CONSTRUCTION SPECIFICATIONS FOR PREFABRICATED LIFT STATIONS

500 General

This section identifies the planning and design approach to be used for sanitary sewer pump stations in the WMU service area and defines specific criteria by which sanitary pump stations will be designed and delineates submittal requirements required by WMU for review and approval of sanitary pump stations.

Only in extreme instances in areas served by WMU, will WMU approve pumping wastewater in lieu of designing for gravity flow to the wastewater treatment plant. All proposed pump stations must be approved in advance by WMU. The following conditions and factors may justify the need for a pumping station:

- The area to be serviced is too low to be drained by gravity to the treatment plant; or is isolated by topography or distance from any trunk sewer which drains by gravity to the wastewater treatment plant.

- Service is required for adjacent areas to the proposed development's gravity sewer that are outside the natural drainage area but within the development area, and no other alternate for provision of sanitary sewer service is identified.

501 Sanitary Pump Station Plan Submittal Procedures

The Developer/Engineer shall submit to WMU, for review and approval, a Concept Plan, a Preliminary Design, and a Final Design for any sanitary sewer pump station. Approval by WMU staff will be required for each step prior to proceeding to any succeeding phase. Following approval of the final design by WMU Staff, the pump station design must be approved by the WMU Commission and the Kentucky Energy and Environment Cabinet, Division of Water, as outlined in Section 101 of the Development Manual.

501.1 Concept Plan Submittal

The purpose of the Concept Plan is to provide WMU with preliminary design data for proposed facilities (sanitary sewers, pump station, force mains) to determine the compatibility of the proposed facilities with the approved Winchester/Clark County Comprehensive Plan (latest revision).

Concept Plan submittals for developments requiring a sanitary sewerage pump station shall include the following elements:

1. A narrative description of the proposed development and drainage areas that can be served with the proposed facility.
2. Population and flow projections for the proposed service development and drainage areas.
3. A description of alternative means of serving the proposed development which were considered.

4. A recommended plan for the provision of sanitary sewer service to the area, including connection to existing facilities. The recommended plan should include preliminary drawings to illustrate the proposed facilities.
5. A description of how the proposed pump station will be eliminated if the proposed pump station is not shown as a permanent pump station in the Sewer Master Plan.
6. Description of existing facilities and a narrative about the impact of the proposed facilities on existing infrastructure.

501.2 Preliminary Plans

During the preliminary design phase, the proposed pumps, motor control system, hoist systems, valves, valve control devices, hatch openings, and method of construction shall be discussed with WMU. Brochures shall be submitted for recommended items.

The design Engineer shall also discuss with WMU the housing structure, if required, before design drawings are prepared. The superstructure shall be designed functionally to provide ease in installation and removal of equipment. The exterior of the building shall be compatible with the neighborhood.

Necessary surveys and site inspection shall precede preparation of the design plans. The plans shall show the general layout of the site, sewers, force main, wet well, , equipment, valves, sluice gates, backup generators, telemetry, controls and access arrangements. Cross sections shall show the elevations of functional components, equipment, piping and floors, and dimensions of concrete elements. Plans and elevations of the superstructure shall show the architectural treatment of the surface. The general layout of power and pump controls, lighting, heating and ventilating equipment shall also be shown. The design plans shall be accompanied by hydraulic and other computations necessary to support the design, pump operating curves, and control equipment functional characteristics. Outline specifications describing all equipment, controls and method of excavation, and dewatering and construction shall be submitted at this time, along with a list of patented articles for which no alternatives are contemplated.

The design plans shall also include provisions for easy elimination of the pump station in the future, if WMU decides there is such a possibility.

The future elimination provisions shall include but are not limited to the following:

- A manhole just upstream of the pump station.
- The manhole shall include a sanitary sewer stub with a plug, ready for future connection to a gravity sanitary sewer.
- Stop plank grooves in the force main at least 12 inches upstream of the outlet pipe feeding the pump station. When the pump station is eliminated, the space between stop planks and manhole wall will be filled with a concrete plug.

