# WASTEWATER LIFT STATIONS AND FORCE MAINS

## STANDARDS & SPECIFICATIONS MANUAL

**MOORE COUNTY PUBLIC WORKS DEPARTMENT**

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# PREFACE

This Manual is for the Moore County Public Utilities and the East Moore Water District water and sewer systems, all of which are operated by the Moore County Public Works Department (MCPW).

These standards are for design and construction of general construction activities related to water mains, wastewater mains, lift stations, force mains, and flow metering stations, which will come under the jurisdiction of Moore County Public Works (MCPW). **These standards alone do not constitute a complete set of construction documents. The owner's or developer's Professional Engineer is responsible for providing plans that encompass all the needs of the project and comply with the standards within this manual.** These standards are set forth as the minimal requirements to achieve a suitable quality level for utilities which will become the property of MCPW.

The standards do not include a complete commentary on methods or installation and detailed information or quality of workmanship in place. The owner's or developer's Professional Engineer must include detailed information on methods of construction and should expand on the testing and any of the special requirements to the engineer's satisfaction, subject to the approval of MCPW.

From time to time, these standards will be amended and/or expanded at the pleasure of the MCPW Engineering Division. It will be the responsibility of the owner or developer to contact the MCPW to obtain updated standards.

There may be circumstances whereby the design engineer may wish to propose changes or modifications to these standards, when this occurs permission from the County Engineer shall be obtained prior to submission to NCDEQ.

## Disclaimer

To the best of their ability, the authors have insured that material presented in this manual is accurate and reliable. The design of engineered facilities, however, requires considerable judgment on the part of designer. It is the responsibility of the design professional to insure that techniques utilized are appropriate for a given situation. Therefore, neither Moore County Public Works, nor any author or other individual, group, etc., associated with production of this manual, accepts any responsibility for improper design, any loss, damage, or injury as a result of the use of this manual.

# TABLE OF CONTENTS

# STANDARD & SPECIFICATIONS MANUAL - WASTEWATER LIFT STATIONS AND FORCE MAINS

## 1.0 PREDESIGN REQUIREMENTS

In situations where gravity flow to an existing sewer is not feasible, MCPW will consider the installation of a wastewater pumping station and a force main. Certain factors must be addressed by the developer for the project for consideration by MCPW. The factors include:

1. Determine the wastewater flow that would be generated by the total built-out of the natural drainage basin based upon the existing zoning. Pumps shall be sized for a minimum of 20 year build out or as approved by the County Engineer.

2. Evaluate the capacity of the receiving sewer main at the point of discharge and down-stream facilities to determine that sufficient capacity is available for the transferred sewer flow.

## 2.0 PUMP AND SITE DESIGN

### A. Lift station

1. Lift stations shall be designed to store and transport raw wastewater.

2. Lift station structures shall be designed to withstand the hydrostatic forces that they will be subjected to, including uplift.

3. Lift stations shall be of the Enclosed Above Grade Self-Priming Package type or Submergible type as approved by the County Engineer. All hardware shall be Stainless Steel.

4. All stations shall have a minimum of 2 pumps of equal capacity, with each pump sized to handle design flow, and shall be capable of handling flows in excess of the expected peak flow. Where three or more pumps are required, they shall be of such capacity that with any one unit out of service, the remaining units will have capacity to handle peak sewage flows, per NCDEQ minimum guidelines. Where pumping stations may be designed to handle larger future flows, the wet well, piping, electrical equipment, etc. shall be sized to accommodate the future flow.

5. Where a lift station is sized to accommodate growth and will operate at less than 25% of its capacity, chemical feed facilities shall be provided for odor and corro-sion control. These facilities shall include all feed equipment and storage facilities, including secondary containment and shall be approved in advance by the County Engineer.

6. A receiving manhole, separate from the wet well, shall be provided within 20 feet of the Wet-Well. This receiving manhole shall have a rim elevation one foot minimum below the Wet-Well rim and two feet above the 100 year flood elevation. Where multiple sewers converge at a pumping station, they shall be brought together at the receiving manhole and only one influent line shall enter the wet well. This manhole shall be situated to facilitate future upstream extensions of the gravity sewer.

7. Lift station piping should be sized to maintain flow velocities between 2.0 and 8.0 fps. The minimum size force main shall be 4 inch diameter.

8. Lift station, access drains, structures, electrical equipment, etc. shall be protected from physical damage by sitting no less than 3 feet above the predicted 100 year flood water elevation. Stations shall remain fully operational and accessible during the 100 year flood. The predicted 100 year flood elevation shall be shown on all site plans. The final station elevation shall be indicated on the record drawings. The 100 year flood elevation shall be converted to the same datum used for the station design.

9. Wet Well and Electrical Service shall be designed for built-out conditions.

10. Equipment Removal Methods/Equipment: Station structures shall have access hatches, doors, skylights, etc. of sufficient size such that the largest piece of equipment (i.e. Engines, Control Panels, VFD, etc.) may be removed without damaging the integrity of the structural design.

11. Above ground station structure that is walk-in accessible shall be ventilated, with power ventilation, to achieve the continuous ventilation. There must be 12 complete air changes per hour.

**B. Site Work**

1. The site work shall be generally level graded to remove runoff from site in a non-erosive manner. Drainage swales shall be provided to direct drainage away from the site.

2. The site shall be stabilized inside the fence, if required, and one foot around the outside perimeter with ABC stone 6 inch thick. A landscaped buffer shall be constructed outside of the fence to screen the station from adjoining properties. The proposed landscaping shall be shown on the approved plans. All proposed landscaping shall be of species suited to the climate region and require minimal maintenance. (2 inch tree trunk, 3 gallon shrub, etc.)

3. An all-weather access road constructed with 6" minimum of compacted aggregate base course and located within a 30 foot minimum access easement shall be provided to the pumping station site. The road shall be a minimum of 20 feet minimum in width, with shoulders, side ditches and cross drainage as needed. A

turn around area large enough for a fuel oil truck (NCDOT-SU design vehicle) shall be provided outside of the lift station fence. The maximum roadway grade shall be 8 percent for stone base roadways. Steeper roads shall be paved. Pavement shall be Concrete or Asphalt. The roadway shall be (1) foot above the 100 year base flood elevation.

4. Suction and discharge piping shall be ductile iron pipe designed and manufactured per ANSI/AWWA C150/A21.15-05. The pipe shall have protective interior coating a minimum of 40 mil equivalent to "Protecto 401" by American Cast Iron Pipe.

**C. Emergency Pump Connection**

Lift stations shall be equipped with an Emergency Pump Connection fastened to the outlet line from the Valve Vault. The connection shall have a plug valve, an emergency pump connection approximately 2 feet above the ground and with a 90 degree flanged connection parallel to the ground's surface. A Bauer 6 inch quick connect and blind flange with stainless steel bolts shall be provided. All pipes shall be DIP and there shall be a 4 inch concrete pad surrounding the connection and plug valve. (See STD. No. PS 1)

**D. Yard Hydrant**

Each pumping station shall have a potable water supply service line consisting of a 1" service line with an approved RPZ type backflow preventer and terminating at the lift station site with a freeze-proof yard hydrant. An insulated enclosure shall be provided to protect the RPZ from freezing. (See STD. No. PS 2) The Yard Hydrant to be Simmons Sanitary Yard Hydrant, 802LF, 54 inch or approved equal.

**E. Fencing**

All pumping station sites shall be fenced for security unless approved by the County Engineer. Pumping stations located in remote areas shall have a chain link fence as described below. (See STD No. PS 3) Stations that are adjacent (visible) to residential and commercial areas shall have a wooden shadow box style fence where required.

1. Wooden Fencing

Where a wooden fence is provided around the pumping station site, the fence shall have the following features:

| | |
|---|---|
| Height: | 6 1/2 feet to top of pickets |
| Gates: | 1 – 12 feet double-leaf vehicle gate<br>1 – 4 feet single-leaf personnel gate |

The fence shall be of the shadow box style (80% opaque), with vertical pickets (alternating inside and out), constructed entirely of pressure treated lumber with galvanized hardware and fasteners (torx head decking screws).

a. Vertical Pickets - shall be 5/4 inch by 6 inch by 6 feet nominal dimension treated lumber

b. Posts - shall be 6 inch by 6 inch by 10 feet nominal dimension treated lumber, with the tops beveled at a 45-degree angle each way (pyramid top)

c. Horizontal Rails - shall be 2 inch by 4 inch by 7 feet and 6 inches nominal dimension treated lumber, three per panel section

Posts shall be set at 8 feet centers, maximum, at each corner and at each side of each gate. All posts shall be set 36 inches deep in concrete. Horizontal rails shall be set 12 inches, 42 inches and 72 inches above grade. Pickets shall be attached to the horizontal rails with the bottoms 6 inches above grade and alternating inside and out. All lumber shall be pressure treated Southern Yellow Pine and bear the mark of the American Wood Preservers Association Standard No. C2/C9.

All gates shall be equipped with lockable latches and tamper proof hinges. For vehicle gates, keepers shall be provided to hold gates in the open position.

