



Technical Manual

**Requirements and Specifications
For
Wastewater and Pump Station Facilities**

**Henderson, Water Utility
Henderson, Kentucky**

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1. WASTEWATER AND PUMP STATION TECHNICAL MANUAL

1.1 INTRODUCTION

This document contains technical guidance for the construction of wastewater and pump station facilities to serve existing and new development. It establishes uniform policies and procedures for the construction and acceptance of wastewater facilities to provide efficient, reliable service.

HWU staff responsible for working with developers and others subject to the procedures and specifications contained herein may be contacted by telephone at (270) 826-2824, or may be visited at the System Operations Center at 230 N. Alvasia Street, Henderson, KY 42420.

1.2 PURPOSE

The purpose of this manual is to provide standards to assure consistent quality in the design and construction of wastewater infrastructure that becomes a part of the HWU system. The manual establishes uniformity in design assumptions and general methods of design, and sets policy regarding design standards and specifications. Finally, the manual outlines the required calculations and designs applicable to wastewater infrastructure.

Provision of Wastewater Facilities

HWU reserves the right to design and construct all improvements to the wastewater system for existing and new developments. In certain instances, HWU may allow others to design and construct wastewater facilities that are to become part of HWU's System. Construction by outside agents may require signing of an agreement; negotiation of possible future reimbursement of costs; and all required licenses, permits, easements and rights of way must be obtained and provided to HWU. In addition, HWU must inspect all elements of the construction, and witness and approve all testing prior to acceptance.

Wastewater System Extensions

The procedures in this manual will apply to extensions to furnish sewer service to a prospective customer or customers including new developments. The customer(s) being served are expected to pay the cost of the extension unless prior arrangements have been made with HWU to share the cost. HWU may require developers or others requesting line extensions to pay the full cost of off-site improvements necessary to serve a development when the improvement is necessary to serve the development.

Any additions to the public wastewater system made as a result of an agreement with HWU shall become the property of HWU, which reserves the right to further extend the lines or provide other facilities deemed necessary without reimbursement to another party, unless specifically covered by a reimbursement agreement.

If a line extension is to be built on road frontage or vacant land, the extension will normally stop at the last point of service. To insure that right of way will be available for future use, HWU may require the granting of an easement over the entire frontage, or to the furthest property line.

1.3 GENERAL REQUIREMENTS

The following is a list of requirements to be followed by a developer or others who wish to design, finance, and construct sewer system facilities that will become a part of the HWU system. These

procedures must be followed in order for the proposed sewer system facilities to be considered for acceptance and connection to the HWU system.

Where an industry or national standard (AWWA, ANSI, etc.) is referenced, the latest revision shall apply, unless noted otherwise.

The Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers "Recommended Standards for Wastewater Facilities" (10-States Standards) shall govern for any item of design or specification not covered by this Manual.

Design Criteria

The following is a list of minimum design criteria required for any sewer facility to be approved to connect to the HWU system. For all these requirements, deviation requires prior written approval.

1. Pipe size and material shall be as determined by HWU, and shall be manufactured and installed in accordance with the specifications contained herein. Sewer pipe shall be a minimum of 8-inch diameter for gravity lines and 6-inch diameter for sewer taps and laterals. Gravity sewer lines are to be sized so that the design peak flow is no greater than 2/3 flow depth.
2. Sewer force mains shall be designed for a minimum velocity of 2 feet per second, with a maximum of 15 feet per second. Force mains shall be sized for potential growth.
3. All pipe shall be installed on a level bottom with holes for the bells cut at each joint. Crushed stone bedding shall be required.
4. Gravity sewer lines shall be laid true to lines and grades as shown on the approved design plans and profiles. Minimum cover over gravity sewers shall be 42". Force mains shall have nominal cover of 42"-48".
5. The size, type, class and thickness or pressure rating of sewer line material shall be as shown on the approved plans and specifications.
6. PVC and ductile iron pipe shall have a gasketed joint used in conjunction with an integral bell, which shall be a homogenous part of the pipe. PVC and ductile iron pipe joints shall be in accordance with recommendations of the manufacturer. HDPE pipe shall be fusion welded and installed per manufacturer's specifications.
7. All pipe shall have its location marked by using a detectable marking tape, installed 18 to 24 inches above top of pipe.
8. A manhole shall be placed at every change in direction or grade, at each end point, at intersections with other sewer mains, at changes in pipe material, and at 400 feet maximum spacing (500 feet for 18-inch or larger sewer).
9. All new manholes shall be pre-cast reinforced concrete with pre-cast base with flow lines. Use of "dog-house" style manholes shall be avoided wherever possible.
10. Combination air and vacuum release valves shall be located at significant high points in force mains.
11. Sanitary Sewer lines shall be laid at least 10 feet horizontally from any existing or proposed water main. The distance shall be measured from the outside of each pipe wall. Where a separation of 10 feet is not feasible, the sewer shall be laid so that the top of the sewer pipe is no less than 18 inches below the bottom of the water main. Sewer lines crossing water mains shall have a vertical

distance of 18 inches between the outside of the water main and the outside of the sewer. If a sewer line is to be laid above a water main, the sewer main shall be constructed of ductile iron pipe or in a steel casing, with one full length of pipe centered on the water main. At all crossings, one full length of the water main pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

