Kimball Midwest or approved equal.

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:

- Flange Installation
  Ductile iron pipe Class 53 ANSI A-21.51 (AWWA C -151). All bolts and nuts for flange connections must be 304 stainless steel (minimum). All flange gaskets must be full face 1/8" thick red rubber.

- Grooved End Installation
  Ductile iron pipe Class 53 ANSIA-21.51 (AWWA C-151) with rigid radius grooves for end preparation in accordance with AWWA C606. Mechanical couplings shall be of ductile iron conforming to ASTM A- 536, Grade S nitrile gasket compounded to conform to ductile iron pipe surfaces with 316 stainless steel nuts and bolts.

2. Three inch (3") Diameter:

- Solvent-Weld Installation
  ASTM 1785 Schedule 80 PVC

- Grooved Installation
  ASTM 1785 Schedule 80 PVC roll grooved pipe in accordance with C-606. Mechanical couplings shall be of ductile iron conforming to ASTM A-536, Grade T or S nitrile compound gaskets conforming to ASTM D- 2000 designation 5BG615A14B24 with stainless steel nuts and bolts.

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 C151)
   - 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 ASTM D2241 (SDR 21) with integral bell and gasket joint design meeting the requirements of ASTM 03139 and F477, minimum pressure class shall be PC 150
   - Ductile iron pipe Class 52 ANSI A-21.51 (AWWA C-151).

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.

1. The valve shall be equipped with all backwash accessories.

2. The body of the ARV shall be supported to the wall of the structure by a 1-1/4" x 1-1/4" x 1/8" stainless steel angle bracket.

3. Air release valves shall be installed in a concrete valve vault with a minimum 42" I.D. The valve shall rest on a concrete pad as required to support the valve. A standard size vented access cover shall be provided at each air release valve.

Acceptable Manufacturer: Val-Matic Model 801SBW, Apco Model 445, ARI

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. Inside drops will not be permitted.

C. Gravity Manhole Rehabilitation

The sides and bottom of the force main discharge manhole and a minimum of five (5) manholes downstream of the point of connection (unless otherwise directed by the City) shall be lined with a solventless, 100% solids, corrosion resistant epoxy coating or a lining have multiple, structural fiberglass layers with a non-porous diaphragm bonded between the layers of fiberglass, and molded to the existing structure.

Acceptable Manufacturer: Raven Lining Systems AquataPoxy A-6, Terre Hill Composites Multiplex Liner THC-610-SL-68, or approved equal.

D. New Manhole Construction

When a new manhole is to be constructed at the point of connection to the gravity system, the manhole shall be manufactured with a flexible sheet liner with locking extensions. The bottom of the new manhole shall be treated with the epoxy coating specified above.

Acceptable Manufacturer: Ameron Protective Lining Division, Amer-Plate T- Lock, or 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. Clean-Outs

The need for clean-outs on the force main shall be determined during plan review by the City. As a general guide, clean-outs will not be required on force mains less than 1800 feet in length. If clean-outs are required, refer to the MSD construction specifications.

G. Tracer Wire

Tracer wire, 8 Gauge Copper, will be required to be placed along the forcemain. A minimum of two tracer wire witness posts containing a tracer wire access box shall be placed along the forcemain alignment. Additional location of the tracer wire witness posts and access box shall be as described below. When the end of a section of wir is reached and a new section of wire is used, the two sections will be securely connected with a Kearney Connector or equivalent.

H. Location of Witness Post and Tracer Wire Access Box

Witness Posts shall be installed:

- Every 500 foot along force main runs.
- Five (5) feet back from the pavement edge on both sides of a road crossing
- Or as directed by the City.

4.3 TRANSITION PIPING

When PVC pipe (See Section 4.1) is used for force main outside the structural walls, a transition pipe must be used to make the transition between the header 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 cast iron tee. A flanged DIP stub shall be bolted to the tee then passed through the A-lok or Z-lok gasket 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 socket 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 SDR-21 PVC force main with a PVC coupling outside of the valve chamber.

4.4 DISCHARGE RISERS

Stainless steel support braces must be installed between the riser and wet well wall. The braces shall be placed approximately every 3’ on center.

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 water hammer. No pump discharge valve shall be vertically mounted or located in the wet well area.

A. Shut-off Valves

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.

1. Flange Valves

Flange valves shall be in accordance with ANSI B16.1 Class 125 standards.

2. Grooved End Valves

Grooved end valves shall have end-to-end dimensions in conformance with AWWA C-509 with the grooved ends conforming to AWWA C-606 rigid grooving dimensions. Sleeve type bearings shall be utilized in both the upper and lower trunnions. Bearings shall be corrosion resistant and have a low coefficient of friction.

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

- 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 property installed.

Acceptable Manufacturer: Valves are to be Milliken, fig. #601-N, Victaulic Series 365, Val-Matic Cam-Centric® 5800 series, or approved equal.

B. Check Valves
Check valves shall be of the swing check type with iron body and bronze trim. Check valves shall be flanged end type or grooved end type with outside spring and lever or weighted arms.

Acceptable Manufacturer: Check Valves shall be Victaulic Series 317, Val-Matic Series 7800 Swing Check Valve, or 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 4-inch 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" x 3') 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., EVA Type CPO-4".

4.7 PRESSURE SENSORS

Each installed pump shall have an in-line full ported pressure sensor installed on the pump side of the discharge line. The sensor shall be located in the valve chamber ahead of the plug and check

valve. Sensor specifications are provided in Section 6.9.

4.8 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 12-inches in diameter.

Concrete or PVC gravity lines in these areas will not be acceptable.

4.9 DETENTION PIPE

Detention pipe(s) shall be a minimum of Class II, O-ring type reinforced concrete pipe. In areas where there will be vehicular traffic Class III, O-ring reinforced concrete pipe shall be required as a minimum unless other factors dictate another pipe class.

The detention pipe ends shall be bulkheaded using pre-cast bulkheads with a soil-tight and water-tight gasket installed in the outfall side.

4.10 QUICK CONNECT BYPASS

A bypass fitting shall be made available for connecting a portable pump to the forcemain to bypass the lift station. Said bypass shall be 4" DIP terminating in a 90 degree bend in accordance with the standard details. Connection to the forcemain shall be accomplished by a tee to the forcemain with appropriate restraint. The 90 degree bend shall have a quick connect with a cap to allow for the portable pump connection and a plug valve shall be located along the bypass piping between the forcemain and the bend. Bollards may be required by the City to protect the bypass connection depending on location of the bypass connection.

4.11 FLOWMETER

A flowmeter shall be installed. See section 6.11 for additional information.

SECTION 5 - SUBMERSIBLE WASTEWATER PUMPS

5.1 MINIMUM STANDARDS

Pump selection shall be based on the following minimum standards:

- Single-phase pumps are not acceptable.
- Pumps less than three horsepower (3 Hp) are not acceptable.
- Non-clog pumps are the preferred type pumps
- City will only allow the use of grinder pumps upon receipt of a written request for variance and acceptable justification.
- 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, with the exception of grinder pumps, which shall require City concurrence for size of the pump suction and discharge piping.

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 or 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 or ASTM A-48, Class 35B, 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 A167 304 or AISI type 316 stainless steel.

B. Watertight Seals

All mating surfaces where watertight seating is required shall be machined and fitted with nitrile O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result 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 the 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.

An acceptable alternate design would be that the cable entry system shall consist of submersible plug assembly which allows the cable to be easily disconnected from the pump for service or replacement. Cable sealing shall be accomplished by a Nitrile compression grommet with both cylindrical and conical sealing surfaces, flanked by a stainless steel washer and an integrated strain relief. The plug assembly shall be fastened with stainless steel fasteners and shall be sealed by an o-ring.

The system shall be anti-wicking by design, and shall prevent any water that enters the cable through damage to the jacket from entering the motor. Cable entry designs which utilize potting compounds to provide a water tight seal, or those which do not allow the cable to be easily changed in the field shall not be considered equal.

C. Cooling System

Each unit 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 cooling jackets are used, cooling jacket shall surround the stator housing, and an environmentally safe non-toxic propylene glycol solution shall be circulated through the jacket by an axial flow circulating impeller attached to the main motor shaft. The coolant shall be pumped through an integrated heat exchanger in the base of the motor whenever the motor is running, allowing excess heat to be transferred to the process liquid. Cooling systems that circulate the pumped medium through the cooling jacket, or those that use a toxic cooling liquid shall not be acceptable. The use of external heat exchangers, fans, or the supply of supplemental cooling liquid shall not be required.

Regardless of the cooling system used, the motor must be designed to allow the motor to run continuously under full load while in an unsubmerged or minimally submerged condition. Motors with intermittent full load ratings or motors requiring oil for cooling will

not be allowed.

D. Impellers

The impeller shall be constructed of gray cast iron, ASTM A-48 Class 30 or 35B. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications. The impeller shall be non-clogging and of the semi open (single shroud), enclosed (double shroud), or vortex design. 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, and shall be securely fastened to the shaft by a stainless steel bolt which is mechanically prevented from loosening by a positively engaged ratcheting washer assembly.

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 stainless steel or cast iron 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 wear plate shall be mounted to the volute with three stainless steel securing screws and three stainless steel adjusting screws to permit close tolerance adjustment between the wear plate and impeller for maximum pump efficiency.

When vortex impellers are used, the impeller shall be an open multi vane design. The impeller shall have a slip fit onto the motor shaft and drive key, and shall be securely fastened to the shaft by a stainless steel bolt which is mechanically prevented from loosening by a positively engaged ratcheting washer assembly. The head of the impeller bolt shall be effectively recessed within the impeller bore to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation

The volute shall be of single piece gray cast iron, ASTM A-48, Class 35B design and shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller. The discharge flange design shall permit attachment to standard ANSI or metric flanges/appurtenances. Proprietary or non-standard flange dimensions shall not be considered acceptable.