2. Chain Link Fencing

Where a chain link fence is provided around the pumping station site, the fence shall have the following features:

| | |
|---|---|
| Height: | 6 feet to center of top rail |
| Barbed Wire: | 3 strands at top |
| Gates: | 1 – 20 feet vehicle gate (2 – 10 feet swing gates) |

All fencing materials shall be vinyl coated galvanized steel, green or black in color. The fencing materials shall be as follows:

Vinyl Coated Chain Link Fence - woven 2 inch mesh of No. 9 gauge (0.1483 inch) copper bearing steel wire, 72 inches wide, galvanized after fabrication. Minimum tensile strength of wire shall be 90,000 psi. The top edge shall be barbed.

Steel Line Posts - line posts shall be 2 1/2 inches OD vinyl coated galvanized steel pipe weighing 3.65 lbs per lineal foot.

Steel Top Rails - the top rails shall be 1-5/8 inches OD vinyl coated galvanized pipe weighing 2.27 lbs per lineal foot, with expansion couplings of outside sleeve type. Rails shall be continuous for outside sleeve type for full length of fence.

Steel Terminal, End, Corner & Pull Posts - (referred to herein as terminal posts) – 3 inch OD vinyl coated galvanized steel pipe weighing not less than 5.79 lbs per lineal foot. Posts shall be of sufficient length to permit the bottom 36 inches to be set in concrete.

Bracing for Use between Terminal, End, Corner, Gate & Pull Posts and First Adjacent Line Posts – 1 5/8 inches OD vinyl coated galvanized steel pipe weighing not less than 2.27 lbs per lineal foot.

Gate Posts - 4" OD vinyl coated galvanized steel pipe weighing 9.11 lbs per lineal foot.

Tension Bars – 3/16 inch X 3/4 inch minimal steel, vinyl coated galvanized and one-piece for full height of fabric.

Stretcher Bar Bands - steel, wrought iron, or malleable iron (painted or vinyl coated) to secure stretcher bars to terminal, end, pull, corner and gate posts. Spaced no greater than 12 inch on center.

Gate Frames – 2inch OD vinyl coated galvanized steel pipe weighing not less than 2.72 per lineal foot. A 12 feet double swing gate (two 6 feet leaves) and a 4 feet single-swing gate shall be provided.

Gate Hardware:
Hinges - pressed or forged steel or malleable iron to suit gate size, or non-lift-off heavy duty type, offset to permit 180º gate opening.

Latches - provide latching devices, lockable with padlock from either side. Latches for double gates shall have automatic engaging latch on one leaf and drop rod type latch on the other leaf. Furnish drop rod complete with suitable casting set in concrete to hold gate leaf in place when drop rod is engaged.

Keepers - provide keepers for all gates to automatically engage gate leaf and hold it in open position until manually released.

Anchorage - line posts, gate posts and corner posts shall be set in concrete 36 inches deep X 12 inch diameter (minimum). Concrete shall have a minimum compressive strength of 3,000 psi at 28 days.

Combination Post Top Cap & Barbed Wire Supporting Arm – Shall be steel, wrought or malleable iron complete with provisions for anchorage to posts and attaching 3 rows of barbed wire. Provide one cap and vertical arm for each post where barbed wire is required.

Barbed Wire - vinyl coated galvanized 2 strands, 12 1/2 gauge wire with 14 gauge 4-point barbs spaced 5 inches on center.

Vinyl Slats - Single wall slats, approximately 75% wind load and privacy factor (based on wire/mesh used-stretch tension), shall meet ASTM F3000 and F3000M standards with a 7 year, pro-rated limited warranty

Miscellaneous Items & Materials - Line posts shall be spaced at a maximum interval of 10 feet.

Top rails shall be installed with expansion couplings at intervals of not more than 20 feet and shall be attached to the posts with appropriate wrought iron fittings.

Bracing assemblies shall be installed on all terminal posts, gate posts and at both sides of corner posts and pull posts. Diagonal tension members shall not be less than 3/8" diameter, with a tension take-up device, and shall extend from compression member to base of posts. Posts shall be plumb when diagonal rod is under the correct tension.

Gate frames shall be constructed with heavy malleable iron fittings at the joints to produce rigid joints. Bracing shall be installed so as to provide a rigid, non-sagging or twisting gate. Gate fabric shall be the same as fence fabric and attached in a like manner. Frames shall be furnished with 3 strands of barb wire at the top.

## 3.0 ENGINEERING/DESIGN REQUIREMENTS

### A. Engineering Calculations

Calculations must be signed, sealed and dated by a North Carolina Registered Professional Engineer (PE). Such calculations shall include, at a minimum, the following items:

1. Total dynamic head calculations for all applicable pumping stations, at low water level and high water level.

2. System curve/pump curve analysis used to determine pump selection and operational point.

3. If discharge elevation is lower than highpoint, provide calculations for expected hydraulic conditions.

4. Lift station cycle and pump run times, including an evaluation of any depressed sections of the force main to determine if the lift station is capable of completely flushing the force main section being evaluated in a single pumping cycle.

5. Lift station flotation/buoyancy calculations.

6. Provide re-prime calculations for suction lift stations.

7. Minimum velocity within the force main.

8. Maximum detention times within the lift station and force main.

9. Provide Generator size calculations.

**B. Downstream Sewer Evaluation**

Demonstrating that the lift station discharge will not overload the receiving sewer line:

1. In situations where the lift station discharges into a gravity sewer, the downstream gravity sewer shall be evaluated based on peak flow from the proposed project as well as peak flows already tributary to the downstream gravity sewer.

2. In situations where the lift station discharges into another lift station, the downstream lift station and force main shall be evaluated to verify its ability to convey peak flow from the proposed project as well as peak flows already tributary to the downstream lift station.

3. In situations where the lift station discharges into a force main, the downstream force main shall be evaluated on peak flows from the proposed project as well as peak flows already tributary to the downstream force main. The ability of each lift station tributary to the downstream force main to pump against additional head created by greater flows through the force main shall also be evaluated. An evaluation of the discharge point of the downstream force main as described above shall also be performed.

## 4.0 PUMP REQUIREMENTS

**A. General**

1. Only pumps designed and manufactured for use in conveying raw, unscreened wastewater shall be acceptable.

2. Pump selection shall consider the duty requirements as well as the physical and chemical characteristics of the wastewater being conveyed. Materials used in pump construction shall also be suitable from the physical and chemical characteristics of the wastewater being conveyed. Accepted submersible pump manufactures are **Fairbanks Morse, Barnes** or approved equal. Suction lift stations shall be **Gorman Rupp** or approved equal.

3. Lift stations conveying residential, commercial, institutional, or industrial domestic wastewater shall be provided with pumps that are suitable for continuous duty in conveying raw unscreened wastewater.

4. Pumps shall be capable of handling a three-inch solid and any trash or stringy material that can pass through a four-inch hose. A mechanical means of solids reduction is installed at the lift station if required by County Engineer.

    a. Pumps shall be made non-clog either by passing solids, trash, and stringy material through a non-clog or vortex-type impeller or by grinding, chopping, or cutting them prior to passing them through the impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material.

    b. Acceptable mechanical means of solids reduction shall include mechanical bar screens, trash bucket or other similar devices.

5. Pump suction and discharge openings shall be no less than four inches, in diameter unless the pump is capable of grinding, chopping, or cutting solids, or a mechanical means of reducing the size of a three-inch solid and any trash or stringy material that can pass thorough a four-inch hose is installed at the lift station.

6. The power source, voltage and phasing shall be verified before ordering the pumps.

**B. Number and Capacity**

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

    a. In duplex lift stations; the pumps shall be of the same capacity. If pumps in series are required, each set of pumps in series shall be viewed as a single pumping unit.

    b. All auxiliary systems for pump functionality, shall be provided in multiple numbers

    c. At least one standby pump and motor shall be provided.

2. For Regional Stations, pump capacity shall be based on wastewater flow expected to become tributary to the station at build out. Capacity shall be based on wastewater flow expected from the entire service area over the life of the lift station.

3. Interim sizing of pumps and associated lift stations shall be allowable, although not for economic purposes. A statement of initial service capacity shall be on the drawings for projects that are approved for an interim condition. Additional wastewater flow shall not be made tributary to the station until a request for

permit modification is submitted, approved, and the lift station upgraded and certified.

4. The peak hourly wastewater flow to the station shall be appropriate for the service area as well as the associated wastewater generation patterns and population being served by the lift station. The minimum peak hourly wastewater flow to the station shall be calculated using the design daily wastewater flow in conjunction with a peaking factor determined from the following equation:

$$PF = \frac{Q_{phf}}{Q_{ddf}} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

PF = peaking factor
$Q_{phf}$ = peak hourly flow (gallons per day)
$Q_{ddf}$ = design daily flow (gallons per day)
P = service population (thousands)

The above equation yields a peaking factor that is intended to cover normal infiltration and inflow for well-maintained and constructed sewer systems. In no case shall the peaking factor be less than 2 1/2 for any lift station.

5. Peaking factors for stations conveying industrial or process wastewater shall be based on actual operating conditions, but in no case shall the peaking factor be less than 2.5.