502 Sanitary Pump Station Plan Submittal Procedures

Sanitary Sewer Pump Station Submittals shall comply with the provisions as outlined in Section 100 and Section 300 of this manual.

502.1 Final Design Plans and Specifications

The final plans shall detail all structural members, piping, valves, gates, equipment supports, site work, wiring, controls, and all parts of the work. Details of pumps, motors and components of controls may be omitted from the plans if unusually complex, and if fully described in the specifications. The pumping station design data shall be shown on the final plans.

The plans and specifications shall leave the choice of construction methods to the contractor, but shall include criteria for a possible sequence of excavation, design of sheet piling or caisson, if required, and control of ground water.

The final design submittal shall include population and flow projections and calculations.

1. Wet well calculations.
2. Force main calculations.
3. Pump selection criteria
4. Pump curve/system curves in feet of total dynamic head versus flow in gallons per minute with the following labels:
   - Pump Curve; Single Pump Operation Curve; Two Pump Operation Curve; Three Pump Operation Curve (if applicable)
   - Design Point(s)
   - Operating Points(s)
   - Operating Envelope.
   - Shutoff head shall be included where it will be a controlling point.
5. Total hydraulic efficiency at operating point(s).
6. Pump cycle time.
7. Valve configuration.
8. Float setting calculations.
9. Buoyancy calculations.
10. Force main pressure and water hammer calculations.
11. Odor control calculations and/or assumptions along with mitigation measures if appropriate.
12. Electrical calculations and power requirements.
13. Determinations for air-release and/or combination air/vacuum release valves.
14. Site plan showing details of site access, electrical utility pole or service rack location.
15. Projected annual cost to operate and maintain the pump station.

503 Design Approach

The proposed construction or expansion of sanitary pump stations shall be in compliance with the approved 2012 Facilities Plan and the Sanitary Sewer Master Plan.

Prior to construction of sanitary pump stations, the design documents must receive the approval of the Winchester Municipal Utilities Commission and the Kentucky Energy and Environment Cabinet, Division of Water, as outlined in Section 101 of this Manual.

All submittals must be stamped and signed by a Professional Engineer currently registered in the Commonwealth of Kentucky.

504 Design Criteria

Definitions

1. Population Equivalents (PE) – The population number determined by dividing the total anticipated flow from all zoning classifications in the watershed by 120 gallons.
2. Average Daily Flow – Population Equivalent number times 120 gallons.
3. Average Flow Rate – Average Daily Flow divided by 1,440.
4. Peak Hourly Flow Rate – Average Flow Rate X Peaking Factor.
5. Peaking Factor – A factor determined by the Ten States Standards' expression $Q_{peak}=(18+\sqrt{P})/(4+\sqrt{P})$, where P= population of the sanitary sewer pump station service area in thousands of population equivalents.

General

Population and flow projections for developed and undeveloped areas which are used to design sanitary pump stations shall be as defined in the Sanitary Sewer Master Plan and the Winchester/Clark County Comprehensive Plan.

For instances where the Winchester/Clark County Comprehensive Plan are undefined or long range, the Design Engineer will prepare population projections which will be subject to review and approval by WMU.

Pump stations shall be of the dual wet well type utilizing submersible pumps. They shall operate automatically under normal conditions but be capable of manual control. Where pump station locations are not based on ultimate development of the drainage basin, they shall be planned and designed for ease of future elimination.

Precast concrete or cast-in place concrete wet wells are acceptable.

Design shall be based on an average daily flow of 120 gallons/capita/day with a peaking factor as determined by the Ten States Standards' expression $Q_{peak}=(18+\sqrt{P})/(4+\sqrt{P})$, where P= population of the pump station service area in thousands of per capita equivalents. The minimum cycle time shall be 7 and 1/2 minutes based on the average flow of 120 gallons/capita/day.

The pumps shall be sized such that, with any one pump out of service, the remaining pump(s) will handle the peak hourly flow rate.

The pump station shall be raised so that a 2-foot minimum freeboard shall be maintained above the 100-year flood, if in a flood plain, or two feet above the local surface water flow of a 100-year frequency storm. In either case, the pump station shall be sealed to provide maximum protection against flooding.