E. Pump Motor

The pump motor shall be squirrel-cage, induction, and shell type NEMA type B design, housed in an air-filled watertight chamber. The stator winding and stator leads shall be insulated with moisture resistant Class H insulation materials, rated for 180ºC (356ºF). The motor shall be designed for continuous duty, capable of sustaining a minimum of ten (10) starts per hour. The maximum continuous temperature of the pumped liquid shall be 40ºC (104ºF), and intermittently up to 50ºC (122ºF). The service factor (as defined by the

NEMA MG1 standard) shall be a minimum of 1.15. The motor shall have a voltage tolerance of +/- 10% from nominal, and a phase to phase voltage imbalance tolerance of 1%. The rotor bars and short circuit rings shall be made of cast 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. L-10 bearing life shall be a minimum of 50,000 hours at flows ranging from ½ of BEP flow to 1½ times BEP flow (BEP is best efficiency point).

The pump shaft shall be AISI 420 stainless steel. The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation.

H. Mechanical Seals

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 must 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 seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe nontoxic material.

The following seal types shall not be considered equal: Seals of proprietary design, or seals manufactured by other than major independent seal manufacturing companies. Seals requiring set screws, pins, or other mechanical locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, any system requiring a pressure differential

to seat the seal and ensure sealing.

I. Seals Failure Early Warning System

The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned between the primary and secondary mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be filled with environmentally safe nontoxic oil. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the primary mechanical seal, the probe shall sense the increase in conductivity and signal the solid state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage, thereby preventing damage to the submersible pump, and allowing scheduled rather than emergency maintenance

Acceptable Manufacturer: Sewage pumps are to be manufactured by the Flygt Company, SULZER, Chicago/Yeomans 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, clevises 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 smaller than 3/16" stainless steel diameter links. The chain shall be a minimum of 5' longer than the station depth.

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 manufacturers recommended depth. Pump base anchor studs shall be sized as follows:

- 4" pumps and smaller = 5/8" 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, SUBMERSIBLE TRANSDUCER AND SETTINGS

A. General

Floats shall be located near the flow of the incoming sanitary lines. All floats shall be located away from the turbulence of the incoming flow. Floats shall be connected to pump controller

Submersible transducer shall also be used to monitor the pumps. Transducer shall have 4-20 mA output.

Sewage shall not rise to the level of the incoming gravity lines or the detention pipes during normal pump operation.

B. Operating Levels

The following levels shall guide the operating levels of the floats.

Pumps Off	The Entire Pump Shall be covered at the Off Level
Lead Pump On	No Less than 1-1/2 Feet above Top of Pump Motor
Lag Pump On	No Less than 2 Feet above Top of Pump Motor
High Level Alarm	No Less than 2-1/2 Feet above Top of Pump Motor and No More than 1-lnch Below the 12-Inch Pipe to the Detention Tank
Detention Alarm	Set to a Level Equivalent to 75% of the Detention Tank Capacity

C. Float Leads

Float leads shall be hung with stainless steel kellum grips from a stainless steel cable holder bracket similar to a Halliday Products J4A. 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.

E. Transducer

The submersible level transducer shall be mounted inside of a smooth wall PVC pipe stilling well. The stilling well shall extend from approximately 6" above the bottom of the wetwell to a minimum of 1-ft. above the top of the emergency storage tank. The stilling well shall allow for easy access and removal of the transducer.

Manufacturer: Level transmitter shall be as manufactured by Keller America: series Valueline or Levelgage (freshwater applications) or Levelrat (wastewater applications), or equal. Warranty shall include lightning damage for transmitters with 4 – 20 ma output.

6.6 ACCESS HATCHES

The pump and valve chambers access hatches shall be aluminum, rated for a 300 lbs. 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 hinged and flush 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 and shall include a fall protection grating system. Doors shall be provided with padlock lugs.

All access hatch construction materials and appurtenances shall be manufactured from stainless steel, aluminum or brass.

Signs shall be permanently affixed to both the top and underside of the lift station access cover with the following:

WHEN HATCH IS OPEN FALL PROTECTION SHALL BE PROVIDED IN COMPLIANCE WITH CURRENT OSHA REQUIREMENTS

Signs shall be 1.5" high black letters on a white background. Signs shall be 18 gauge aluminum.

Acceptable Manufacturer: Hatches shall be Halliday Model S1S or S2S, USF Fabrication, or approved equal.

6.7 SAFETY POST

On the top two manhole steps under the access provide stainless steel or aluminum safety extension post manufactured by Halliday or 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 LOCKING HARDWARE

All equipment enclosures, access hatches, entrance gates and service disconnect arms shall be provided with locks. Locks shall have 2" high shackles with 5/16" diameter shanks. Temporary construction cores and keys will be provided by the manufacturer until such time as the facility is inspected and accepted for maintenance by the City. All temporary keys and cores will be turned over to the City at that time.

Acceptable Manufacturer: Locks shall be provided by Best Access Systems. Best Stock #21B772-L with stainless steel body.

6.9 PRESSURE SENSOR UNITS

Pressure sensors shall be of the full flange design with through boltholes or one-piece wafer style with carbon steel flanges. Sensors shall clamp between standard ANSI pipeline flanges. All exposed surfaces shall be epoxy painted or of a non-corrosive material. Sensor shall be flow through design with flexible Buna-N elastomer sensing ring around the full circumference.

Sensors shall be provided to the installer, assembled complete, from the supplier. The units shall be filled with a 50/50 ethylene glycol and water mixture and have no entrapped air in the system. The supplier shall pre-test the unit at the minimum operable sensing level of the switch prior to delivery to the installer.

Pressure switches shall have Nema-7 Housings with Single Pole Double Throw, snap- action switching elements. Switches shall be wired normally closed, with adjustable pressure settings.

The pressure range shall be specified for each specific installation.

Acceptable Manufacturers:

Gauges:	2-1/2" dial, Span Model LFS 220 with 1/4" connection.
Switches:	"NEO-DYN Model 132P4-8C6"
Pressure sensors:	"Red Valve" Series 40 flanged or Series 48 wafer sensor or EVR type PWS
Accessory piping:	1/2" or 1/4" Parker Hex stainless steel with reducing fittings where necessary to connect instruments.

Note that pressure sensors shall have a local reading at the lift station or a secondary gauge will need to be installed to provide a local reading.

6.10 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 help prevent any explosions from occurring due to electrical arcing in the wet well area.

Acceptable Manufacturer: MTL 5016 dual channel or approved equal.

6.11 FLOW METER

A flow meter shall be installed with a control system capable of measuring flows in the pipe and interface with the communication system to provide remote monitoring and reporting.

1. Provide a flow meter with 4 – 20 mA transmitter providing instantaneous flow indication for installation by the contractor. Flow transmitter shall be provided for installation in the control panel mounted to the subpanel with 120 vac surge suppressor and 4 – 20 ma surge suppressor. Where the flow transmitter is installed separately from the flow tube, two types of cable (standard cable and special cable) shall be supplied for installation between the flow tube and flow transmitter. Where the flow tube is to be installed in an area where it may become wet or submerged (such as in a metering vault), a submersible kit shall be provided.

2. Equipment shall be as manufactured by Siemens, series 5000, or pre-approved equal.

3. Provide equipment for the following flows:
   a. Station Flow

A spool piece of pipe shall be included in the wetwell of the same size as the flow meter. Spool piece shall be utilized if the flow meter is removed for maintenance.

SECTION 7 - ELECTRICAL

This section shall apply to NON-VFD pump systems, usually using 3-phase Utility Service, 480Y/277 volt or 208Y120 volt, 3-phase, 4-wire power and FVNR (full voltage, non-reversing) or SSRV (solid state reduced voltage soft start) starters for pumps depending on horsepower rating of the motors, float control of pumps, connection to a continuous level transducer and a magnetic flowmeter for monitoring and trending only, SCADA monitoring, and standby generator with automatic transfer switch as backup to Utility power. 480 volt systems are preferred.

Another option included in this specification is for the Utility-supplied single-phase source and use of VFDs as phase converters. This should be a fairly rare case and should only be used if 3-phase power cannot be obtained at the site without very excessive cost. The VFD used as a phase converter shall operate at a single pre-set speed as if it was a FVNR starter. Use of this option must receive Owner authorization prior to design.

Another option is for the Utility-supplied 3-phase source and using VFD starters for pump speed control and controlling the pump operation with SCADA and continuous level sensing with backup control using floats. This option is not included in this specification. Design of such a "smart pump station" will need to be carefully coordinated between Owner, Engineer, and System Integrator.

7.1 PUMP CONTROL PANEL

A. The pump control panel shall be the responsibility of a single manufacturer/supplier, hereafter designated as the Systems Integrator. All aspects of the system including fabrication, component installation, programming, start-up, and testing and training shall be by one entity. Sub-letting of work shall not be accepted. The Systems Integrator shall provide a fully complete system operating in a satisfactory manner.
   a. The Systems Integrator shall have offices located in the St. Louis, MO area, and within 100 miles of the end user's office to facilitate timely system support. The Systems Integrator shall employ at least two (2) full time field service technicians, and two (2) full time programming technicians.
   b. Systems Integrator/control panel manufacturer shall be a UL 508 certified control panel manufacturing facility and shall be regularly engaged in the manufacture of controls for the municipal water/wastewater industry. Components shall be UL listed. The system specified herein shall be the product of a manufacturer having at least ten (10) years' experience in the construction of such control equipment.
   c. Systems Integrator shall be Electric Controls Company, 2735 Mercantile Drive, St. Louis, MO (314-645-2400) or pre-approved equal.