6. Pump capacity shall also be based upon the need to maintain a minimum force main velocity of 2.0 fps.

**C. Selection Methodology**

1. Pump selection shall be based on a hydraulic analysis of the system. The design operating point(s) of the pump(s) shall be determined using a pump curve-system curve analysis for all Total Dynamic Head (TDH) requirements for the lifetime of the station.

2. A system curve plotting TDH versus capacity shall be developed for all operating conditions. TDH for the system shall be calculated by summing the following:

   a. Static head requirements for both the suction and discharge sides of the pumps shall be evaluated including intermediate high points in the force main and the discharge elevation.

   b. Friction head requirements for the suction and discharge sides of the pumps shall be evaluated. The friction head shall be calculated using the Hazen-Williams formula:

$$h_f = L \times \frac{10.44\ Q^{1.85}}{C^{1.85}\ D^{4.87}}$$

$h_f$ = friction head for pipe segment (feet)
L = length of pipe segment evaluated (feet)
Q = pumping rate (gallons per min)
C = Hazen-Williams coefficient
D = diameter of pipe segment evaluated (inches)

Conditions shall be evaluated including, multiple pump operation within the subject force main, simultaneous lift station operation for common force main situations and the possibility for gravity flow conditions in force main segments with extreme negative slopes that may not flow full.

c. Head derived from minor losses of valves and other fittings shall be evaluated.

d. If applicable, the pressure head at the junction of the existing force main shall also be evaluated, considering the effects of simultaneous lift station operation and multiple pump operation in other lift stations.

3. System curves shall be evaluated for present day and conditions that may exist over the expected lifetime of the lift station.

   a. The following maximum values shall be allowable for C:

| Pipe type | Initial Service | End-of-Service C |
|---|---|---|
| DI | 125 | 120 |
| PVC | 140 | 120 |
| HDPE | 140 | 120 |

   b. Friction head and minor losses shall be evaluated for initial condition and the end-of-service condition.

   c. The design operating point(s) shall be the intersection of the pump curve and the calculated system curve(s).

4. Pumps shall be selected such that all design-operating points are on the pump curve as supplied by the manufacturer. Pumps shall be selected such that the net positive suction head available ($NPSH_A$) shall be greater than the net positive suction head required ($NPSH_R$) at each of the design operating points.

5. Pumps shall be selected such that the pumps will not cavitate. Freewheeling (i.e., operating at pump run-out) or deadheading (i.e., operating at pump shut-off) of pumps shall not be allowed.

6. Pumps shall be selected so operating efficiency is maximized during all hydraulic conditions over the lifetime of the lift station.

    a. Consider minimizing motor speeds during the pump selection process.

    b. The horsepower rating of each pump motor shall be at least 1.15 service factor but design shall be non-overloading.

    c. The selected pumps and motors shall operate at the most economical efficiency under average daily flow conditions.

**D. Cycle and Pump Run Times**

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

    a. Automatic pump alternation shall be provided with a selectable lead/lag toggle switch.

    b. Pumps shall be designed to operate between two and eight times per hour at design daily flow (DDF).

    c. The following equation shall be used to determine the active storage volume (between pump on and pump off elevations).

$$V = TQ_{ddf} \times 1 - \frac{Qddf}{Q}$$

Where:

V = active volume within the lift station (gallons)
T = allowable cycle time between starts (minutes)
$Q_{ddf}$ = design daily flow to lift station (gallons per minute)
Q = pumping rate of a single pump (gallons per minute)

    d. If less than two cycles per hour will occur at DDF, or if the station is to provide equalization of hydraulic surges, measures to control odor and corrosion shall be employed when detention times cause septic conditions.

2. Pump run times shall be such that excessive wear of the pumps does not occur.

3. At DDF, adequate time shall be provided to allow a constant speed pump to "ramp up" to full speed before the pumping cycle ends and shall not be less than or greater than those recommended by the pump manufacturer.

## 5.0 WET WELL REQUIREMENTS AND DESIGN

The effective capacity of the wet well should be such that it can contain the flow capacity of the drainage basin with the required cycles of the pumps. The inflow line is to be designed to prevent a vortex within the wet well. (For typical Section See STD. No. PS 4 and PS 5)

### A. Valves

1. Valves shall be suitable for use with raw, unscreened wastewater, as well as the normal and maximum operation pressures expected at the lift station.

    a. A full closing shut-off "full port plug style" valve shall be on the discharge piping of each pump.

    b. A check valve shall be on the discharge piping of each pump, between the pump and shut-off valve. Check valves shall be equipped with outside lever and counter weights and/or springs, approved by County Engineer, to prevent water hammer and back siphoning. All internal metal parts shall be Stainless Steel.

    c. Air release valves shall be provided in the valve vault after the check valve on the submersible station and suction lift station. Discharge shall be piped into the wet well.

2. Valve Forces

    a. A check valve and a plug valve shall be provided for the discharge line of each pump. Valves shall be rated for 200 psi working pressure, and shall have full port openings equal to 100% of the adjacent pipe area. Check valves and shut-off valves shall be mounted in the horizontal position unless installed vertically by the manufacturer in prefabricated stations.

    b. All piping, couplings, fittings, valves, etc. shall be Class 125 flanges meeting ANSI B16.1 Specifications, unless class 250 flanges are required for high head installations. All piping shall be factory flanged with Stainless Steel hardware. Flanged coupling adapters, Dresser, Romac or Smith-Blair or an approved equal, shall be provided on one side of the check valve to allow removal and replacement.

### B. Allowable Velocities

1. Suction pipe velocities should be in the range of 2.0 to 5.0 feet per second (Self priming pump suction velocity may exceed 5.0 feet per second), with a maximum of 8 feet per second.

2. The force main velocities of flow shall be greater than 2.0 feet per second but less than 8.0 feet per second.

**C. Bypass Pumping**

Connections shall be provided to allow emergency bypass pumping to occur. The bypass pumping shall have a Bauer quick connect couplings, as indicated in the standard detail for all lift stations (See STD. No. PS 1).

**D. Pump Submergence Depth**

1. Sufficient submergence of the pump or pump suction piping shall prevent vortexing within the wet well.

2. In no case shall the all pumps-off activation level and the minimum distance between the wet well floor to pump bottom be less than the minimum level required for successful pump operation, as recommended by the pump manufacturer.

**E. Appurtenances**

1. Consideration shall be given to protecting lift station structures and equipment from physical damage or clogging from solid material normally present in wastewater through the use of bar screen.

   Bar Screen

   Where required by the County Engineer, the influent sewer shall have an open flange connection within the wet well and have a bar screen with a clear opening of no less than 1 inch or more than 1 3/4 inch. Manually cleaned screens should be placed on a slope of 30 to 45 degrees from the horizontal. At design average flow conditions, approach velocities should be no less than 1 1/4 feet per second to prevent settling and no greater than 3.0 feet per second to prevent forcing material through the openings. The bottom of the screen channel shall be placed at least 6 inches below the invert of the incoming sewers to allow for some accumulation of screenings without affecting the flow in high water level in the wet well. Adequate clearances for ease of maintenance shall be provided. Bar Screen shall be built of Stainless Steel only.

2. Pump Removal Methods/Equipment

   a. Provisions shall be made so that the largest piece of equipment installed at the lift station may be removed, which may include hoisting equipment or designing clearance around the lift station for mobile hoisting equipment access.

   b. Station structures shall have access hatches, doors, skylights, etc. of sufficient size such that the largest piece of equipment may be removed without damaging the integrity of the structural design.

c. Stations utilizing submersible pumps in wet wells shall provide for the removal and installation of the pumps without requiring entry into the wet well.

Each pump shall be provided with guide rail and a stainless steel chain. Rail system and the chain shall be capable of withstanding the forces required to disengage the pump from the wet well. Rail system and the lift-out chain shall be stainless steel.

3. Access

Ensure access for operation and maintenance is easy, unobstructed, and safe. Each station structure shall have separate means of access. Under no circumstance shall access to the wet well be provided through a drywell. Steps, ladders, stairs, landings, hatches, and other means of access shall conform to OSHA standards, local and state building codes.

4. Ventilation Equipment

a. Wet wells shall be adequately vented to complete compliance with local codes as well as OSHA and NFPA standards. At a minimum, lift station wet wells shall be provided with a gooseneck-type vent. Active ventilation units shall also be acceptable. Vents shall be 3 feet above 100 year flood elevation and constructed with DIP flanged pipe. Vents shall be provided with an insect/bird screen of stainless steel. Under no circumstance shall steel or galvanized steel be used.

b. Drywells or other enclosed lift station structures into which routine operator entry is required shall either have a positive pressure ventilation system that meets, at a minimum, the requirements of NFPA 820 "Standard for Fire Protection in Wastewater Treatment and Collection Facilities." Consideration shall be given to installing sensor and alarm systems to detect the accumulation of dangerous levels of hazardous gases.