All gate and check valves shall be installed horizontally in a shallow concrete vault next to the wet well, which shall meet the same elevation and sealing requirements. The arrangement shall provide for easy access to the equipment to facilitate the maintenance work required. Valve vaults are confined spaces, and therefore require adequate means for ingress and egress, including ladders and hatches of sufficient size, as well as automatically activated ventilation of sufficient quantity to comply with OSHA requirements.

Pump station discharge flow monitoring shall be provided by means of a full diameter magnetic flow meter mounted in the force main. The output values, both flow rate in gallons per minute and total flow, of the magnetic flow meter shall be transmitted to a display installed in the pump control cabinet.

The magnetic flow meter shall be installed in a separate concrete vault, downstream of the valve vault, with the output display in the control panel.

The pump station design shall include the necessary accessories such as slide guide rails, lifting chains, and a portable hoist for lifting the pumps and/or valves. A socket for the portable hoist will be provided in both the wet well tops and the valve vault tops.

An access hatch with hinged cover, including a locking device shall be provided for each wet-well and the valve vault.

An above grade structure may be included in the design to house the pump control centers and other equipment. For smaller pump stations, the above grade structure may be eliminated, but the pump control centers must be designed for outdoor service (NEMA 4X stainless steel, minimum). Should conditions require a higher rating for the pump control center enclosure, WMU will advise the developer/engineer of such requirement during the review process.

All pump stations shall be surrounded by a 6-foot high chain link security enclosure, with a minimum 12-foot entrance gate. The entrance gate shall be located to provide access for a boom truck to reach the wet wells. All of the ground surface within the enclosure fence shall be at an elevation of one foot above the 25-year flood elevation, if in a flood plain, or one foot above the local surface water flow of a 25-year frequency storm. The entire area inside the security fencing shall be paved with bituminous concrete pavement.

A paved access road with a minimum width of 12 feet and a turn-around to accommodate an AASHTO SU design vehicle will be provided to the pump station, with a minimum surface elevation equal to the elevation inside the station fenced area.

The pump station shall be provided with water service. For all stations, backflow preventers shall be installed to prevent possible cross connections.

All pump station designs shall comply with all regulatory codes, such as electrical, sanitary, safety and plumbing.

Any deviations from the above criteria shall be submitted to WMU for review and approval.

505 Wet Well Design

Wet wells shall be designed for the ultimate peak flow of the drainage basin, or portion thereof, which the pump station will serve. Each of the dual wet wells shall be designed to provide the necessary control levels for adequate pump cycle times and starting and stopping of units for a 7 and 1/2 minute minimum cycle time with one wet well out of service. Maximum detention time in the wet well shall average no more than 30 minutes without provision for odor control.

Minimum wet well volume between starting and stopping levels for a pump can be calculated from the following approximate equation:

Volume = 1/4 pump output x cycle time

Detention times for both initial average flow and ultimate average flow conditions shall be computed.

Wet well volume and sizing shall be based on a drawdown range of 4 feet.

The wet well bottoms shall have a horizontal area no greater than necessary for proper installation and function of the pumps. The floor of the wet well shall slope upward from the horizontal areas at a minimum slope 60 degrees. Filler volumes shall be deducted in determining the effective wet well volume.

There shall be provided a 6-foot diameter conjunction manhole to provide flow splitting upstream of the wet well. All gravity flows to the pump station shall pass through this manhole prior to entering the wet well. Each of the two outlet pipes of the conjunction manhole shall be provided with a wheel operated slide gate to isolate the flow to either of the wet wells.

Between the conjunction manhole and the wet wells of large pump stations (over 750 GPM) there shall be a self-cleaning bar screen with bars spaced with 1/2-inch clear openings. A platform at the bar screen level shall be sized to allow room for cleaning of the bar screen, removal of screenings and access to floats, etc. For small stations, a ladder will be considered; however, for stations in excess of 2500 GPM, a staircase will be required. Where a screening facility is provided, the isolation valves for the wet wells shall be located at the outfall of the screening facility.