B. Refer to SECTION 8 of this Specification for SCADA MONITORING & ALARM SYSTEM

C. Systems Integrator shall provide
   a. Pump Control Panel with PLC/telemetry unit to match existing system, radio, antenna, disconnect and overcurrent protective devices, motor starters, pressure/flow transmitter(s) (where required), level transducers (where required), and other peripheral equipment as detailed in this specification and on the drawings.
      i. Engineering services for design, startup, training, operation manuals shall be included. If alternate equipment is proposed, the contractor shall be responsible for any additional design, labor, and material costs associated with revisions to provide a functional system. No additional compensation shall be allowed to accommodate this requirement.
      ii. It is the intent of these specifications that all motor control and control components be supplied by a single supplier. Controls shall not be assembled on site.
      iii. SCADA equipment shall be made an integral part of the control panel being manufactured by the Systems Integrator. All SCADA system components shall be fully compatible with the Owner's existing SCADA system.

D. City shall provide
   b. All SCADA/PLC programming/configuration/documentation/start-up/training for the addition of the "site" to the existing SCADA/PLC network. This work to be performed by the City Programmer
   c. Required height of antenna pole.

E. Panel Configuration
   a. The pump controls shall be housed in a NEMA-3R, enclosure, constructed using 12-gauge 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 no greater than 64" high by 70" wide by 24" to 30" deep. **Note: For some pump station requirements, such as when large pumps or more than two pumps are used, it may be considered to use side-by-side panel sections instead of an "H" style panel. This shall be carefully coordinated with the Owner, Engineer, and System Integrator.** 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 comer seams, all exterior seams shall be "Mig" welded, ground smooth, and brush finished. The cabinet's exterior inside comer seams, shall be "tig" welded.
   b. 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 bottom of Section #1 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 1/4" (304) stainless steel. Two removable solid ring 5/8"- 11 tpi. lifting

eyes shall be mounted over the top of sections #1 and #3. Gasketed stainless steel 5/8" bolts shall be provided for eye replacement following cabinet installation.

c. 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-griping flange mounted EPDM 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 or approved equal. All outer compartments doors shall be secured with three-point interior stainless steel latching mechanism attached to stainless steel exterior mounted handles. The handles must be capable of accepting padlocks. Latching mechanisms shall be Austin #48-5655XSS or approved equal.
d. 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 3/4" lip. All panels shall be painted white and mounted on 3/8"-16 standoff studs per NEC and UL 508.
e. All hardware on the panel exterior shall be stainless steel with the exception of the temporary lifting eyes.
f. All labeling within the control panel shall meet OSHA standards.

F. Panel Section #1

a. Section #1 shall be a single door NEMA 3R enclosure. 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" unless specifically noted otherwise.
b. 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 are not acceptable). All control switches, hour meters, GFI receptacles, and indicator lights shall be mounted on the hinged inner door.
c. This section shall be used for installation of the Supervisory Control and Data Acquisition (SCADA) system. This system will be referred to as SCADA or PLC throughout the remainder of this document. Other control components such as HOA Switches, Intrinsic Safety Barriers, Seal Fail relay interface, and control and time delay relays shall also be located in Section #1.
d. This section shall also be used as an entrance point for the following conduits stubbed through the panel's concrete mounting pad:
    i. Conduit from the valve chamber control junction box
    ii. Control conduits to/from Automatic Transfer Switch (ATS) and Generator
    iii. Radio coax conduit from the antenna
    iv. Pump motor conduit from power junction box in valve chamber
    v. Pump power wires shall pass through section #1 to be terminated in section #2, such that 480 vac power is not exposed in this section.

G. Panel Section #2
    a. Section #2 shall be accessed through its own exterior door, which shall be hinged from the left-hand side. An opening shall be cut from each side of Section #2 to provide access into Sections #1 and #3 when the adjacent corresponding sub-panels are removed. The size of the cut outs shall be 38” x 10”, to provide a 1" stiffening perimeter around the sides of Section #2.
    b. This compartment shall be the main control compartment and shall house the power terminal blocks, SPD (Surge Protection Device), Circuit Breakers, Starters, Control Power Transformer, and PM (Power Monitor). All panel wiring and equipment layout shall be performed per NFPDA, NEG 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.

H. Panel Section #3
    a. Section #3 shall be accessed through its 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 plastic window to allow the electric meter to be read from outside the cabinet. The window shall be a Hoffman #A-PNK95NFSS or approved equal. 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” x 10” 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:
        i. Power service conduit
        ii. Power conduits to and from ATS

I. Panel Mounting
    a. 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:
        i. The control structure shall be set on a 4-inch concrete pad (see Section 3.10).
        ii. Conduits shall be run into the power supply cabinet from beneath the structure per the detail drawing.
        iii. The panel shall be centered on the concrete pad and set 4-inches in from the rear edge of the pad.
        iv. 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 panel bottom.
        v. The control panel shall be firmly anchored to the concrete mounting pad with twelve (12) 3/8-inch stainless steel stud anchors, six (6) for each of sections #1 and #3. Anchor holes in the concrete pad shall be drilled to the manufacturer's recommended depth. There shall be no obstruction

preventing full movement of the access door.

1. Acceptable Manufacturer:
    a. Hilti Quick Bolt Two
    b. approved equal

J. Panel Components
    a. Power Distribution Block
        i. Provide a main power distribution block sized for incoming power to the panel. Each pole of the block shall be supplied with a clear cover for operator protection. Power block lugs shall be of the sizes and quantities for the wiring to be connected to them. More than one wire connected under a single lug shall be allowed.
    b. Surge Protective Device (SPD)
        i. The pump station shall be protected by a Surge Protective Device (SPD) sized for the incoming power service voltage and shall be provided in addition to the coaxial Surge Suppressor. This SPD shall be located in the pump control panel and shall have an auxiliary contact indicating SPD Fault for monitoring by SCADA. SPD shall be as manufactured by Innovative Technology, Inc. (314-895-5912) or approved equal.
    c. Phase Sequence and Loss Monitor (PM)
        i. All stations supplied with three phase power shall be protected by a phase sequence and loss monitor. This monitor/relay shall be a single pole, plug-in-type with automatic reset. The relay shall interrupt the control circuit immediately after the circuit breaker that serves the system controls (but not the ACE). There shall be an auxiliary contact indicating that acceptable power is available for monitoring by ACE.
            1. Acceptable Manufacturer:
            2. Symcom #460-14
            3. approved equal
    d. Thermal Magnetic Breakers
        i. Individual thermal magnetic circuit breakers shall be provided for branch disconnecting service and short circuit protection of all motor and auxiliary circuits and shall be located in the power distribution section of the control panel. Circuit breakers shall have a interrupting rating greater than the available fault current but in no case shall 120/208/230 volt breakers have a rating less than 10,000 AIC and 277/480 volt breakers have a rating less than 14,000 AIC. Combination circuit breaker and overload mechanism shall not be allowed.

e. Motor Controllers
    i. Magnetic Full Voltage Non-Reversing (FVNR) across-the-line horsepower-rated motor starters shall be supplied for each pump rated at less than 20 horsepower. (Selection range of motor horsepower for using FVNR vs SSRV starters may be modified for specific pump stations based on overall size of the pump station and the voltage available.)
        1. Acceptable Manufacturer:
            a. Eaton XTC Series with Overload relay shall be Eaton XTO Series, and 120 volt coils
            b. approved equal
    ii. Soft Starters - Solid State Reduced Voltage (SSRV) soft starters shall be used for pumps rated at 20 horsepower and greater. (Selection range of motor horsepower for using FVNR vs SSRV starters may be modified for specific pump stations based on overall size of the pump station and the voltage available.)
        1. 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 at least 1,500 PIV. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt characteristics of the electrical system.
        2. The logic board shall be mounted for ease of testing, service and replacement. It shall have 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.
        3. The paralleling bypass contactor shall energize when the motor reaches full speed and close/open under 1 x motor current. 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.
        4. 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.
        5. The solid-state logic shall be phase sensitive, and shall inhibit starting on incorrect rotation. Improper phase rotation shall be indicated on the starter.
        6. Starters shall protect against a phase loss/unbalance condition shutting down if a 35% current differential between any two phases is encountered.
        7. 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).

8. The following adjustments are required:
    a. Ramp time: 1-45 seconds
    b. Initial torque:100-200% current
    c. Current limit: 100-500% current
    d. FLA of motor: 4-1 range of starter
9. Smooth stopping shall be available to provide a linear voltage deceleration. It is to be adjustable from 1-45 seconds.
10. Acceptable Manufacturers:
    a. Eaton IT
    b. approved equal

iii. Phase Converter – For smaller pump stations, if it is determined either that the Utility Company cannot provide 3-phase power to the site or the installation cost to bring 3-phase power to the site cannot be justified, use of Variable Frequency Drives (VFD's) in lieu of FVNR starters will be considered. This decision must be approved by the Owner. **(The Owner will determine the motor horsepower ratings for which use of VFD's as phase converters will be acceptable.)** This is the only type of phase converter that will be considered.