**F. Drainage**

Station structures other than the wet well shall be provided with a means to remove accumulated water and wastewater from the structure. All floor and walkway surfaces shall be sloped to an appropriately sized drainage pipe. Drainage pipe shall convey water to the wet well or wastewater collection system and shall be higher than the high-water alarm activation level or the maximum water level expected. The drainage pipe shall be provided with device to prevent backflow of wastewater and gases from the wet well into the structure.

**G. Structure**

1. Temperature - Consider controlling station temperature and humidity to a level appropriate for reliable operation of the electrical and instrumentation/control systems.

2. Hydraulic Force - All lift station structures shall be designed to withstand the hydrostatic forces that they will be subjected to, including uplift.

3. Corrosion Protection - In Above Ground Stations the wet well walls and piping shall be epoxy coated and in Submersible Stations the wet well and valve vault walls ONLY shall be epoxy coated. The interior of the wet well shall receive two successive coats shall have an interior coating thickness of 100 mils of 100% solids epoxy, such as Raven 405 or approved equal. All epoxy coatings shall be installed per manufacturer's recommendations, following all surface preparation steps required. The coating shall have a Spark (Holiday) Test performed and shall conform to ASTM G62-07 and NACE SP0188-2006. After epoxy coating has been installed and has sufficiently cured, it shall be inspected with high-voltage detection equipment to locate pinholes, voids, metal particles protruding through the coating and any gross faults. This spark test is used by providing a 100V per mil that penetrates the coating. If defects are found they shall be repaired per manufacturer's recommendations and the Spark Test repeated. Spark Testing shall be performed in the presence of the Engineer or representative and is the responsibility of the Contractor.

4. Cover Slabs - for wet wells shall be reinforced concrete with integral cast in place access hatch covers. Cover slabs shall be reinforced as per ACI Code and specially reinforced around openings. Access covers shall be sized and positioned according to pump unit installation. Access covers and frames for pumps shall be a double leaf aluminum diamond pattern floor hatch certified by the manufacturer of being H-20-44 loading without permanent damage. Each leaf shall open 90º degrees and be attached to the frame by stainless steel hinges. The door shall have a lock in the open position and vinyl grip handle to release lock for closing.

   The wet well access landing area shall have a "Retro-Grate" cover to permit safety access and washing the wet well walls. Grating shall be stainless steel and coated with orange or safety yellow paint.

5. Wet Well - Wet well structures may be cast in place reinforced concrete or precast concrete construction. If precast units are utilized, they shall conform to the requirements of ASTM C478, with watertight joints per ASTM C443. The minimum wet well diameter shall be 6 feet. The wet well bottom fillets are to have a minimum slope of 60 degrees.

6. Inlet & Discharge - Inlet sewer shall enter into a drop pipe that extends below the low pump level to reduce air entrainment in the wet well. Discharge piping shall

be designed to provide adequate thrust restraint during pump operating cycle. Inlet and discharge piping shall have stainless steel pipe supports and hardware.

**7.** Exfiltration Tests - Exfiltration test shall be performed on the wet well before backfilling. Each inlet shall be plugged and wet well filled with water to a depth no less than the top for a period of seven (7) days. No leakage shall be allowed. Any leaks, damp spots or other defects found shall be repaired and made water tight to the satisfaction of the County Engineer. The first 48 hours of the test is utilized for the concrete to absorb the water. After the first 48 hours of the test, the water level shall be noted and monitored for the remaining five (5) days. A reduction in water greater than 0.1% per 24 hours shall be considered excessive and shall constitute failure of the test. (NOTE: Rainfall and evaporation shall be considered during calculation of water loss. Rainfall shall be added to and evaporation shall be deducted from the measured loss to determine net water loss.) Testing may be must be completed in the presence of the Engineer or representative.

## 6.0 VALVE VAULT

A separate valve vault shall be required for submersible lift stations. The valve vault shall consist of a precast rectangular base section, or a cast-in-place custom built section.

Vault shall have an aluminum access hatch.

Vault shall be sloped and piped to drain into the Wet Well with a check or flap valve.

Interior of valve vault shall be coated with appropriate epoxy system as wet well.

Check valve shall be of the horizontal swing arm with spring type with an outside weighted swing arm with all internal Stainless Steel metal parts.

A tap isolation valve for a pressure gage shall be supplied on both sides of the check valve for each pump installed with a stainless steel saddle, stainless steel snubber and all other stainless steel hardware.

## 7.0 PUMP CONTROLS

### A. Control Sequence

On rising liquid level in the wet well, a non-mercury type float switch shall initiate operation of the lead pump at the elevation indicated on the DRAWINGS. Should the liquid level continue to rise to a point above the lead pump setting, a second non-mercury float switch would initiate operation of the Lag Pump. The pump(s) would continue to operate until the liquid level recedes to the point where a third non-mercury float switch would stop the pumps.

The 2 pumps shall automatically alternate between the "lead" and "lag" positions by means of an electric alternator with toggle switch in the panel.

Should the liquid level continue to rise to a point above the "Lag Pump On" level, a fourth non-mercury type float switch would activate the alarm circuit.

The float settings shall be set such that the pump manufacturer's minimum submergence is maintained, there are 2 to 8 operating cycles per hour during average influent flow conditions, there is no less than 6 inches between the lead and lag setting, there is no less than 6 inches between the lag and high level setting and there is no less than 12 inches between the high level setting and the invert into the wet well.

**B. Control Panel**

The pump control panel shall be furnished to operate the pumps in the specified sequence. The control panel and all control equipment shall utilize equipment and components approved by a third party testing agency that is accredited by the NCBCC and accepted by the State of North Carolina, and shall be so labeled as an assembled panel. (See STD. No. PS 7)

The control equipment shall be housed in a NEMA 4X enclosure with hinged outer and dead-front inner doors. The outer door shall be fastened by quick release latches that require no tools to operate. The enclosure shall be of aluminum. The panel shall contain the following elements and accessories:

1. Incoming power circuit breaker - 3 pole. The circuit breaker must have a minimum ampere interrupting capacity of 10,000 symmetrical RMS amps.

2. A lightning arrestor shall be supplied in the control panel and connected to each line on the incoming side of the power input terminals with capability of a bypass. The arrestor shall protect against damage due to lightning strikes on the incoming power line.

3. A phase-loss/unbalance/reversal, under-voltage protection assembly with adjustable nominal voltage setting shall be supplied with three extractor type line voltage fuses. This device shall dropout the pump control and auto-dialer power circuit if all phases drop below 90% or if any one phase drops below 80-83% nominal voltage. This device shall have a 5 second dropout delay and adjustable restoration time delay of up to five minutes.

4. A thermal magnetic molded case circuit breaker shall be supplied as branch circuit protection for each pump motor. The circuit breaker must have a minimum ampere interrupting capacity of 10,000 symmetrical RMS amps.

5. A NEMA-rated magnetic motor starter with ambient-compensated, quick-trip Class 10 overload sensing in each phase shall be furnished to provide over current and running protection for each pump motor. Pumps rated 7 1/2 horsepower and greater shall have Soft-Starter. Over current

protection shall be provided by accurately sized, replaceable heater elements. Units requiring replacement of complete over blank load to match motor current are not acceptable. Overloads shall be equipped with auxiliary contacts for reporting an overload trip out to the alarm dialer.

6. An oil-tight pilot light for each pump shall be provided to indicate "Pump Running", "Over temperature", "Overload Tripped" and "Seal Fail" conditions. An additional lamp indicating "Control Power On" shall also be provided. The pilot lights shall have a replaceable, screw or bayonet base bulb. A "push to test" circuit shall be provided to enable testing of individual lamps.

7. A separate circuit breaker for control circuit shall be supplied to provide short circuit protection and a disconnect means for the control circuit.

8. Control power transformer (on 480 VAC stations) no less than 2 kVA.

9. Condensation heater with adjustable thermo switch shall be provided.

10. Running time meter for each pump shall be provided to measure hours and tenths of hours of operation, up to 10,000 hours. These shall be 120 VAC devices operating from the control voltage by an auxiliary contact of the motor starter.

11. Seal failure protection shall be provided to operate in conjunction with the moisture sensor in each pump motor. The control shall provide a dry contact closure for the alarm dialer. The circuitry shall include a seal failure indicating light. A set of dry contacts shall be provided for the alarm dialer.

12. Over temperature protection shall be provided to operate in conjunction with the over-temperature switch in each pump or motor, depending on the pump style. The control shall provide lockout of pump operation upon occurrence of high temperature. The circuitry shall include a high-temperature indicating light and reset button for each pump for high-temperature alarm indication and manual reset capability. A set of dry contacts shall be provided for the alarm dialer.

13. Wet well level responsive automatic pump and alarm control system using four direct-acting liquid level sensors in the wet well shall be provided. The control system shall include a Hand-Off-Auto selector switch for each pump, automatic alternator (with manual override selector), 24 volt control power transformer for floats, control relays, alarm relays, control terminal board, and internal wiring as required. The control panel shall be configured such that the pumping station will restart automatically after a power failure. An adjustable time delay relay (0 to 60 second range) shall

be provided in the "lag" pump circuitry to delay starting the "lag" pump after a power service interruption.