For stations in excess of 2500 GPM, a split screening well with a gate between the walls and two self-cleaning bar screens will be provided. Screening grinders may also be used, with WMU permission, with each grinder unit sized to accommodate the maximum flow.

506 Force Main Design

Force mains shall be designed for ultimate peak flow conditions with a cleansing velocity rate of at least 2 fps and checked for initial and ultimate peak flow conditions to insure the velocity ranges.

Pipe material for force mains shall be as addressed in Section 303 of this manual. Sewage combination air release valves shall be provided at all high points in the force main to prevent air locking. Long horizontal runs and increases in slope may require air/vacuum and/or air release valves. Cleanout facilities shall be provided at low points in the force main and wherever else WMU shall deem necessary.

Thrust restraints and blocks shall be provided at bends. For slopes of 20 percent or greater, anchors shall be provided at each joint or at 20 foot intervals, whichever is lesser. A flexible through-wall connector shall be used at pipe penetrations through structures to allow for differential settlement.

The following design values shall be used for computing the force main friction losses based on the Hazen-Williams equation. The method of thrust restraints shall be approved by WMU.

Minimum Pipe Size = 4 inches

1. *Roughness Coefficient*
   - *HDPE pipes* = 140
   - *D.I., epoxy lined pipe* = 120 (checked at 140 and 90)
   - *C900 PVC* = 150

2. *Velocity Range* = 2.0 to 5.0 fps
   (velocities outside this range must be approved by WMU)

507 System Head Curve

The system head curve is a plot of the discharge through a pipe system of a given size against the head losses as a result of friction in that pipe system. Selection of pump size shall be based on static head and total dynamic head. The design operating point is at the intersection of the pump curve and the system curve. The pump shall have an impeller size such that the shut-off head exceeds the pumping head at $Q_{peak.}$

Static head or static pressure (h_s) shall be based on the mid-point of lead pump on/off, as follows:

h_s= (Elevation of highest pt. in the force main) - (Mid-pt. elevation of lead pump on/off)

Fittings and valves shall be converted to equivalent lengths of force main to compute pump station and force main friction losses.

Friction losses (h_f) in the force main shall be computed according to the following variation of the Hazen-Williams formula:

$$h_f = 10.44L \times \frac{Q^{1.85}}{C^{1.85}\,(d^{4.8655})}$$

Where

L = Length of pipe in feet
Q = Flow rate in gallons per minute
C = Hazen-Williams coefficient
d = Pipe Diameter in inches

Compute the total dynamic head as follows:

$$TDH = \text{Static Head} + \text{Friction Loss}$$
$$= h_s + h_f$$

The TDH shall be calculated for both the roughness (C) coefficient shown previously, and per the pipe manufacturer's recommended roughness coefficient. Both system curves shall be plotted on the pump curve submitted.

The operating point for the selected pump shall fall in the range or initial peak flow to ultimate peak flow. The selected pump and pumping rate must be approved by WMU.

The pump efficiency shall be included in the final design submittal. Following pump selection, the system should be checked for low static head conditions (full wet well condition). The minimum head curve shall be plotted on the pump curve.

When the pump station is proposed to discharge into a gravity sewer, the capacity of the gravity sewer receiving the discharge shall be checked to determine the impact on the sewer's capacity.

When the pump station is proposed to discharge into a force main sewer, an analysis of the existing pump station shall be performed to evaluate the impact of the additional flow in the existing force main and the effect this situation will have on the existing pump(s) performance. The engineer shall check initial and ultimate flow conditions to see if the existing pump capacity is compromised. Conditions shall be checked when the existing pump is pumping and when it is not pumping. An analysis of the potential for reverse flow through the existing pumps shall be included. Where conditions warrant, an upgrade of the existing station may be required. Approval of systems that discharge into force mains will be evaluated on a case by case basis.

508 Buoyancy

Where high ground water conditions are anticipated buoyancy shall be analyzed on the wet wells and the conjunction manhole to determine whether additional methods of restraint are necessary. Mechanical equipment, water weight and other temporary loads shall not be included in the analysis. A safety factor of 1.5 (minimum) is required.