1. If voltage conversion is required, a shielded and isolated step-up transformer rated at least 1.5 times the total pump load requirement must be provided.
2. The converter shall be a VFD set up to run at a pre-determined speed, preferably 100% speed.
3. The VFD shall be derated for operating the 3-phase motor from the single phase source. The VFD supplier shall certify that the VFD used in this manner is rated to operate the motor being supplied. VFD shall be rated for no less than 50 Deg C.
4. The operation of the single phase pump supplied from the VFD as a phase converter shall be identical to that of a 3-phase pump being supplied from a FVNR starter.
5. Acceptable Manufacturers:
    a. Danfoss VLT Series
    b. approved equal
6. An air conditioning unit shall be provided for the control panel section to remove the heat generated by the VFD's.
7. For these units installed in panels mounted in a non-climate-controlled environment, provide an approximately 800 watt, 120 VFD section of the enclosure to maintain minimum temperatures in the enclosure as specified by the VFD supplier. The equivalent to this heater may be integral to the air conditioning unit for the panel section.
8. VFD's shall be provided with 6-year manufacturer's warranty, including component failure and surge damage to the VFD. Warranty shall include factory on-site service, BUT travel cost/expenses over 2

hours travel time per incident are not included in the warranty, and are at additional cost to the owner/end user per Danfoss Field Service Rate pricing.

f. Control Power
    i. The control power shall be 120 volts AC. A minimum 5 KVA transformer shall be supplied with primary protection. Individual 120-volt circuit breakers shall be provided for each separate power requirement. The PLC shall be powered from a separate dedicated circuit breaker served by from the control circuit. A 15-ampere Ground Fault Interrupter receptacle shall be mounted on the inner door of the control panel.
    ii. Provide circuits to serve the generator battery charger and the generator block water heater. If the power requirements for the block heater exceed the capacity of a 1P-15A, 120 volt circuit breaker, the block heater shall be rated at 480 volts and shall be served from a 480 volt circuit breaker rated to serve 125% of the load.
g. Main Terminal Strip
    i. 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. Provide labels to match the wiring diagrams.
h. Intrinsic Barriers
    i. The wet well area of the pump station is considered by NFPA 820 to be a Class I, Division 1, Group D hazardous area. Therefore Intrinsic Barriers shall be installed where the level floats are connected in the Control Panel to prevent arcing from occurring in these floats in the wet well.
    ii. The Hazardous Area Controller (HAC) shall provide intrinsically safe power to the Lead, Lag, and Stop floats for control of the pumps and shall have both alternator and duplexer functions. The alternator function shall change which pump is the lead pump for each on-off cycle of the pumps. The duplexer function shall cause the lag pump to operate in the event of water continuing to rise in the wet well. When the water level in the wetwell drops below the stop float, both pumps shall be stopped.
    iii. The Hazardous Area Relay (HAR) shall provide intrinsically safe power to the Wetwell High Level and the Retention High Level floats for alarming these levels.
    iv. An intrinsic safe repeater shall be used as required for any analog device such as a pressure or level transmitter installed in the wet well. Verify exact requirements of devices to be served.
    v. Acceptable Manufacturer:
        1. Symcom
        2. approved equal
i. Relays
    i. For pump stations supplied with three-phase power, all control and time delay relays shall be at a minimum DPDT 8- or 11-pin octal base D.I.N. rail mounted.
    ii. Acceptable Manufacturer:
        1. Control Relay:

a. IDEC RR2-ULAC120
b. Finder 60.13.8.120.0050
c. approved equal

2. Time Delay Relays
   a. IDEC RTE-P11-120VAC
   b. Diversified TBC-120-ABA
   c. Finder 85.04.0.125.0000
   d. approved equal

j. Seal Fail and Over temperature Monitoring
   i. Motor high temperature switches shall be connected in the motor control circuits to stop the pump motor is a high temperature condition in the motor windings occurs.
   ii. A Seal Fail relay shall be included to monitor the moisture probes inside the pump motor housing. When moisture is detected, an alarm shall be initiated at a PLC input and a light on the control panel shall be illuminated but the pump motor shall not be stopped.
   iii. If the pump manufacturer or supplier requires that a specific seal fail and over temperature relay be used as a part of the system protection and alarming, that relay shall be supplied to the System Integrator fabricating the Control Panel and the System Integrator shall install and wire that device in the panel.

k. Forced Entry Limit Switch
   i. Forced entry limit switches for each of the Control Panel outer doors shall be wired directly to the PLC. The limit switches shall alarm the opening of the control panel outer doors.
      1. Acceptable Manufacturer:
         a. Micro Switch Model 1AC2
         b. approved equal

l. Work Lights
   i. LED work lights (approximately 12 inches long) with safety lenses shall be mounted inside the top of the control panel in Sections #1 and #2 without penetrating the panel outer skin with screws or fasteners. Each light shall be operated with an on/off switch mounted on the inner door.
   ii. Light may also be an LED bulb with a porcelain fixture.

m. Panel Heaters
   i. Low wattage strip heaters shall be installed inside the compartments of Sections #1, #2 & #3 to prevent the accumulation of condensation.
      1. Acceptable Manufacturer:
         a. Watlow #02012096A-40
         b. approved equal

n. Wiring
   i. All wires in the pump control panel shall be numbered at each end with either clip sleeve or heat shrink type 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. A final 11" x 17" as-built schematic shall be laminated to the inside of the control pane1 exterior door.

o. Miscellaneous devices shall include, but not be limited to, the following:
    i. Selector Switches – Selector switches shall be 30 mm oil tight type with lever operators and a minimum 10 amp contacts. Knob operators shall not be accepted. Contact blocks shall be provided as required ans shall be rated for a nominal voltage of 500 VAC and 10 amps. The number and designation of positions for each selector switch shall be as indicated on the drawings.
    ii. Pushbuttons – Pushbuttons shall be oil-tight industrial units. Contact blocks shall be provided as required and shall be rated for a nominal voltage of 500 VAC and 10 amps. They shall be maintained contact or momentary contact as required.
    iii. Pilot Lights – Pilot lights shall be push-to-test oil-tight industrial units utilizing 120 volts (unless otherwise indicated on the drawings). Lamps shall be high-intensity LED such that they can be reliably viewed in direct sunlight. Lenses shall be colored as shown on the drawings.
    iv. Elapsed Time Meters – Provide an elapsed time meter for each pump controlled for monitoring pump operating times. Each meter shall be 6-digit, non-resettable, reading in hours and tenths of hours. Run times and starting cycles shall also be recorded and displayed in SCADA.

7.2 PUMP STATION INTERIOR

(Wet Well & Valve Vault)

A. Five mercury level sensors or floats shall be provided with sufficient length cord to extend uninterrupted to the valve chamber control junction box. The five float levels shall be: pumps off, lead pump on, lag pump on, wet well high water alarm, and retention tank high level alarm. All floats shall be connected to intrinsic safety barriers located in the pump control panel.

B. Wet well level control float leads shall be hung with stainless steel kellem grips from a series J Halliday 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 kellem 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.

C. 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 should be maintained between the control and power wiring.

D. 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 at a properly sized terminal boards inside a 12" x 10" x 6" plastic hinged,

watertight junction box. There shall be two junction boxes, one for control wiring and one for power cables.

a. Acceptable Manufacturer: Carlon #CS12106 or approved equal.
b. Valve chamber junction box connections are to be made with plastic rubber grommeted portable cord connectors equal to T & B #25xx.

E. Wiring from the pressure switches shall be 18 AWG S.T.O. portable cord T & B #25xx portable cord connectors shall be used on the switch end as well as the junction box end of the wire. The cord shall be neatly routed along the discharge pipe with ties, to the chamber joining walls and then run along the walls to the junction box.

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

7.3 ELECTRICAL OPTIONS

A. All pumps shall operate using 480 VAC three phase power.

208 VAC three phase power may be used if that is the only source available. This must be carefully coordinated with Owner and Engineer. Single phase motors should never be used.

B. The following is a list of the basic electrical requirements:

a. The City will provide generic electrical drawings for a three-phase source.
b. SCADA shall perform all monitoring and alarming functions.
c. The transducer and float system and hardware shall perform all control functions.

7.4 STATION OPERATIONS

A. PROCESS CONTROL MODE SELECT

Basic process control is to pump down the wet well level, turning pumps on when level rises, and off when level falls.

Two modes of process control exist.

Primary mode of operation (Level Controller) is the normal operating mode. In this mode, a "LEVEL CONTROLLER" pilot light is illuminated. The system operates in this mode when the conditions are normal (as explained in the following paragraphs). When in this mode of operation, the level controller runs the pumps based wetwell level as sensed via a level transmitter. Wetwell high/low alarm and pump start/stop setpoints may be set via the level controller. Pump alternation is accomplished via level controller programming.

Secondary mode of operation (FLOAT) is the backup operating mode. In this mode, a "FLOAT" pilot light is illuminated. The system operates in this mode when selected, or when conditions are abnormal (as explained in the following paragraphs). When in this mode of operation, hard-wired relays and timers run the pumps via based on wetwell level as sensed via floats. Pump alternation is accomplished via hard-wired alternator. The system is capable of running in this mode as long as

necessary.

Primary Control Selector Switch

A “Float-Level Controller-Reset" selector switch exists on the control panel and is used to select the wet well process demand control mode.

Float: Selects Float control. Wet well process demand is based upon floats and hardwired relays in control panel.

Level Controller: Selects LEVEL CONTROLLER control. Wet well process demand and is based upon level transducer, unless control mode has failed over to Float mode.

Reset: Momentary position. Switch returns to "LEVEL CONTROLLER" position. Control mode is reset to LEVEL CONTROLLER from Float. If all faults have not been cleared at the time the reset position is selected, the system may again fail over to the Float mode.

PRIMARY CONTROL FAIL

While conditions are normal (no high levels), the level controller operates the station.

A high level alarm from either the level controller or the float enables the float circuit. Primary control fail must be manually reset by selecting "Reset" on the panel-mounted selector switch.