14. Red xenon strobe high level alarm light shall be mounted externally (See STD. No. PS 7).

15. Power feed from the control circuit (after the phase monitor) to the alarm dialer.

16. The Control Panel shall be covered with a rainhood to protect components and personnel. (See STD. No. PS 6)

**C. Control Floats and Accessories**

Level control float switches shall be a molded polyethylene body with internal redundant polyurethane foam floatation, and containing a non-mercury tube-type switch inside. Each float switch shall have potted cable, switch connections and fine-strand #18 AWG cable with heavy duty synthetic rubber jacket. Cable length shall be as required to run un-spliced to the junction box.

Float switches shall be installed on a stainless steel cable and weight utilizing stainless steel clamps and hardware. The cable shall be suspended from a stainless steel bracket at the top slab of the wet well adjacent to the hatch cover. Each wet well shall have minimum of 5 floats (high water, lead, lag, pump off and low level)

Floats switches shall be Roto Floats manufactured by Anchor Scientific or an approved equal.

## 8.0 LIFT STATION ELECTRICAL WORK

All wiring and electrical equipment shall conform to all applicable sections of the National Electrical Code (NEC), latest edition, and local electrical codes.

All lift stations shall be serviced with 3-phase, 4 wire power, with the neutral brought in and bonded. Stations with pump motors larger than 15 horsepower shall have 480 volt, 3-phase power. Single phase to three phase converters shall not be allowed.

Plans shall include all conduit and wiring sizes, power riser and distribution diagrams, and switchgear sizes. All conduits shall be PVC. Each wire entering the pump control panel from the wet well shall be equipped with a Cord Grip and shall be suitable for conditions of use and location and approved for the purpose by a nationally recognized testing laboratory, inspection agency or product evaluation organization. Where power or control cables exit conduits, conduit bells and strain relief devices shall be provided. A vented junction box shall be placed between the wet well and the control panel to ease the removal and installation of control wires and the pumps.

All switchgear, controls, distribution panels, etc. shall be located under an aluminum rain shield constructed of 1/8" material. In the case of very large control panels, a separate rain shield may be required. The rainshield shall be supported on I-Beam, anchored in concrete, located at distances not to exceed 4 feet on center. An outdoor type, 40 watt fluorescent work light shall be installed under the rain shield. This light shall be operated by a weatherproof switch. A GFCI convenience receptacle shall also be located under the rain shield. (See Std. No. PS 6)

A separate electrical distribution panel shall be provided for supplying the area light, work light, receptacles, RPZ enclosure, generator engine block heater and battery charger. This panel shall be fed from the feeder between the automatic transfer switch and the pump control panel and shall remain energized if the pump control panel main breaker is in the off position. On 480 volt stations, a dry transformer (10 kVA minimum) shall be provided for 120/240 volt power. (See Std No. PS 7).

All electrical fixtures are to be explosion proof and located in serviceable locations. Interior electrical conduit shall be PVC conduit. Seals shall be installed to prevent gases from traveling to the panel box.

Provide manual utility disconnect switch between Service Meter and ATS, between ATS and Generator. All panels are to be located under the rain hood.

## 9.0 ALARM DIALER SYSTEM

### A. General

Each lift station shall be equipped with a telemetry/auto-dialer in addition to audible and visual alarms. Contact County Engineer for any other special equipment. It shall be the responsibility of the Contractor to install the necessary switches, contacts, relays, etc. and associated wiring required to monitor and report the alarm conditions as noted herein. The Contractor shall also be responsible for arranging for the telephone service in the name of the MCPW and installation of the required phone jack.

### B. Wireless Alarm Communication

A Wireless Alarm Communicator provides a wireless communication link between the alarm panel and a central station receiver. The 15” x 13” x 7” unit normally sits atop the electrical panel roof and is housed in a lockable, NEMA4X weather tight enclosure.

The following alarm conditions shall be monitored at the lift station. The fault conditions shall be grouped to provide eight (8) alarm groups to the dialer:

Fault I - High Level Wet Well
Fault II - Pump #1 Failure
Fault III - Pump #2 Failure
Fault IV - Generator Operating
Fault V - Generator Fail
Fault VI - Low Generator Fuel
Fault VII - Commercial Power Failure
Fault VIII -Pump #3 Failure (if applicable)

Each pump failure alarm condition shall include failure due to overheating, overloading and seal failure (submersible pumps only). The alarm conditions above shall appear on a label to be mounted to the dialer. The power service shall be a 20 Amp receptacle (2 Gang).

**C. Enclosure and Mounting**

The system shall be housed in a heavy gauge, JIC, UL listed steel cabinet painted with epoxy or baked-on enamel paint, NEMA 4X. A thermostatically controlled strip heater shall be provided inside the enclosure. A power feed for the enclosure heater, separate from the dialer operating power, shall be provided.

The unit shall be mounted on the electrical rack under the rain shield.

**D. Shop Drawings**

The supplier shall furnish six (6) copies of Shop Drawings giving complete descriptive information on the dialer system to be provided.

**E. Manufacturer**

The dialer system shall be specified and approved by MCPW.. The appropriate expansion module(s) shall be included to provide a sufficient number of alarm inputs.

**F. Dialer Programming**

The dialer shall be programmed in accordance with the MCPW's directives.

**G. Telephone Service**

The CONTRACTOR shall arrange for telephone service, in the name of the MCPW, to the lift station electrical rack, if required. Wiring from the telephone system network interface to the dialer enclosure shall be completed by the CONTRACTOR.

**H. Alarm Light and Horn**

This unit shall be mounted atop the rainhood with the following items: 1) Strobe Lamp for the alarm light, 2) a pushbutton to silence the horn and strobe lamp, 3) a cycle timer to be added so the alarm on and off time can be adjusted from 0 to 60 sec., 4) the timer shall start with the off delay time first with an initial setting of 10 sec. off and 5 sec. on, and 5) the alarm test to be pushbutton.

**I. Start-Up Services**

The supplier shall provide complete installation and operating instructions for use by the MCPW. Start-up by a factory representative is required and shall be conducted in the presence of the Engineer and MCPW staff.

## 10. FLOW MONITORING EQUIPMENT

**A. General**

Each lift station shall be equipped with a telemetry/auto-dialer in addition to audible and visual alarms. Contact County Engineer for any other special equipment. It shall

be the responsibility of the Contractor to install the necessary switches, contacts, relays, etc. and associated wiring required to monitor and report the alarm conditions as noted herein. The Contractor shall also be responsible for arranging for the telephone service in the name of the MCPW and installation of the required phone jack, if needed.

The supplier of the communication system (Vendor) is Aquavx.

**B. Quality Assurance**

The installation of the equipment in Contract B shall be completed by a licensed electrical contractor licensed in the State of North Carolina.

**C. Shop Drawings**

The supplier shall furnish six (6) copies of Shop Drawings giving complete descriptive information on the dialer system to be provided.

**D. Equipment Compatibility**

The Contractor shall be responsible for coordinating the work such that the equipment remains in service during the installation.

**E. Functionality**

1. The wastewater facilities remote monitoring, reporting and alarm notification system shall be comprised of a hosted, Web-based user-interface which communicates to remotely monitored stations via a readily available commercial cellular network. The system shall contain:

    a. Hardware located at each remote station that continually monitors pump activity, fault conditions, tank level, flow meter data, rainfall data and computed volumetric inflow and outflow and reports this information on a periodic and exception basis to a Web-based user-interface using a secure protocol over the cellular network.

    b. A web-based application that is configured to present all fault conditions, operating conditions, computed values in tabular, graphical, map and report formats. The application will provide alarm notification to designated personnel based on alarms detected by the remote hardware and by computations performed by the Web-based system.

2. The system shall be fully integrated between the hardware and Web application providing complete programming capability of the hardware from the hardware installed at each station and/or the Web application. The Web application shall be automatically updated whenever any configuration changes are made to the hardware and vice versa.

**F. Station Hardware**

1. User Interface: The station hardware may include a user interface for operations viewing and configuration. The keypad/display would allow the user to view the status of any/all pumps being monitored, computed or historic conditions, current and historic faults and configuration of operational parameters.

   Alternatively, Status LED's on the motherboard may be provided to:
   - Display the status of each digital input.
   - Provide radio strength by at least 8 LED's in 5db increments between -75db and - 110db to facilitate accurate antenna placement.

2. Status: The user shall be able to select any of the monitored conditions to be included in an automatic scrolling display that presents the current value and status of the condition. Remote of local status monitoring is acceptable. The following parameters may be available for the user to select:

   - Level
   - Pump run-times
   - Pump cycles
   - Inflow rate and Inflow total volume
   - Outflow total volume and previous cycle volume
   - Rainfall
   - Pump running/off
   - Pump starter faults
   - Phase monitor fault
   - Seal failures
   - Over temperatures
   - Intrusion/On-site
   - Cellular signal strength
   - Main power
   - Battery Power
   - Any digital, analog or Modbus channels being monitored
   - Surge protection on power and inputs

3. Manufacturer: Type A Model monitoring systems are Aquavx Scout model as manufactured by Antx, Inc.

**G. Submersible Level Transducer**

The submersible level transducer shall sense the liquid level or pressure variation and convert these variations into a linear analog output (4-20 mA).