Buoyancy Force shall be calculated as follows:

Buoyancy Force = Displaced Volume x Unit Weight of Water

Opposing Force shall be calculated as follows:

Opposing Force = Weight of Structural Concrete (Pre-cast or Poured in Place) + Weight of Invert Fillets + Net Weight of Saturated Soil over Bottom Slab Extension + Any Additional Restraints (No mechanical or electrical components shall be included)

Factor of Safety is calculated as follows:

$$\text{Factor of Safety} = \frac{\text{Opposing Force}}{\text{Buoyant Force}} \geq 1.5$$

509 Force Main Pressure and Water Hammer Calculations

Force main pressure and water hammer calculations shall be provided for the force main pipe proposed. Where water hammer is excessive, WMU may require provisions for controlling the closure rate of the check valves in the system.

510 Odor Control

The design engineer shall consider the need for odor control if detention time in either the wet well or the force main, based on average flow, exceeds 30 minutes.

When odor control is warranted, the design engineer shall make a recommendation to correct potential odor problems. If chemicals and/or additives are approved for odor control, the systems shall be installed in accordance with applicable standard codes.

511 Pump Stations Components

511.1 Pumps

Pumps shall be of the submersible type installed in the wet well and designed to handle unscreened, grit laden raw sewage. The motors shall be integrally mounted on top of the pump.

Motors shall be housed in an air or oil-filled watertight chamber for operation under liquid surface.

The pumps shall be designed to operate at a speed compatible with the impeller type.

For solids passing impellers, this speed should not exceed 1800 rpm. For recessed impellers, 3600 rpm will be allowed.

The pump and motor shall be affixed to a rod mounted to the bottom of the wet well and extending to above the wet well hatch, so that the pump and motor can be lifted out of the wet well and mounted back in place without losing the alignment or having to drain the wet well.

The discharge connection elbow shall be permanently installed along with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered in place, and shall be easily removed for inspection or service. There shall be no need for personnel to enter the pump well for removal of the pump. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. A sliding guide bracket shall be an integral part of the pumping unit. The entire weight of the pumping unit shall be guided by the guide bars and pressed tightly against the discharge connection elbow. Sealing of the discharge interface by means of a diaphragm or other flexible devices will not be acceptable. 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 under water without loss of watertight integrity to a depth of 1.5 times the shutoff head or 65 feet, whichever is greater.

Two pumps shall be installed in small stations having a design capacity of 700 GPM or less. Where flows exceed 700 GPM, three or more pumps shall be provided. In all stations, pumps shall be sized with such capacity that with any one pump out of service the remaining pumps will have the capacity to handle the maximum sewage flows.

Pumps and ancillary system components shall be as manufactured by Flygt, ABS, or Myers.

The design engineer should refer to the technical specifications for pump stations in the Section 4 of the Development Manual for detailed requirements concerning pump construction and materials, motors and accessories, and valves and piping.

512 Pump Control

The pumping station shall be designed for manual and automatic pump operation using an electric mercury float switch system.

Should the design engineer wish to propose other methods of pump control, they will be evaluated on a case-by-case basin. WMU shall have final approval of the method of pump control.

The controls shall operate the pumps and shall perform automatic alternation and duplexing for two pumps or triplexing for three pumps. The alternator shall alternate the lead pump once the wet well has been pumped down to stop elevation. The alternator shall also provide for energizing the other pump(s) as a backup or lag pump if needed. Provisions shall also be made for overriding the alternator by manually selecting the pump sequence.

A step control or variable level scheme shall be used for the pump control. These schemes shall establish the following sequence of operations:

Constant Speed Pumps – The lead pump shall start when the wet well volume from the pumps "off elevation" to the lead pump "start elevation" is equal to the volume derived in section 3 - 306. The minimum separation between these elevations shall be 6 inches with both wet wells in service, and 12 inches with one wet well in service.