Any of the following result in primary control fail:

1. Wet well High level float (hard-wired in control panel)
2. Wet well High level from transducer (programmed in level controller)

B. Starter Control and Monitoring
   a. The starters shall be controlled by the level sensors (transducer or floats) through a combination intrinsic safe barrier and alternator/duplexer. Monitoring of the operation shall be by the PLC. Alarm floats, auxiliary starter contacts, seal fail alarms, and other monitoring/alarm functions shall be wired to the PLC as digital inputs. The Level Transducer and Flowmeter shall be wired to the PLC as analog inputs. A normally closed contact of a time delay relay shall interrupt the starter coil when expected pump discharge pressure is not sensed. Pump Failures shall be reset by switching the H-O-A switch to the OFF position. The contact ratings of the relays shall be 5 amperes minimum.

C. Device Identification
    a. All devices mounted flush on the inner or exterior cabinet doors shall be identified with engraved phenolic legend plates using black letters on a white background.
    b. All devices mounted on the interior of the cabinets, including but not limited to starters, circuit breakers, terminals, relays, etc., shall be labeled with printed, not hand-written, adhesive-backed labels adhered to the subpanel. These are not required to be engraved phenolic legend plates. No labels shall be adhered to wire covers.

7.5 FIELD WIRING SPECIFICATIONS

A. Control panel wiring shall be as follows:
    a. All wiring installed on the line and load side of the electric meter shall be THHN/THWN or XHHW stranded copper wire.
    b. Electric service to the station shall be sized to provide the maximum total station amperage plus 25% of the largest motor's current with all installed pumps running under a fully loaded condition.
    c. All pump station control panels shall be provided with a minimum 100-amp service.

B. Analog wiring shall be as follows:
    a. Two-conductor #18 shielded twisted pair with outer PVC jacket.

C. Grounding system shall be as follows:
    a. Provide a minimum of two (2) 5/8" x 10' copperweld ground rods, one each side of the control panel, connected to each other and to both the control panel grounding connection and to the antenna pole/conduit using minimum #2 copper conductor.
    b. Underground connections shall use exothermic welding or other engineer-approved methods.

D. Wire Insulation Color
    a. 480 volt and 208 volt wiring shall follow industry (and NEC) standards.
    b. Conductors supplying 120 VAC on the line side of a disconnecting switch shall have black insulation for the ungrounded conductor.
    c. 120 VAC wiring (except for neutrals) shall have red insulation. 120 VAC neutral wiring shall have white insulation.
    d. 50 VAC or less shall have yellow insulation.
    e. 12/24 VDC wiring shall have blue insulation.
    f. Intrinsically safe wiring shall have purple insulation.

7.6 CONDUIT SPECIFICATIONS

A. 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 City for specific conduit sizes. **(Note that these conduit sizes may be reduced for some pump stations based on wiring used for that specific project.)**
    a. A 2-1/2" conduit shall be routed from Utility supply source to the electric meter mounted in control panel section #3. The meter and disconnect switch shall be connected together with a rigid steel conduit nipple in section #3.

b. (2) 2-1/2" conduits shall be routed from the bottom of section #3 to the Automatic Transfer Switch (ATS) – one from the disconnect switch in control panel section #3 to the Utility connections of the ATS and one from the Load connections of the ATS back to the control panel for connection to the main power distribution block.
c. A 2" conduit shall be used to route all power wires from the bottom of section #3 to the 12" X 10" X 6" power junction box in the valve chamber.
d. (3) 1" conduits shall be used to route all control wires from the bottom of section #1 to the 12" X 10" X 6" control junction boxes in the valve chamber. Intrinsically-safe (nonincendive) circuit wiring shall be installed in separate conduits from non-intrinsically-safe wiring. Analog wiring shall be installed in separate conduits from other wiring. These conduits shall be sized based on 40% fill of the conduits with the wiring in the design and 50% spare capacity.
e. The transfer switch may be mounted on the back of control panel section #2.

B. A 1.25" - 2-1/2" rigid conduit shall be used to serve as an antenna pole and to run the antenna coax from beneath the antenna into Section #1 of the control panel. This conduit/pole shall have a cap at the top to prevent intrusion of water and dirt and shall have a closure/mounting foot at the bottom for bolting to the concrete pad with anchors similar to those used to bolt the control panel to the pad. This conduit/pole shall be bonded to the grounding system and to the control panel. Coax may also be run to the under-side of section #2.

C. All conduits running to or from the control panel shall be run underground at a minimum depth of 36 inches below finished grade.

D. All below ground conduit and their stub-ups shall be PVC schedule 80 or fiberglass.

7.7 ARC FLASH ASSESSMENT

PART 1 GENERAL

A. SCOPE
   a. The scope of the studies shall include the electrical distribution equipment as identified by the Owner.

B. RELATED SECTIONS
   a. Drawings and general provisions. Drawings will be made available to the Contractor for review upon release of a purchase order if drawings for the equipment to be studied are available.

C. REFERENCES
   a. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      i. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
      ii. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
      iii. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis

iv. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
v. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
vi. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

b. American National Standards Institute (ANSI):
i. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
ii. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
iii. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
iv. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

c. The National Fire Protection Association (NFPA)
i. NFPA 70 -National Electrical Code, latest edition
ii. NFPA 70E – Standard for Electrical Safety in the Workplace

D. SUBMITTALS FOR REVIEW/APPROVAL
a. The studies shall be submitted to the responsible City representative for review and approval prior to final completion.

E. FINAL SUBMITTALS
a. The results of the short-circuit protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Electronic PDF copies of the report shall also be provided.
b. The report shall include the following sections:
i. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
ii. Short-Circuit Methodology Analysis Results and Recommendations
iii. Short-Circuit Device Evaluation Table
iv. Protective Device Coordination Methodology Analysis Results and Recommendations
v. Protective Device Settings Table
vi. Time-Current Coordination Graphs and Recommendations
vii. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
viii. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.

ix. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis. All drawing files must also be submitted electronically as a .dwg file format for future updating by City personnel.

F. QUALIFICATIONS

a. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
b. The Registered Professional Electrical Engineer shall be an employee of the approved contractor.
c. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
d. The approved contractor shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.
e. The contractor shall have a minimum of ten (10) years of experience in performing power system studies.

G. COMPUTER ANALYSIS SOFTWARE

a. The studies shall be performed using ETAP software or approved equal. The purpose of this requirement is to allow the City to obtain studies and reports that remain consistent and similar by design to studies that have already been provided to several of our locations.

PART 2 PRODUCT

A. STUDIES

a. The Contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies.

B. DATA COLLECTION

a. Field data collection shall be performed by the Contractor's professional engineer and they must be a qualified person (as defined by NFPA 70E) to ensure accurate equipment modeling. The engineer shall have completed an instructor-led Electrical Safety Training Course. The course shall include NFPA 70E training which includes the selection and use of personal protective equipment.
b. The Contractor will visually inspect to verify the equipment ratings, conductor ratings and overcurrent device data by removing panels, covers and doors where required to document the necessary data used in the analysis. These inspections can be performed with the equipment energized provided the incident energy values are

less than 40cal/cm², greater values or unusual site conditions will require an equipment shutdown so the equipment can be inspected de-energized.

c. The City shall provide qualified personnel to show the Contractor the equipment location and to open all equipment doors, locks, etc. necessary to collect nameplate data.
d. The Contractor will verify the Owner's one-line drawings (when available) and provide marked corrections where discrepancies are found.
e. Data collection shall begin downstream from the utility service and continue down through the Owner's electrical distribution system as defined under scope of work. The study shall not include any single phase AC circuits or DC distribution systems as these types of circuits and systems are excluded from IEEE 1584-2002 Arc Flash calculation guidelines. The study will not include equipment below 240 Volts, per Section 4.2 of IEEE 1584, unless it involves (1) 125KVA or larger low impedance transformer in its immediate power supply capable of supplying 10,000 AIC or greater.
f. The Contractor shall obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

C. SHORT-CIRCUIT ANALYSIS

a. Transformer design impedances shall be used when test impedances are not available.
b. Provide the following:
    i. Calculation methods and assumptions
    ii. Selected base per unit quantities
    iii. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis. All drawing files must also be submitted electronically as a .dwg file format for future updating by City personnel.
    iv. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
    v. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
    vi. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system to include an engineer's cost estimate for recommended improvements.

c. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.
d. Protective Device Evaluation:
    i. Evaluate equipment and protective devices and compare to short circuit ratings
    ii. Adequacy of switchgear, motor control centers, and panel board bus bars to withstand short-circuit stresses
    iii. The Contractor shall notify the City in writing, of any circuit protective devices improperly rated for the calculated available fault current.

D. PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS
a. Protective device coordination time-current curves (TCC) shall be displayed on loglog scale graphs.
b. Include on each TCC graph, a complete title with descriptive device names.
c. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
d. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
e. Plot the following characteristics on the TCC graphs, where applicable:
    i. Electric utility's overcurrent protective device
    ii. Medium voltage equipment overcurrent relays
    iii. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
    iv. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
    v. Transformer full-load current, magnetizing inrush current, and ANSI throughfault protection curves
    vi. Medium voltage conductor damage curves
    vii. Ground fault protective devices, as applicable
    viii. Pertinent motor starting characteristics and motor damage points, where applicable
    ix. Pertinent generator short-circuit decrement curve and generator damage point
    x. The largest feeder circuit breaker in each motor control center and applicable panel board.
f. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
g. Provide the following:
    i. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known. All drawing files must also be submitted electronically as a .dwg file format for future updating by City personnel.
    ii. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

iii. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
iv. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram
v. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
vi. The Contractor shall notify the City in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements to include an engineer's cost estimate for the recommended improvements.