**H. Rain Gauge**

The rain gauge shall be self-emptying, tipping bucket type.

**I. Current Switch**

Current switches shall provide positive indication that current is flowing to the sewage pumps (pump is running) and shall clip over the wire powering the pump and close a contact upon detecting current flow.

**J. Light Protection**

Lightning protection shall be provided on all of the digital, analog and antenna signals. The pressure transducer shall also be protected from damaging surge voltage and current and shall have a multi-stage design.

**K. Installation**

1. Contractor shall install and make operational all components of the communication systems and appurtenances as specified herein. Installation shall include mounting the RTU, installing all electrical and instrumentation and software programming to make the complete system operational for the purpose intended.

2. Install the work in strict accordance with the manufacturer's recommendations and shop drawings as approved by the County.

3. Upon completion of the installation, carefully inspect each component and verify that all items have been installed in their proper location, adequately anchored, and adjusted to achieve optimum operation. If required, the Vendor shall adjust the antenna placement or elevation to obtain consistent, stable operation of the system.

4. Delineate timing of RTU installation and commissioning.

5. Level Transducer Installation: Where needed, core bore hole in clearwell where directed by the County. Install 3" PVC stilling well pipe from core to approximately 6" off the bottom of the wetwell. Install electrical junction box on the outside of the wetwell at the core. Provide SS wall bracket within wetwell with SS bolts to secure the stilling well pipe. Install PVC conduit from the junction box to the RTU.

**L. Service**

The Contractor shall furnish a written report prepared by the instrumentation equipment manufacturer's field service technician certifying that:

1. The equipment has been properly installed in accordance with manufacturer's recommendations;

2. The equipment check out and initial start-up activities have been completed in accordance with manufacturer's recommendations and under the technician's supervision;

**M. Warranty**

All services and equipment shall have a warranty of one (1) year from date of acceptance.

## 11.0 STANDBY POWER GENERATOR SYSTEM

**A. General**

Moore County requires that all pump or lift stations be provided with a complete standby electric power system consisting of a diesel engine driven generator set, an automatic load transfer switch, time switches, contactors, wiring, conduit, piping and accessories. The engine generator set and automatic load transfer switch shall be completely built, tested and shipped by a manufacturer who has been regularly engaged in the production of such equipment and who has parts and service facilities locally available so there is one source of supply and responsibility. The performance of the electric plan shall be certified by an independent testing laboratory as to the plant's full power rating and voltage and frequency regulation. All equipment shall be warranty for 5 years or 1,500 running hours from date of acceptance. The engine-generator set shall be enclosed in a weatherproof housing which sets top of the fuel tank. Alarms to the dialer from the generator shall be Low Fuel, Generator Operation and Generator Fail warnings. There shall be 2 extra wires install to the generator in conduit for the purpose of transmitting the other alarm signals to the alarm dialer or control panel. Also, there shall be 2 receptacles install in the generator.

**B. Manual Transfer Switch**

The manual transfer switch shall be rated for Service Entrance applications and shall contain a 200 Amp standard or 100% rated over current device for the utility power switching device as indicated on the drawings. The generator power switching device shall be rated for 100% continuous load without de-rating. The current rating shall be based on all classes of load including resistive and motor loads.

The manual transfer switch must utilize electrically operated transfer mechanism that have been listed or certified to the following safety standards: UL 1008 Automatic Transfer Switches for use in Emergency Systems and CSA C22.2 No.178-1978 Automatic Transfer Switches. The completed assembly shall be mounted in a NEMA 4X enclosure suitable for outdoor application with controls mounted on an interior door. Exterior door shall provide additional protection against outside environment and vandalism.

Adequate size and quantity of ground lugs shall be provided and shall conform to NEC/CEC guidelines. Where a ground bus is provided, it shall be a full length copper ground bus bonded to the frame with adequate size and quantity of ground lugs and shall conform to NEC/CEC guidelines. Where load bus bars are utilized, they shall be tin plated round-edge high conductivity copper and be sized for 100% continuous load rating of the transfer switch, in accordance with NEMA, CSA and UL guidelines. The short circuit withstand rating of the completed bus assembly shall be not less than the short circuit fault current of the system. Provision shall be

made to terminate all incoming and outgoing power cables and grounding conductors. Connections shall be via screw type cable lugs. The Power Switching units shall be fix-mounted, utilize fully enclosed contacts and the withstand and closing rating shall be equal to or exceed the required withstand rating of the complete mechanism.

The unit shall permit manual mechanical operation of the transfer switch while the system is energized and carrying rated load. All internal control devices used in the Manual transfer switch shall be cable of being de-energized and isolated from the system by use of an accessible isolation plug for servicing procedures as required.

The Manual transfer switch design shall provide front accessible components and wiring for easy serviceability. Power or control connections, which are not readily serviceable while the transfer switch is mounted in its enclosure, are not acceptable.

The service entrance rated manual transfer switch transfer the load to the source 1 supply when an operator selects the "source 1" position on the door mounted source selector switch provided source 1 is energized at nominal rated voltage. The Manual transfer switch shall transfer the load to the source 2 supply when an operator selects the "source 2" position on the door mounted source selector switch provided source 2 is energized at nominal rated voltage. The transfer switch shall incorporate an isolating mechanism and over current protection on the utility supply to allow operation as the main service disconnect in accordance with NEC requirements. The transfer switch power switching devices shall be mechanically and electrically interlocked to prevent the utility and generator supplies from being interconnected.

The switch should have these standard control features.

1) The transfer switch shall be rated for use on multiple system voltages. The transfer switch shall be field configurable to operate on the following nominal system voltages; 208V, 240V, 380V, 480V, 600V.

2) Transfer switch control power must be obtained from the source being transferred to. The controls shall not require any connection to external power sources. Transfer switches requiring power from the engine starting (or other) battery are not acceptable.

3) A control circuit isolation plug shall be provided to isolate all control circuitry inside the transfer switch to facilitate maintenance procedures. When isolated, there shall be no voltage present on the control circuitry.

4) Pilot lights shall be provided to indicate load on source 1 status (green) and load on source 2 (green). Pilot lights to be long life LED type.

5) Source Selector Switch: A 2 position spring-return selector switch shall be

provided on the door of the transfer switch to allow an operator to manually select the desired source.

6) Source 1 Supply Auxiliary Contact (AUX-U): One (1) auxiliary contact shall be provided which operate when the source 1 is on load. The auxiliary contact shall be supplied with a rating of 10A, 120/240VAC, 5A, 28Vdc resistive, Form

7) Source 2 Supply Auxiliary Contact (AUX-G): One (1) auxiliary contact shall be provided which operate when the source 2 is on load. The auxiliary contact shall be supplied with a rating of 10A, 120/240VAC, 5A, 28Vdc resistive, Form C.

**C. Automatic Transfer Switch**

The manufacturer shall furnish schematic and a wiring diagram for the particular automatic transfer switch and a typical interconnection wiring diagram for the entire standby system. The automatic transfer switch shall be rated for continuous operation in ambient temperatures -25º F to +125º F. The transfer switch shall be rated for all classes of load, both inductive and non-inductive, at 600-volts, and shall be designed, built, and tested to close on an inrush current up to and including 20 times the continuous rating of the switch without welding or excluding burning of the contacts. The transfer switch shall be capable of enduring 6,000 cycles of operation, at rated current, at a rate of 6 cycles per minute, without failure. One cycle shall consist of complete opening and closing of both sets of contacts on an inrush current 10 times the continuous rating of switch. The automatic transfer switch, with terminal lugs for either copper or aluminum wire, shall have individual, heat resistant chambers enclosing solid silver cadmium oxide, double break contacts. The transfer switch, with mechanical and electrical interlocks to prevent simultaneously energizing both normal and emergency service, shall be mechanically held on both sides, with manual operator and auxiliary contacts rated 6-amp, 120-volt AC; 3-amp, 240-volt AC on both sides. It shall be mounted in a NEMA 4X enclosure with handle and lockable hasp on the door. Control accessories shall mount on a dead-front, swing-out control accessory panel to avoid shock hazard while adjusting control functions, but will swing out exposing the wiring to facilitate servicing. Indication lamps and meters shall be set in the front door of cabinet. Transfer switch shall be of the programmed transition type which shall provide dead band time adjustable from 1 to 10 seconds when the load is not connected to the normal power source, or to the engine generator. Control accessories shall be solid state type and shall provide the following functions:

1) Monitor each ungrounded line with calibrated dial, adjustable voltage, solid state UNDERVOLTAGE SENSORS to sense a decrease of voltage below a set point, or a loss of voltage on any phase or a reversal of phases on the normal power source. Voltage sensors shall be temperature compensated for 2% maximum deviation above the temperature range -25 º F to +175 º F.

2) Signal the engine-generator set to start in the event of a power disturbance as sensed by the monitoring system. A solid state TIME DELAY START

(adjustable from 0 to 60 seconds) shall delay this signal to avoid nuisance startups on momentary voltage dips or power disturbances.