If the influent sewage flow into the wet well is greater than the capacity of one pump, the second (and third, if a triplex station) pump shall start at predetermined levels (start elevations) and continue to run until the liquid level in the wet well(s) is pumped down to the "stop elevation" for all pumps.

Variable speed pumps: Will be considered by WMU on a case-by-case basis.

All pumps shall stop at a wet well level no lower than the mid-line of the motor of the largest pump. The low water alarm and cutout points for all pumps shall not be at a level lower than the top of the volute of the largest pump. A minimum control range of at least 3 feet is desirable between the maximum and minimum wet well levels. A manual power reset will be required after a low water cut-off. The high water alarm level shall be lower than the invert of the influent pipe and at least 6 inches above the last pump start elevation.

All levels will be determined based on motor manufacturers' recommendations for cycle times, provided the minimum cycle time of 7 and 1/2 minutes is met. Cycle time will be defined as the time between starts of the same pump under the worst expected condition.

Control interface devices on the inner door of the control cabinet shall include:

There shall be automatic alternation of the lead pump with a three position switch to control the following:

Position	Operation
No. 1	*Pump #1 shall be lead pump*
No. 2	*The lead pump shall change automatically after each stop of the lead pump*
No. 3	*Pump #2 shall be the lead pump*

For triplex stations, more positions will be necessary

Pump Motor Control Switches – Three position switches which provide the following:

Position	*Operation*
Hand	*Pump motor starts and runs until switch position changes*
Off	*Pump motor will not run*

Auto *Pump motor is controlled by the operation sequence previously mentioned.*

There shall be a green pilot light for each pump to indicate that the pump is running.

There shall be a red pilot light for each pump to indicate pump overheat, and an amber pilot light for each pump to indicate pump seal leak. The warning pilot lights shall be appropriately labeled.

There shall be a momentary push button for manually resetting the alarms.

There shall be an AC voltmeter and ammeter to monitor the incoming service. The meters shall indicate volts/amps on an arc or digital scale. Each shall be rated from 0 to an appropriate full-scale value. The voltmeter shall have a selector switch to monitor voltage between any two phases or to ground. The ammeter shall have a three-position selector switch to monitor line current on any phase.

Elapsed time meters for each pump to indicate the pump run times shall be provided. The meters shall be non-resettable, capable of registering elapsed time up to 99,999.9 hours.

Sensors and control hardware shall be provided to monitor the following conditions:

a) *Motor-stator over-temperature*
b) *Seal leakage*
c) *Loss-of-phase, phase reversal, or under-voltage.*
d) *Electrical overload (solid state, temperature compensated).*

All of these conditions shall de-energize the appropriate pump(s) with the exception of seal leakage. Motor-stator over-temperature and seal leakage are to be indicated individually in the control panel. Motor-stator over-temperature and electrical overload shall require a manual reset in the control panel before pump re-start.

The motor-stator over-temperature circuitry shall be automatically re-enabled after a power outage.

Loss-of-phase, phase reversal or under-voltage condition shall de-energize all pumps. The monitor for these conditions shall reset automatically once the problem parameter falls within its appropriate range. If, after the monitor has reset, the control system calls for more than one pump, the additional pump(s) shall be energized after a time delay.

A local alarm system is required on all pump stations, in addition to the telemetry alarm system. It shall be enclosed in a NEMA 4X stainless steel enclosure. The alarm system shall be powered by a 12-volt maintenance free battery with a solid state battery charger. The battery shall be capable of powering the station alarm light for five hours without recharging. The battery charger shall be capable of powering the alarm light continuously in addition to providing the maximum charging current to the battery.

The following local alarm conditions shall be provided:

a) *High wet well level*
b) *Power failure*

These alarms shall annunciate locally via a red flashing light. The light shall remain on during an alarm condition, and de-energize automatically upon reset or satisfaction of the listed alarm conditions.

513 Pump Station Electrical Criteria

All electrical documents shall be signed and sealed by a Professional Engineer currently registered in the Commonwealth of Kentucky.