E. ARC FLASH HAZARD ANALYSIS

a. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 7.7.C) and the protective device time-current coordination analysis (Section 7.7.D)
b. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panel boards, busway and splitters) where work could be performed on energized parts.
c. Circuits less than 240 , where available bolted short circuit current is less than 10 kA, may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E Table 130.7(C)(9)(a), including footnote 3.
d. Circuits less than 240 fed by transformers 112.5 kVA or less may be omitted from the computer model and will be assumed to have a hazard risk category 0 per IEEE 1584.
e. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
f. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
g. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous

generators with the electric utility, where applicable as well as any stand-by generator applications.

The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

h. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
    i. Fault contribution from induction motors should not be considered beyond 5 cycles.
i. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.
j. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
k. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
l. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
m. Provide the following:
    i. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
    ii. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.
    iii. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety. If any new equipment recommendations or improvements are made by the contractor to reduce the incident energy levels, include an engineer's cost estimate for the recommended improvements.

PART 3 EXECUTION

A. FIELD ADJUSTMENT

a. The City shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
b. The City shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
c. The Contractor shall notify the City in writing of any required major equipment modifications.

B. ARC FLASH LABELS

a. The Contractor shall provide a 4.0 in. x 4.0 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
b. The labels shall be designed according to the following standards:
    i. UL969 – Standard for Marking and Labeling Systems
    ii. ANSI Z535.4 – Product Safety Signs and Labels
    iii. NFPA 70 (National Electric Code) – Article 110.16
c. The label shall include the following information:
    i. System Voltage
    ii. Flash protection boundary
    iii. Personal Protective Equipment category
    iv. Arc Flash Incident energy value (cal/cm^2)
    v. Limited, restricted, and prohibited Approach Boundaries
    vi. Study report number and issue date
d. Labels shall be printed by a thermal transfer type printer, with no field markings.
e. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:
    i. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
    ii. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
    iii. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.
f. Labels shall be field installed by the Contractor. The technician providing the installation shall have completed an 8-Hour instructor led Electrical Safety Training Course with includes NFPA 70E material including the selection of personal protective equipment.

SECTION 8 - SCADA MONITORING & ALARM SYSTEM

8.1 SYSTEM REQUIREMENTS

A. Each pump station shall have a Control Panel with a PLC conforming to the City's existing system. The major components of the ACE system shall include:
   a. PLC, Allen-Bradley 1766-L32BWAA
   b. Other auxiliary equipment indicated on the drawings and in other parts of this specification

B. The City's system operates on 205-225 MHZ utilizing a PLC for interrogation and acknowledgment of alarms.

C. The PLC shall be provided by the System Integrator inside the Control Panel. The contractor shall install and terminate the Control Panel per the construction drawings. The PLC shall not be energized until City programming personnel are present for program download and startup.

D. The control panel shall be fabricated with an open area on the back sub-panel to mount the PLC. Terminal blocks shall be adjacent for all PLC wiring. This will insure easy integration into the panel. Details will be included on the contract drawings.

8.2 ANTENNA

A. The antenna azimuth shall be in the direction of the nearest satellite receiver +/- 15 degrees.

B. The actual working antenna height is to be determined by the City Programmer. The minimum height allowable per the City is 20’ above finished grade. If the antenna needs to be located higher than 20’, contact the Pump Station Division for additional pole specifications. Coax cable shall be through weather head at top of antenna pole.

   a. Acceptable Manufacturer: Antenna
      i. Comtelco #Y6623D– 200
      ii. approved equal

8.3 POLE SPECIFICATIONS

A. The antenna shall be mounted a minimum of 20’ from finished grade on the rigid galvanized steel, aluminum, or fiberglass conduit referenced in the conduit section of this specification. Connect to the grounding system to protect all antennas.

8.4 POLE SITE LOCATION

A. Antenna pole/conduit shall be installed behind the control panel as indicated on the control panel drawings.

8.5 ALARM COAXIAL CABLE

A. The antenna coaxial cable shall be installed as follows:
   a. The coaxial cable shall be run in one continuous length with no splices. The coax shall be terminated at the antenna connector on one end and a lightning arrestor on

the other end. Another cable shall be connected from the lightning arrestor to the connector on the outside of the radio cabinet (to be installed per vendor drawings).

b. All R.F. cable connectors outside of the radio cabinet shall be properly terminated and sealed with 3M Cold Shrink.
c. Acceptable Manufacturers:
    i. Coax: Belden #8267 (RG213U), or LMR-400
    ii. Lightning Arrestor: Polyphasor: #VHF50HN
    iii. RF connector: Andrew #400BPNM-C
    iv. Cold Shrink: 3M P/N (8425-7 and 8426-9)

8.6 SYSTEM INTEGRATOR SCOPE OF WORK

A. Refer to paragraph 7.1 of this specification for further description of the required Scope of Work for the System Integrator.

SECTION 9 - GENERATOR & ATS SYSTEM

A standby generator system complete with diesel engine, alternator, battery charger, weather-protected housing, integral fuel tank, generator disconnect, automatic transfer switch (ATS), and all appurtenances shall be provided by the contractor. The major equipment and components shall include the following:

9.1 GENERATOR

A. REFERENCES

1. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. ANSI/NEMA MG 1 - Motors and Generators.
3. ANSI/NFPA 70 - National Electrical Code.
4. ANSI/NFPA 99 - Health Care Facilities.
5. ANSI/NEMA AB 1 - Molded Case Circuit Breakers.
6. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines.
7. NFPA 110 – Emergency and Standby Power Systems.

B. SYSTEM DESCRIPTION:

1. Engine generator system shall provide a source of emergency and standby power.
2. System Capacity: Minimum **50** KW at an elevation of 1,000 feet above sea level, and ambient temperature between -20°F and 110°F; standby rating using engine-mounted radiator. **(This generator rating is based on a pump station with 20 hp pumps that are duplexed and alternated and using a 480 volt, 3 phase, 100 amp service or less. Each project shall determine the correct size of generator, automatic transfer switch, and utility service based on the pump station configuration and size. The Engineer shall run Generator Sizing software and enter all simultaneous loads and starting sequences to determine the necessary size of the engine-generator set.)**
3. Operation: In accordance with ANSI/NFPA 99.Functional Description.
4. Subject to compliance with requirements, provide completely assembled and tested engine-generator units by one of the following engine generator set manufacturers:
   a. Caterpillar, Inc.
   b. Cummins Power Generation
   c. Kohler Company
   d. MTU On Site Energy

C. SUBMITTALS

1. General: Submit the following according to Conditions of Contract and Division 01 Specification Sections.
2. To be Submitted before Equipment Order:
   a. Product data for products specified in this Section. Include data on features, components, ratings, and performance. Data shall include weights, fuel consumption rates, ventilation and combustion air requirements, exhaust flow data, cooling system data and engine and generator data. Include dimensioned outline plan and elevation drawings of engine generator set and other system components.

b. Shop Drawings: Detail fabrication, piping, wiring, and installation of the field-installed portions of the system. Include general arrangement drawings showing locations of auxiliary components in relation to the engine generator set and duct, piping, and wiring connections between the generator set and the auxiliary equipment. Show connections, mounting, and support provisions and access and working space requirements. Submit all pertinent construction details for weatherproof enclosures.

c. Wiring Diagrams for System: Show power and control connections and distinguish between factory-installed and field-installed wiring. Terminals for field wiring the system controls and between equipment shall be labeled in a consistent point to point manner by the manufacturer.

D. MANUFACTURER SEISMIC QUALIFICATION CERTIFICATION: Submit certification that engine-generator set, batteries, battery racks, accessories, weatherproof enclosure and components will withstand seismic forces as defined for the pump station site. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. CERTIFIED SUMMARY OF PROTOTYPE UNIT TEST REPORT:

1. Submit certified copies of actual prototype unit test report.

F. EMISSIONS

1. Submit certificates for compliance with EPA Emissions Standards for Compressed Ignition Engines.

G. ENGINE GENERATOR SET

1. Type: Water-cooled in-line or V-type, compression ignition diesel electric ignition internal combustion engine.
2. Rating: Sufficient to operate at 100 percent load for two hours at specified elevation and ambient limits.
3. Fuel: No. 2 fuel oil
4. Rated Engine Speed: 1800 rpm.
5. Lubrication System. The following items shall be mounted on engine or skid:
   a. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   b. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
6. Engine Fuel System:

a. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
b. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
c. Engine Fuel Supply System: Comply with UL 142 fuel oil tank.
d. Base-Mounted Fuel Tank: UL listed fuel tank with at least 24 hours of full load operation capacity. Integral rupture basin with leak detection. Provide fueling port with an overfill prevention type receptacle and lockable cap for exterior units. The tank shall include structural steel supports for top mounted engine generator set. Furnish complete with flexible fuel line connectors, lockable cover, and analog level gauge. Furnish complete with float switches to indicate low fuel level 25%, 50%, and 75%. The footprint of the base-mounted fuel tank shall not exceed the footprint of the enclosure for exterior installations.

7. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F, and suitable for operation on 120 volts if rated at 1200 watts or less or 480 volts if rated at greater than 1200 watts. Provide electrical circuiting and protection to the heater based on the load requirements. The minimum wattage of the heater shall be as recommended by the manufacturer
8. Governor: Adjustable isochronous, with speed sensing.
9. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   a. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   b. Size of Radiator: Non-ferrous metal construction sized to contain expansion of total system coolant from cold start to 110 percent load condition.
   c. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
   d. Temperature Control: Self-contained, thermostatic-control valve shall modulate coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
10. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
11. Air-Intake Filter: Heavy-Duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
12. Starting System: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel. Provide the following accessories:
    a. Battery: Voltage to match starter and cranking cycle of three times without recharging. Provide with acid resistant battery tray.
    b. Battery Cable: Size as recommended by engine manufacturer. Include required interconnecting conductors and connection accessories.

c. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating..

d. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

1) Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

2) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

3) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

4) Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

5) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

13. TO BE SUBMITTED AFTER EQUIPMENT ORDER:

a. Factory Test Reports: Provide for units to be shipped for this Project showing evidence of compliance with specified factory test requirements.

b. Maintenance data for system and components for inclusion in Operating and Maintenance Manual.