3) Retransfer the load to the line after normal power restoration. A TIME DELAY RETRANSFER (adjustable from 0 to 30 minutes) shall delay this transfer to avoid retransfer in case of short-term normal power restoration.

4) Provide an automatic RETRANSFER TIME DELAY BYPASS to retransfer the load from generating set to normal source if generating set output interrupts after normal sources restore voltage.

5) Signal the engine-generator to stop after load retransfer to normal source. A solid state TIME DELAY STOP (adjustable 0.5 to 5 minutes) shall permit engine to run unloaded to cool down before shutdown.

6) Provide a TEST SWITCH to simulate an interruption of power from the normal source.

7) Provide a constant-voltage automatic charging (1.40 to 1.24 volt per cell) SCR current limited, BATTERY FLOAT CHARGER to maintain fully charged cranking batteries.

8) Provide an EXERCISER CLOCK to automatically start the generating set at regular intervals and allow it to run for a preset time period, such as 30 minutes per week.

9) Provide WITH LOAD – WITHOUT LOAD SELECTOR SWITCH to select test or exercise as follows: “without load”, the generating set runs unloaded or “with load”. The automatic transfer switch transfers load to generating set, after time delay, the same as it would for a normal source interruption.

10) Provide a CONTROL DISCONNECT PLUG to electrically disconnect the control section from the transfer switch for maintenance service during normal operation.

11) Provide two (2) auxiliary relays or auxiliary contacts on the main power contactors (normal and emergency) so that a remote alarm or light can be connected to indicate that normal power has been lost and that power is being supplied from the engine generator set.

12) The automatic load transfer switch and/or the generator control panel shall have relays and wiring which provide contacts for closure in the event of a generator-set failure after transfer to emergency power. The contacts shall be made available for connection to the existing alarm transmitter.

13) Provide two (2) sets of auxiliary contacts to be actuated when the transfer switch is in the normal position and two (2) sets of auxiliary contacts to be actuated when the transfer switch is in the emergency position.

14) Provide a "neutral" position timer (adjustable from 0 to 10 seconds) to allow loads, such as motors, to come to a complete stop before being transferred to another source.

The automatic transfer switch to be supplied as part of the standby power system shall meet all applicable requirements set forth by the National Electrical Code and OSHA. The transfer switch shall also conform to the requirements as specified below:

1. Enclosure
   - Mounting type ..... Surface
   - Enclosure type ..... NEMA 4X

2. Electrical Ratings
   - Operating voltage ..... Compatible with station voltage
   - Operating current ..... No less than main disconnect
   - Withstand and closing rating ..... 10,000 Amps, RMS, Symm. (min.)

3. Transfer Switch:
   - Operating mechanism ..... Single solenoid
   - Holding mechanism ..... Mechanical
   - Interlock ..... Mechanical and electrical
   - Contact material ..... Silver alloy
   - Neutral delay ..... 0.1 - 10 seconds

4. Timer Setting Ranges:
   - Utility dropout ..... 70-95%
   - Utility pick-up ..... 70-95%
   - Utility interrupt delay ..... 0.1-10 sec.
   - Engine min. run ..... 5-30 min.
   - Engine warm-up ..... 5-180 sec.
   - Return to utility delay ..... 1-30 min.
   - Engine cooldown ..... 1-30 min.
   - Standby voltage ..... 70-90%
   - Standby frequency ..... 80-90%
   - Exerciser ..... Once/week

5. Operation Selectors:
   - Exercise ..... With/Without load
   - Engine warm-up bypass ..... On/Off
   - Neutral delay ..... On/Off
   - Mode selector ..... Manual Test/Standby/Off

**D. Standby Power System Capacity**

The standby power system shall be capable of providing continuous standby power for the wastewater pumping station. The generator set shall be capable of starting all pump motor loads sequentially with the full miscellaneous load applied, with no more than 30% dip. **The minimum acceptable generator set rating shall be 25 KW for any station.** The CONTRACTOR/DEVELOPER shall coordinate the starting requirements of the exact pumps being furnished on the project with the generator set supplier to insure that the generator set has adequate motor starting capability.

**E. Installation**

The generator set shall be mounted and anchored to a reinforced concrete pad, one foot above the 100 year flood elevation, located to provide adequate access for fueling and servicing. The exact dimensions of the pad, conduit entries and anchor bolts shall be based on the manufacturer's shop drawings. The pad shall have outer dimensions 1 foot greater than the footprint of the base tank, to provide 6" of exposure on all sides. All exposed edges shall be chamfered or rounded with an edging tool.

All connections to it shall be made with flexible pipe, conduit, etc., to minimize transfer of vibration.

Prior to shipment, the following tests shall be conducted at the plant of the manufacturer, and certified results of these tests shall be delivered to the Engineer for transmittal to the Owner: Full load test of the generator set for one hour with fuel consumption, output voltage, engine speed, voltage and speed-regulation and generator winding temperature measured and recorded at ten-minute intervals.

**F. Tests**

Authorized Distributor of the manufacturer shall inspect the equipment installation after it is completed and perform initial start-up and test of the system and shall submit a certificate of this inspection and test. The date of acceptance as referred to hereinbefore is defined as the date on which this certificate of inspection and test is received by the Owner. The following test shall be performed in the presence of the Engineer or their representative:

(1) Generator output voltage unloaded and loaded, each phase, based on 2-hour load bank test

(2) Voltage dip as loads are applied

(3) Complete operating sequence (simulated utility power failure and restoration)

(4) Pressure test engine cooling system for leaks

(5) Test battery charging systems

(6) Test operation of all safety systems

Upon completion of break-in and testing, the engine shall be serviced as follows:

(1) Change engine oil and filter
(2) Verify anti-freeze protection (-34° F)
(3) Refill fuel tank (tank shall be left full)
(4) Check belt tension
(5) Check battery connections and state of charge

During this start-up period, the MCPW personnel shall be fully instructed in the proper maintenance of the standby power system.

**G. Manufacturer**

The generator set, controls, and transfer switch shall be furnished by a single supplier. The generator set and accessory equipment shall be supplied by Caterpillar Cummins or Kohler, ASKA or an approved equal.

The supplier shall be the authorized dealer of the engine-generator set manufacturer, and shall be fully qualified and authorized to provide service and parts for the engine and generator at any time during the day or night. Parts and service shall be available 24 hours per day 7 days a week, from a location within a 100-mile driving radius of the location of the installed generator set.

**H. Shop Drawings**

Prior to purchase of stand-by power generation equipment, the Contractor shall submit not less than six (6) sets of data to the Engineer for approval, including: equipment data, accessories, sizing calculations, etc., as may be appropriate to determine compliance with these Specifications.

**I. Operating Instructions**

Six (6) complete copies of operating instructions and parts list shall be provided prior to acceptance of the unit. Parts list shall include schedule of type and quantity of parts recommended for stock.

**J. Spare Parts:**

The following spare parts shall be furnished at the time of start-up to MCPW:

Engine Fan & Accessory Drive Belts .....1 sets
Oil, Fuel & Air Filters.....2 sets
Spare Indicator Lamps & Fuses .....2 sets

Other items as may be recommended by the manufacturer. Spare parts shall be boxed and labeled with the pumping station identification.

**K. Warranty**

The complete standby power generating system shall be warranted for five (5) years or 1,500 running hours after the acceptance of the generating system by the MCPW. The warranty shall cover all defects in equipment, parts, assembly and installation. The warranty shall be issued in writing by the supplier and delivered to the MCPW.

## 12.0 PUMP TYPES

Provide standby auxiliary pumping system, including bypass pumps and the auxiliary pumping system shall be activated by the Automatic Transfer switch or other approved means.

For Gorman Rupp pumping systems, alti-start auxiliary pumping system is acceptable.

## 13.0 FORCE MAIN

### A. General

Force Mains shall be constructed of ductile iron pipe coated with Protecto 401 Cement Epoxy, PVC C-900 or PVC C-905 or approved equal. Force Mains 8 inch and smaller shall have a minimum of 3 feet of cover and force Mains larger than 8 inches shall have a minimum of 3.5 foot cover. (See STD. No. PS 9)

Force Mains shall be encased by a steel encasement pipe under secondary roads, primary roads and railroad crossings. Encasement pipe for installation under highways and railroads shall be 35,000 psi pipe conforming to ASTM A139. Encasement pipe shall conform to NCDOT specifications for pipe laying for highway crossings and specifications for railroad crossings. The pipe shall be furnished with a bituminous coating on the outside. Carrier Pipe shall be DIP and shall be installed using boltless restraining gaskets. Boltless restraining gaskets shall be “Field-Lok”, “Fast-Grip”, “Gripper Gasket” or approved equal. Carrier pipe shall also have spacers installed. Spacers shall be steel, epoxy coated “spiders”. Provide one spacer in the center of pipe and one spacer on each end of the same pipe stick.

Force mains shall be sized such that velocities are not less than 2.5 fps or greater than 8.0 fps.

All force main pipe and fittings shall be adequately blocked against thrust reaction in accordance to the Standard Specifications for water mains.