All systems, designs, and procedures are to meet or exceed the requirements of the latest issue of the following codes or standards:

Kentucky Building Code	*KBC*
National Electrical Code	*NEC*
Underwriters Laboratories, Inc.	*UL*
Factory Mutual System	*FM*
National Fire Protection Association	*NFPA*
National Electrical Manufacturers Association	*NEMA*
Occupational Safety and Health Administration	*OSHA*
Kentucky Occupational Safety and Health Standards Board	*KYOSH*

Pumps and equipment shall normally be designed to operate from a 230/460 volt, three phase power source. No single-phase to three-phase converters will be allowed without express permission from WMU. Larger stations may require larger voltages and should be studied on an individual basis. Power transformers will be required to facilitate auxiliary equipment on 120 volts. All motor starters and controls shall be located in a factory assembled control cabinet, located at ground floor level in the station superstructure.

If there is no superstructure included in the design, pump control cabinets shall be suitable for outdoor installation with NEMA Type 4X classification to provide watertight and tamper-proof service. Control centers shall be mounted on suitable pedestals and installed to the side of the wet well.

All conductors shall be insulated, stranded, copper wire rated at 600 volts, minimum.

Fusible disconnect switches shall be provided and rated for use as service entrance equipment and shall be housed in a NEMA 4X stainless steel enclosure.

Reduced-voltage starting, if required, shall utilize solid-state motor starters with bypass contactors. The solid-state starters shall be used to start and stop the pumps with the bypass contactor utilized for full pump speed.

The following key issues must be addressed in the design with calculations and/or NEC references to verify such:

a) *Service size*
b) *Feeder/service conductor size*
c) *Ground conductor size*
d) *Feeder/service disconnect size*
e) *Feeder/service over-current protection*
f) *Branch circuit conductor size*
g) *Branch circuit type of protection*
h) *Branch circuit over-current protection rating*
i) *Motor controller size and overload protection rating*
j) *Pump control system transformer over-current protection*
k) *Available fault current*
l) *Ground fault protection*
m) *Spare capacity for future growth (where appropriate)*
n) *Lightning surge protection*

514 Emergency Power

Emergency standby power will be required on all sites. The cost for the emergency standby power shall be borne by the developer.

All emergency standby power shall be provided with a permanent in-place electrical generator powered by an internal combustion engine. These stations shall be totally automatic and shall include all the necessary transfer switches and other components. The electrical generators shall be installed a sufficient distant from the station wet well, to prevent corrosion from the fumes created in the wet well.

515 Pump Station Heat and Ventilation

All pumping stations that include a housing superstructure shall be provided with automatically controlled heating, dehumidification and ventilation equipment. Small pumping stations shall be supplied with thermostatically controlled strip or electrical heaters and larger stations shall be heated by gas, electric, or oil fired heating equipment.

Adequate fresh air ventilation shall be provided for all pump stations. A separate, positive supply of fresh air furnished by mechanical ventilation (blower) is required to independently ventilate the superstructure and the wet wells and/or screening areas if screens or mechanical equipment requiring maintenance or inspection are located in these areas. The blades on the blowers shall be of a non-sparking material.

The blower for the wet wells, if required, shall provide at least 12 complete air changes per hour for continuous operation and 30 complete air changes per hour for intermittent operation. Motors and blowers for the wet well areas shall be located outside the wet wells.

The blower for the dry well superstructure shall provide at least 6 complete air changes per hour for continuous operation and 30 complete air changes per hour for intermittent operation. Blowers shall force air in to the structure not exhaust air from the structure.

Provision shall be made to control the ventilation and lights from one single switch and should be conveniently located to allow the ventilation and lights to be turned on prior to entering the structure.

516 Flow Monitoring

The pump station shall be provided with a full bore magnetic flow meter, suitable for sanitary sewer service, installed in a separate concrete vault downstream of the valve vault.

The flow meter will measure both flow rate and total flow by means of variance in a magnetic induction field. Flow measurement by ultrasonic means will not be acceptable.

The output of the magnetic flow meter will be transmitted to the pump control panel by means of a 4-20 mA (milliamp) signal in a shielded cable and shown on a digital display mounted in the panel. The display shall read in gallons, and be operator switchable between flow rate in gallons per minute and total flow in thousands of gallons.