14. WARRANTY

a. The complete electrical power system (generator, weatherproof enclosure, engine, controls, automatic transfer switch and accessories) shall be warranted by the manufacturer against defects in materials and workmanship for a period of five (5) years from the date of Substantial Completion. Coverage shall include parts, travel expenses and labor to remove and install the necessary parts and equipment.

15. MAINTENANCE SERVICE

a. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

16. QUALITY ASSURANCE
    a. Manufacturer Qualifications: Firms experienced in manufacturing equipment of the types and capacities indicated that have a record of successful in-service performance.
    b. Manufacturer's Service Personnel: Service personnel shall be factory trained and certified in the maintenance of the specified equipment.
    c. Emergency Service: System manufacturer shall maintain a service center capable of providing training, parts, and emergency maintenance and repairs at the Project site within a time period of less than 4 hours from time of notification, 365 days per year.
    d. Electrical Items and Components shall be listed (or recognized) by Underwriters Laboratories, Inc.
    e. Non-Electrical Components shall be listed (or recognized) by Underwriters Laboratories, Inc. or other applicable Nationally Recognized Testing Laboratory.
    f. Engine Exhaust Emissions: Comply with applicable Federal, State, and local government requirements.
    g. Single-Source Responsibility: Unit shall be a representative product built from components that have proven compatibility and reliability and are coordinated to operate as a unit as evidenced by records of prototype testing.

17. NOISE EMISSION
    a. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

18. DELIVERY, STORAGE, AND HANDLING
    a. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is made safe from such hazards.

19. EXTRA MATERIALS
    a. Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Owner.
        1) Fuses: 1 for every 10 of each type and rating, but not less than 2 of each.
        2) Pilot Lights: 1 for every 3 of each type used, but not less than 2 of each.
        3) Filters: 1 set each of lubricating oil, fuel, and combustion air filters.

20. COORDINATION

a. Coordinate size and location of concrete bases for engine generators. Concrete, reinforcement, and formwork requirements are specified in other sections.

b. Provide generator electronic CAD drawings to Coordinating Contractor for inclusion into composite coordination drawings. Show generator, fuel system components, battery system components, and exhaust system in ¼ inch scale plan.

21. CONTROL AND MONITORING

a. Configuration: Operating and safety indications, protective devices, engine gages, basic system controls, and other indicated components shall be grouped in a combination control and power panel. Panel shall be mounted on the generator set unless otherwise indicated. Control and monitoring section of panel shall be isolated from power sections by steel barriers.

b. Ground Fault: **(Ground Fault sensing and indication is not normally required for generators this small. Each project should make a determination if it is needed. If not, this requirement may be removed.)** Provide ground fault sensing at the generator. The sensor shall be located ahead of the generator service disconnect. Provide a ground fault indication on the engine-generator control panel. Provide an instruction nameplate at the control panel.

1) Instruction nameplate: Provide operational instructions for a ground fault indication as approved by the local Authority Having Jurisdiction.

c. Generator Circuit Breaker: Molded or insulated case, service-rated thermal-magnetic type; 100% rated breaker complying with NEMA AB1 and UL 489.

1) Tripping Characteristic: Designed specifically for generator protection.
2) Trip Rating: Matched to generator rating.
3) Mounting: Provide freestanding enclosure or mount integrally with control and monitoring panel.
4) Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator circuit breaker shall open the circuit breaker to disconnect the generator from load circuits. Protector shall perform the following functions:
   a) Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm shall be integrated with other generator-set malfunction alarms.
   b) Under single or three-phase fault conditions, regulate generator to 300 percent of rated full-load current for up to 10 seconds.
   c) As overcurrent heating effects on the generator approach the thermal damage point of the unit, protector shall switch the excitation system off, open the generator circuit breaker, and shut down the generator set.

d) Sense clearing of a fault by other overcurrent devices and control recovery of rated voltage to avoid overshoot.

5) Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

6) Indicating Devices, Protective Devices, and Controls: Common Audible with Individual Visible Alarm to conform to NFPA 110 requirements for [Level 1] [Level 2] systems. Include necessary Form C contacts and terminals in control and monitoring panel. Include the following:
   a) A.C. Voltmeter
   b) A.C. Ammeter
   c) A.C. Frequency Meter
   d) D.C. Voltmeter (Alternator Battery Charging)
   e) Engine Coolant Temperature Gage
   f) Low Engine Coolant Temperature Indicator Lights
   g) Engine-Lubricating Oil Pressure Gage
   h) Running Time Meter
   i) 4 position Ammeter Phase Selector Switch
   j) Auxiliary Contacts: If required for control of ventilation fans and/or motorized dampers, separate terminal blocks factory wired to separate form C dry contacts. Contacts shall be for field connection and to start generator ventilation fans and motorized dampers. Contacts shall activate upon generator start signal. Provide two Form A and two Form B contacts, each rated no less than 10 amperes at 120 volts AC and no less than 5 amperes at 24 volts DC.
   k) Generator Voltage-Adjusting Control.
   l) Fuel tank derangement alarm with contacts to annunciate to SCADA
   m) Fuel tank high level shutdown of fuel supply alarm.
   n) Generator overload or fault with contacts to annunciate to SCADA
   o) Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items in engine generator control panel unless otherwise indicated.
   p) Temperature Relay: **(Temperature monitoring of the alternator bearing and stator windings is typically used for Prime Power applications as opposed to Standby Power applications. This can usually be deleted.)** Provide temperature relay(s) as required at generator to monitor bearing and stator windings. Provide minimum of two contacts (form C) for each of alarm and shutdown. Factory wire shutdown output contacts to generator control panel. Temperature relay may be omitted if the generator control panel can perform the same monitoring and output contact functions.

22. LOCAL ALARMS AND SHUTDOWN
    a. Conform to NFPA 110 requirements for Level 1 systems. Include necessary Form C contacts and terminals in control and monitoring panel.
    b. Local Alarms: Provide generator set mounted alarms as follows with shutdown where noted:
        1) Over-crank (with shutdown).
        2) Over-speed (with shutdown).
        3) Low lube oil pressure (with shutdown).
        4) High engine temperature pre-alarm.
        5) High engine temperature (with shutdown).
        6) Low fuel main tank.
        7) Generator supplying load.
        8) Low water temperature.
        9) Control switch not in auto.
        10) High battery voltage.
        11) Low battery voltage.
        12) Battery charger A.C. failure.
        13) Storage tank leak.
        14) Low coolant level.
        15) Low cranking voltage.
    c. The above alarms shall be by individually identified visual indications plus a common audible alarm.
    d. There shall be a lamp test switch to test all of the above lamps.
    e. The remote emergency stop switch shall also shut the unit down.

H. GENERATOR, EXCITER, AND VOLTAGE REGULATOR
1. Comply with NEMA MG 1, "Motors and Generators," and specified performance requirements.
2. Rating: As indicated on the drawings, at 0.8 power factor, 60 Hertz at RPM to match engine rating.
3. Electrical Insulation: All windings shall be Class F insulation applied under a vacuum pressure impregnation (VPI) cycle.
4. Temperature Rise 105°C continuous.
5. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
6. The AC generator shall be re-connectible brushless synchronous, four pole generator with brushless exciter and PMG alternator excitation.
7. Enclosure: ANSI/NEMA MG1, open drip-proof.
8. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current as described above under "System Performance."
9. The automatic voltage regulator shall be temperature compensated solid-state design. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. Overvoltage protection shall sense the AC generator output voltage and in

the event of regulator failure or loss of reference, shut down regulator output on a sustained overvoltage of one (1) second duration. Overexcitation protection shall sense regulator output and shut down regulator output if overloads exceed ten (10) seconds duration. Both overvoltage and overexcitation protection shutdowns shall be latched, requiring the AC generator to be stopped for reset.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. GENERATOR OUTDOOR HOUSING

1. Provide a prefabricated or pre-engineered weatherproof housing over unit with the following features:
   a. Construction: Reinforced galvanized-steel, metal-clad, integral structural-steel-framed building anchored to a concrete foundation. Structural design and anchorage to comply with ASCE 7 for wind loads up to 100 mph.
   b. Hinged doors on opposite sides with cylinder type locks keyed alike.
   c. Mount control panel and circuit breaker on inside of housing in such a fashion as to enable opening of the disconnect door and easy access.
   d. Provide louvers in sides and end to allow for engine and generator cooling with screen and filters to allow proper air flow while at the same time preventing dust, bird and rodent entry.
   e. Muffler shall be mounted within the enclosure.
   f. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits as required by engine-generator-set components. **(This may normally be deleted as a space heater and enclosure thermal insulation are usually needed only for custom enclosures such as for walk-in applications that are typically not used for small standby generators.)**
   g. Fuel Tank Vent: Provide vent piping from the fuel tank to the exterior of the enclosure.
   h. Fuel Fill: Provide fill access on the exterior of the enclosure.
   i. Acoustical Treatment: Provide acoustical treatment of the generator enclosure including wall panels, intake and exhaust air paths, ventilation openings, and tailpipe exhaust. Maximum sound level horizontally from the generator set shall be 79 dBA at 3 feet in a hemispherical free field in the configuration shown on the drawings. Sound attenuators shall be concealed within the enclosure panels. Panels shall extend from the enclosure base frame to the height of the generator section. **(These are typical requirements only. The specific sound reduction requirements will depend on the generator set being used, the location and orientation of the generator set on the site, and the nature of the site location and its neighbors. A determination of specific requirements to comply with sound ordinances shall be made for each site and adjustments in the specification shall be made accordingly. If very stringent sound reduction is required, this will probably require a custom enclosure.)**
   j. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of

rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

k. Large generators requiring regular radiator maintenance with access from the top of the unit shall have a fixed ladder installed.