Force mains shall not be closer than 50 feet from any private water supply well or 100 feet from a public water supply well.

Force mains shall include a plug valve ten feet outside of the station but inside the fence.

### B. Velocity

Wastewater velocity occurring in a force main shall be calculated using the continuity equation:

$$V = \frac{0.4085Q}{D^2}$$

Where: V = velocity (feet per second)
Q = pumping rate of single pump (cubic feet per second)
D = diameter of pipe (inches)

Force mains shall be adequately anchored with thrust blocks on MJ pipe bends, tees, plugs, and at any other location where a change in flow direction occurs.

**C. Ductile Iron Pipe**

All ductile iron pipe shall be designed as per ANSI/AWWA C-151/A21.50.02 for a minimum working pressure of 200 psi. Pipe wall thickness shall conform to ANSI/AWWA C-150/A21.50-02. Pipe up to and including 12 inch diameter pipe shall be Pressure Class 200, while pipe greater than 12 inch diameter shall be Pressure Class 250. The County Engineer may require heavier class pipe on a case-by case bases.

Pipe joints shall be of the push-on type with rubber gaskets as per ANSI/AWWA C-111/A21.11-07. Mechanical or special joints may be used as project requirements dictate or as required by the County Engineer. Pipe lining shall be coated with Protecto 401 Cement Epoxy, on the interior, while an external coat of bituminous material, all in accordance with ANSI/AWWA C-104/A21.4-03. Where restrained joints are indicated Mega-Lugs or Grip rings shall be used.

Ductile iron pipe shall be as manufactured by Griffin, U.S. Pipe, American, or Clow. The pipe shall be furnished in 20-feet or 18 feet in lengths and be American made.

**D. Polyvinyl Chloride Pipe, C-900 or C-905**

PVC pipe shall be rigid polyvinyl chloride with integrally formed, factory fabricated bell, with "slip" joint rubber gaskets conforming to AWWA C-111. It shall be suitable for all conditions imposed by plan locations and for a minimum working pressure of 200 psi, plus 100 psi surge allowance at 73 degree F. Pipe shall be Type 1, Grade 1, made from clear virgin material and shall conform to the requirements of ANSI/AWWA C-900-07. All pipes shall bear the National Sanitation Foundation Seal of Approval, the manufacture's name, and class of pipe. The joints shall conform to ASTM D3139-98.

Provision must be made for expansion and contraction at each joint, through the rubber gasket and pipe bell. Where restrained joints are indicated, Mega-Lugs or Grip Rings shall be used.

**E. High Density Polyethylene Pipe, HDPE**

HDPE pipe for directional drilling shall be DR-9, 250 psi, and sized to have the minimum inside diameter the same as the connecting Force Main. Connection of HDPE to Ductile Iron pipe shall be horizontal and made to prevent binding of HDPE. All pipes shall be labeled ANSI/AWWA C906 or C901. Pipe material is to conform to ASTM D2737. Design of pipeline shall meet *PPI Handbook of Polyethylene* Pipe on Performance Pipe website. Maximum bending radius shall meet the *PPI Handbook* requirements, which is 20 times the pipe diameter for DR 9 pipe. Installation of HDPE pipe shall meet ASTM D-2774 *Standard Practice for Underground Installation of Thermoplastic Pressure Pipe.*

After directional drilling, HDPE pipe shall be allowed to retract (release) for 30 days after which connection shall be made to three joints of DIP with restrained mechanical joints, gate valves and reducers. A valve shall be placed between the first and second joint of DIP at each end of the HDPE. Alternately, if less retraction time is desired, the Design Engineer may submit calculations and data referenced in the *PPI Manual*, including Pulling-in calculations, pullout prevention technique, horizontal drilling records, and allowable tensile load calculations for the County Engineer's review.

**F. Fittings**

Fittings for ductile iron pipe force mains, 4-inch diameter and larger, shall be ductile iron. Provide stainless steel hardware.

**G. Air Release and Vacuum Relief Valves**

1. Air release valves shall be located on lines where hydraulics indicates gas pockets may accumulate.

2. The route of the force main shall be such that the number of air release and vacuum relief valves are minimized to the greatest extent possible.

3. A Combination Valve will be needed where the distance between the low points and high points in the Force Main exceeds 2 vertical feet. Each valve shall be quick-opening, slow-closing type to prevent the development of hydraulic surge conditions.

4. Use air release valves with flood protection in areas within the 100-year floodplain or areas where flooding is anticipated to occur. Each valve shall be equipped with flushing connections and one set of flushing hoses. Use ClaVal, Crispin or equal. (See STD. No. PS 8)

**H. Gate Valves**

**1. 12 inch and Smaller:**

Gate valves 12 inch and smaller shall be of the resilient wedge type conforming to ANSI/AWWA Standard C-515. They shall be designed for a working pressure of

200 psi. The valves shall be open-left (counter clockwise), non-rising stem ductile iron body, with O-ring seals and a 2 inch square operating nut. Extension stems shall be furnished when depth of bury places operating nut is in excess of four feet below finished grade.

**2. 16 inch and Larger:**

Gate valves 16 inch and larger, may be the horizontal gate type or butterfly type and shall be used for all main line in sizes 16 inches through 30 inches. Type of valve used shall be approved by County Engineer.

**I. Plug Valves**

Plug Valves shall be full body opening. Plug Valves shall meet or exceed AWWA C-517. Valves shall be side or top cranked in vaults, as approved by County Engineer, and only top cranked if buried with heavy-duty fully rubber encapsulated plug, V-type packing that is self-adjusting and replaceable while under pressure. They shall be stainless steel radial for upper and lower bearings that is permanently lubricated for extended life.

**J. Valve Markers**

Valve Markers are to be installed in rural areas, near the right-of-way line, to better identify their location for all other valve locations. In urban areas, valve markers are to be installed only as recommended by the County Engineer.

For Valve Marking and Valve Box Cover protection, provide a concrete protector ring.

**K. Stream Crossings**

Force mains shall be routed such that the number of stream crossings is minimized. The crossing shall be as nearly perpendicular to the stream flow as possible. Force main installation shall be equivalent to water main standards to construct force mains that cross streams.

**L. Testing**

All force mains shall be tested to water main standards. The section of force main to be hydrostatically tested shall be slowly filled with water at a rate which will allow complete evacuation of air from the line.

**M. Utility Warning Tape**

All force mains shall have warning tape installed 18" below finish grade. The tape shall read “Sewer Main Buried Below”. (See Std. No. PS 9)

**N. Tracer Wire**

Tracer wire shall be installed on all force mains along the top of pipe and secured (i.e. Duct tape) to the pipe every 10 feet. The wire shall be number 12 gauge, colored

green, rated for underground installation with a minimum breaking strength of 450 lbs. and a coating of 30 mils.

All spliced or repaired wire connections in the tracer wire system shall be made using a Wing Nut Wire Connector (for two to four number ten wires), or approved equivalent, and made waterproof using an approved buried service wire closure. The buried service wire closure shall be Frame Gel Closure or equivalent. (See Std. No. PS 9) the testing of tracer wire, after construction, shall be performed by the contractor with the County Engineer or their representative present.

**O. Receiving Manholes**

All receiving manholes shall be fully coated inside with an epoxy approved by the County Engineer. Additional down stream manholes shall be fully coated as required by the County Engineer. If the entrance pipe is more than 2 feet higher than the outlet pipe flow line, a drop shall be installed with a 45 degree bend aimed at the outlet invert. (See STD. No. PS 10)

## 14.0 QUALITY ASSURANCE AND QUALITY CONTROL

The following items are required to assure that the construction quality is acceptable and that information has been provided to assure proper maintenance quality:

1. Three Operations and Maintenance (O&M) Manuals shall be prepared and provided to MCPW before testing and start up for each lift station.

2. Approved Shop Drawings, including design data for all installed equipment and each major component and a pump curve/system curve analysis showing the design operating point(s) and control panel wiring diagrams.

3. Complete Operating Instructions, including preventative and predictive maintenance, for all installed equipment and each major component. Instructions for start-up/shut-down as well as for calibration and adjustment of all installed equipment and each major component.

4. Warranty information for all installed equipment and each major component.

5. Construction Record Drawings that have been signed, sealed, and dated by a North Carolina Professional Engineer. Such drawings shall include, but shall not be limited to, the following:

    a. Plan and profile views of the force main as installed as well as its proximity to other utilities and natural resources. The locations of specific force main materials as well as any valves and other force main appurtenances shall be indicated.

    b. Construction record detail drawings of the lift station.

## 15.0 SECURITY

Access to lift station structures/equipment/appurtenances shall be restricted.

1. All entry into lift stations shall be locked.

2. Fencing shall be 6 feet in height and of sufficient material to deter entry. Locked gates, a minimum of 12 feet wide, shall be provided to allow vehicular access.

Safety Placards, as required by OSHA, shall be provided and be readily visible. (See STD. No. PS 11)

A lift station Identification Sign shall be posted, with the name, emergency number, station address and instructions to call in the event of an alarm condition or other emergency.