517 Remote Monitoring

Whenever a new site is incorporated into the Utilities operations, or an existing site’s control system is replaced or the majority of it modified, the control system shall be designed so that it can be added into the existing SCADA hierarchy.

All sewage pumps stations shall have a local Programmable Logic Controller (PLC) used for monitoring only. In some instances especially on bigger pump stations it may be used for control and monitoring. PLC for pump station shall have the capability to control the pump station if required with minor changes. At all well/tank sites the PLC shall control the pumps and other equipment.

PLC’s shall be furnished completely configured, programmed and tested providing the specified communication, monitoring, display, input/output, annunciation, computational and other requirements for operation within the existing SCADA system. Any additional components required for operation, whether specifically referenced herein or not, shall be provided.

The PLC system shall be based on a scalable modular multi-use open architecture platform that can be efficiently applied to perform the necessary functions of each site. Each controller/telemetry unit shall be a modular hardware style PLC consisting of a CPU with adequate memory and instructions, power supply, local and remote input/output modules, communications ports, and all other components required to make the unit perform all of the functions required in this specification.

The architecture shall meet the requirements as herein defined and allow economical expansion of function and features based on new and evolving technologies. Systems using non-scalable and/or closed proprietary architectures shall not be acceptable.

PLC system for wastewater SCADA system shall be based on an existing data concentrator PLC at WMU and a PLC at each remote pump stations. Data concentrator PLC is an Allen Bradley SLC 5/05 PLC with Ethernet processor. The primary functions of data concentrator PLC is poll the remote sites over radio network or CDMA network and collect data from each site. This data typically includes wet well level, station flow, run time and run counts for all the pumps, power and generator status, alarms etc. Communication failure with remote PLC shall create an alarm for SCADA. Data concentrator PLC shall also synchronize PLC clocks at the remote pump stations.

517.1 PLC Panels

PLC Panels shall be NEMA 4X, fiber glass enclosures. Enclosures shall be provided with swing out panels to allow mounting the local operator interface units (OIT) inside the enclosure. PLC panels shall have individual circuit breakers for each device in the panel. PLC panels shall also be provided with uninterruptible power supplies (UPS) to back up the PLC and telemetry hardware for at least 1 hour of power loss.

517.2 PLC Hardware Requirements

PLC at remote sites shall be from Allen Bradley, ControlLogix family with adequate memory and instruction sets required to make the unit perform all of the functions required by this specification. It is required that the same model PLC device be used throughout the SCADA system providing a complete solution with one common technology. This is to insure complete system continuity, compatibility between like devices, enhancing overall system efficiency by the reduced need to learn, maintain, support and carry spare parts for multiple technologies.

All control signals, status signals, alarm and process variable data shall be transmitted and received between the central location and any remote sites via the radio network. The master and remote PLCs shall be capable of stand-alone control to maintain programmed logic. Remote pump stations PLC's shall be provided with 120 VAC discrete input modules and relay output modules. Analog input and output modules shall be provided with 4-20 mA range. Actual I/O count will vary from pump station to pump station.

517.3 PLC Communication Options

The PLC's shall be supplied with minimum two (2) RS-232 communication ports. The ports shall support DF1 and MODBUS protocol as minimum.

517.4 PLC software

PLC's shall be programmed with Allen Bradley RSLogix Studio 5000 software.

517.5 Local Operator Interface Unit (OIT)

Each remote station shall have local operator interface unit (OIT's). These units shall display wet well level, station flow, pump run times and pump run counts. OIT's for wastewater stations shall allow full control of pumps and other auxiliary equipment, entering various process setpoints, pump status, run times and run counts etc. OIT's shall also display current alarms and alarm history. Operator can delete the alarm history.

518 Water Supply

There shall be no physical connection between a potable water supply and a wastewater pumping station which under any conditions may cause contamination of the potable water supply lines and/or distribution system. The water supply is intended to provide a water source for wash downs and general cleaning as required.