K. VIBRATION ISOLATION DEVICES

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to ¼-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
3. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

9.2 AUTOMATIC TRANSFER SWITCH (ATS)

A. REFERENCES

1. NEMA ICS 1 - General Standards for Industrial Control and Systems
2. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies
3. NEMA ICS 6 – Enclosures for Industrial Controls and Systems
4. NEMA ICS 10 - AC Automatic Transfer Switches
5. UL 1008 – Standard for Automatic Transfer Switches

B. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Emerson; ASCO Power Technologies, LP.
   b. GE Zenith Controls.
   c. Russelelectric, Inc.
   d. Generator manufacturer.

C. GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

1. Provide transfer switches with number of poles, voltage and current ratings and accessories as shown on drawings.
2. Transfer switches shall be electrically operated and mechanically held.
3. The electrical operator shall be a solenoid mechanism, momentarily energized to minimize power consumption and heat generation.
4. Transfer switches shall include both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at the same time.
5. Transfer switches shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized.

6. Transfer switches shall be provided with a microprocessor control panel and a door-mounted display panel for user interface.
7. Inspection of all contacts shall be possible from the front of the switch, without disassembly of operating linkages and without disconnection of power conductors.
8. Transfer switches shall be capable of handling continuous-duty repetitive transfer of full-rated current between active power sources.
9. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
10. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code where applicable and by numbered or lettered wire and cable tape markers at terminations.
11. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
12. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
13. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

D. RATINGS
1. Available interrupting capacity (AIC) rating for each transfer switch shall meet or exceed the values listed within the drawings.
2. Series rating with upstream devices shall be allowed per UL-1008.
3. The required series rating shall be the larger of the two AIC values when the AIC rating of the equipment feeding the normal and emergency sides of the transfer switch is not equivalent.

E. AUTOMATIC TRANSFER-SWITCH SEQUENCE OF OPERATION
1. Initiate Time Delay to Start Alternate Source Engine Generator:
   a. Upon initiation by normal source monitor.
2. Time Delay to Start Alternate Source Engine Generator:
   a. Zero (0) to ten (10) seconds, adjustable.
3. Initiate Transfer Load to Alternate Source:
   a. Upon initiation by normal source monitor and permission by alternate source monitor.
4. Time Delay Before Transfer to Alternate Power Source:
   a. Zero (0) to thirty (30) seconds, adjustable.
5. Initiate Retransfer Load to Normal Source:
   a. Upon permission by normal source monitor.
6. Time Delay Before Transfer to Normal Source:
   a. Zero (0) to thirty (30) minutes, adjustable. Bypass shall have a time delay in the event of an alternate source failure.
7. Time Delay Before Engine Shut Down:
   a. Zero (0) to thirty (30) minutes, adjustable. Time delay shall begin when generator is unloaded.

F. ANNUNCIATOR SYSTEM

1. Functional Description: Contacts for monitoring by a remote annunciator panel include the following:
    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
2. Indicating Lights: Provide indicating lights mounted in cover of enclosure to indicate the following:
    a. Normal Source Available.
    b. Alternate Source Available.
    c. Switch Position.

G. ACCESSORIES

1. Engine Exerciser: Provide an integral engine exerciser to automatically test the engine generator set with or without load on a set schedule and duration. Parameters associated with start time (day, week, month), frequency and duration of test shall be fully programmable.
2. Strip Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

SECTION 10 - SITE REQUIREMENTS

10.1 SITE AND ACCESS ROAD PAVEMENT

Pavement will be required at the pumping station as follows:

A. Station Area

All pump and valve chambers shall have a 6' (minimum width) paved apron placed around the pumping structures. The pavement shall be sloped so as to permit surface water to drain away from the station.

When fencing is required around the station area, the pavement shall be extended an additional foot beyond the fencing perimeter.

B. Station Access Road

The access road shall be: Minimum of twelve-foot wide and be designed to limit the access road grade to a 10% maximum. If the road grade must exceed a 10% slope, a combination of step type sloping and protection barriers will be required.

The access road shall have a tum around area at the station end of the access road large enough to accommodate the turning radius of a 16-foot 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

1. Asphaltic Concrete:
The access road and area surrounding the station shall be paved with 2” of type “C” asphaltic concrete laid over 6” of type “X” asphaltic concrete. All subgrade shall consist of 6” of compacted Type 5 Aggregate Base.

2. Poured Concrete:
Concrete pavement shall be Class A 6” thick, six sack mix with a 4” slump. Pavement shall be reinforced with 8 gauge, 6 x 6 welded wire mesh. The concrete shall be laid over a well-compacted 4” stone base.

D. Entrance Road Barriers

Stations requiring entrance roads shall have 36-inch high barrier posts installed at the road entrance. Post shall be constructed of 6” concrete filled steel or iron pipe, or 6”x6” cedar posts. Posts shall be set 30” below ground in an 18” x 36” 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” x 12” reflective plate shall be attached to the chain at the span center.

10.2 FENCING

Fencing shall be required around all pump station sites. Fencing must be included on the pump station site plan. 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 black or green vinyl clad 6’ high chain link fabric. Wire shall be No. 11 gauge woven in a 2” mesh. Top and bottom selvages shall be barbed.

All posts and other appurtenances used in the construction of the fence shall be black or green vinyl clad schedule 40 pipe. Fiberglass or other material fencing components will not be acceptable.

A 12' wide entrance gate will be provided for access to the station grounds. A 3’ wide man entry shall be provided with a separate lock.

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	1-1/2” Nominal (1.9” O.D.)	2.72 lbs./ft.
Frame End Comer 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.

Extension arms with 3 strands of barb wire shall be installed at the top of each post. 3 strands of barb wire shall be placed continuously along the top. Wire shall also be placed on the top of the gates.

B. Fencing Placement

Fencing shall be located so that:

- There is a 4' space between all auxiliary pump station equipment, panels, antenna poles, 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.

C. Warning Signs

Warning signs shall be placed along all sides of the fence and on each gate. See plan details for additional information. Signs shall be 1.5" high black letters on a white background. Signs shall be 18 gauge aluminum.

10.3 POTABLE WATER FROST PROOF HYDRANT AND SERVICE LINE

Water service shall be provided to the site.

A. Frost proof hydrant

The hydrant provided shall be frost proof and located so as not to interfere with the operations of the lift station, control panel, generator, etc. and shall not inhibit access to the site.

B. Water service line

The water service line shall be 1" with a meter installed per City of St. Charles specifications. Service line and hydrant shall meet all DNR separation requirements.

10.4 SITE MAINTENANCE

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

10.5 RESTORATION

The site shall be restored and ground cover established. Ground cover shall be grass seed or sod and shall match the surrounding area. Final acceptance of the station shall be withheld until the site is restored to the City's satisfaction.

10.6 LIGHTING

A security light shall be provided. The security light shall be directional style and wired to a switch or breaker inside the pump control panel. The light shall be a LED style light with photoelectric control and impact resistant lens. Light pole shall be 20-ft. tall as measured from the ground. Base and foundation shall meet all required local codes.

SECTION 11 - INSPECTION AND ACCEPTANCE REQUIREMENTS

In addition to the ongoing construction inspection by City Inspectors, Operations/Pump Station personnel shall make two inspections of the constructed work at specific stages of the pump station construction. The contractor responsible for constructing the pump station shall notify the City when the facility is ready for inspection. Failure to have the inspection performed at the proper time during the construction process could result in the City requiring the removal and reconstruction of the completed work.

11.1 STAGE ONE OPERATIONS/PUMP STATION CONSTRUCTION INSPECTION

This inspection 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 this inspection.

11.2 STAGE TWO OPERATIONS/PUMP STATION CONSTRUCTION INSPECTION

This inspection 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 pavement have been installed and are in operating condition. Representatives from the pump equipment manufacturer and the installing electrical contractor shall be present at the pump station for this inspection. Representatives shall train City personnel as necessary in the operation and maintenance of the pump station.

A. Submittal Requirements

Prior to requesting this inspection the following items shall be submitted to the City Inspector for distribution to the appropriate personnel:

- Four sets of As-built electrical schematics
- As-Built mylars and three sets of as-built prints of the pump station site, prepared by an engineer or land surveyor registered in the Missouri, certifying that all structures, sewers, roads and other pavement were built in accordance with the approved plans and located within existing easements
- A complete set of the as-built drawing computer files in AutoCADD Lt format (CD)
- 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 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 (2 copies of all documents)
- Copy of electric, gas and water bills to facilitate the transfer of these accounts to the City at the time of dedication.

B. Pump Tests

In the presence of the City personnel, the contractor shall subject the pump equipment to such operating tests as may be required by the City to demonstrate that the equipment performs in accordance with the design requirements. As 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 meg-ohms resistance per winding on a meg-ohm 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 tor 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.

C. Communication System Test

The communication system shall be tested to verify that it has been activated and is in proper working order and interfacing with the City system.

11.3 RE-LNSPECTION OF WORK

The City will perform one inspection and re-inspection at each stage of the construction at no charge to the Owner. The Owner will be responsible for all additional costs associated with the City's re-inspections due to the failure of the Contractor to satisfactorily correct the identified deficiencies.

11.4 CONSTRUCTION ACCEPTANCE

Construction Acceptance of the Pump Station shall be subject to the completion of all items stated above as well the installation of fencing and satisfactory completion of all site restoration.