12. Sanitary sewers shall be designed and built so that they generally run adjacent to, but outside of the road rights-of-way in dedicated utility easements. Easements for sewer lines shall be a minimum of 12 feet in width. Easements for water and sewer lines running parallel shall be of sufficient width to maintain a minimum of 10 feet of separation between the adjacent edges of the water and sewer lines. The outer edge of the easement for single and parallel lines shall be a distance from the outside edge of the pipe(s) based on the formula $(\text{invert depth in feet}/2)$ or 5 feet minimum.
13. Easements wider than those described herein may be required at HWU's discretion.
14. Sanitary sewer tap clean-outs and service connections shall be installed in accordance with the applicable utility provisions by a licensed plumber, at locations shown on the plans. Clean-outs shall be 6-inch minimum in diameter and have covers installed according to the standard drawings. For location of tap, the installer shall place a cap on the end of the tap and use a metallic marker with PVC pipe and cap around it for protection. This marker should be even with the ground. The developer is not required to install the tee and cleanout.
15. During the progress of the work and until the completion and final acceptance, pipes and their appurtenances shall be kept clean throughout. Any obstructions or deposits shall be removed.
16. If, at any time before completion of the work, any broken pipe or any defects are found in the lines or in any of their fittings or appurtenances, they shall be replaced.
17. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that water, earth, or other foreign substances cannot enter.
18. The installer shall adjust manhole tops as required to provide access during all phases of construction. Final adjustment shall be flush with pavement, driveway or sidewalk surfaces, or 1-inch above finished grade in lawn areas, unless specified otherwise. In areas subject to cultivation, manhole tops may be buried no more than 2 feet below the ground surface.
19. Acceptable pipe materials for gravity sewers are: solid wall PVC pipe, ductile iron pipe, reinforced concrete pipe as specified in the Materials Checklist below. At depths of cover of 10 feet or less, any of these pipe materials may be used. At depths greater than 10 feet but no greater than 15 feet, SDR35 PVC shall not be used. At depths greater than 15 feet, no PVC pipe shall be used. If any portion of a sanitary sewer segment crosses one or more of the above threshold depths, the most stringent requirement shall apply; however, manholes may be strategically located to minimize the lengths of deep sewers. Sewer force mains shall be HDPE fusion welded pipe DR-11 unless otherwise specified.
20. Each separate dwelling, commercial building or industrial building shall have a separate sewer connection extending to the sewer main.
21. All gravity sewer pipe in steel casing longer than 200 feet shall be ductile iron pipe with field-loc type gasketed joints.

22. All service connections shall be as per standard drawings.

23. Testing shall be in accordance with this manual.

MATERIALS CHECKLIST

PIPE	PVC SDR-35 OR SDR-26 ASTM D-3034, F-679 J-M Manufacturing Co. or approved equal
PIPE	DI (DUCTILE IRON) Pressure Class 150-350 AWWA/ANSI C150/A21.5 Interior lined with Protecto 401 or approved equal
PIPE	HDPE ASTM D3350, ASTM F714, ASTM D3035 CSR Polypipe Greenview PE 3408 or approved equal
PIPE	RCP reinforced concrete pipe minimum Class III wall thickness KYTC 810.03 interior lined with Permite PCS-9043 Type II or approved equal.
FITTINGS FOR GRAVITY SEWERS	Same material and/or coating as pipe being used.
AIR VACUUM RELEASE VALVE	ANSI-AWWA C512 Made from Non-Corrodible Materials Bronze Saddle, Corp Stop, and Globe Valve Required ARI Model D-020-ST or approved equal
CASING	Steel, Plain end, 35,000 psi yield point strength ASTM A252 Grade 2 or ASTM A139 Grade B Minimum Wall Thickness – Schedule 20; 0.375 for 24” and larger Un- Coated and Un-Wrapped
CLEANOUTS	Cast Iron East Jordan Iron Works or approved equal
FITTINGS FOR FORCE MAIN	Flanged fittings ductile iron with cement lining.

1.4 GENERAL INFORMATION - PLAN AND PROFILE SHEETS

Title Sheet, General Notes, Legend, and Map Index

1. Name of development; name, address, and telephone number of developer in lower right-hand corner of plans.
2. Names of existing utilities, contact person, and telephone numbers.
3. Vicinity map (highlighting proposed extension).
4. Sheet index.
5. A legend that includes all items of work in the plan set
6. General notes that include the following as applicable:
 - a. The contractor is prohibited from excavating until existing underground utilities have been located through Kentucky 811. Utility locations are approximate. Phone numbers for known utilities in the area are shown on this sheet, however other utility companies may also have facilities in the project area. Contractor shall identify and contact all utilities including those who do not subscribe to KY 811 (including Henderson Municipal Power and Light – HMPL).
 - b. Contractor shall be responsible for maintenance of traffic in accordance with requirements of the Manual of Uniform Traffic Control Devices (MUTCD).
 - c. Temporary construction easements shall be a minimum of 30' wide, where possible. All new permanent sewer line easements shall be 12' minimum except as specified herein.

Contents of Sewer Line Plan Sheets

1. Minimum 24" x 36" sheet size.
2. Title block
3. Name, address, and telephone number of developer
4. Name, address and telephone number of engineer
5. Professional engineer seal and signature
6. Sheet number
7. North arrow
8. Scale (maximum 1" = 100')
9. Date
10. Right of way
11. Easements
12. Property owners, PVA parcel number
13. All existing and proposed utilities in project area, including:
 - a. Details of tie in to existing lines
 - b. Size of lines and class of pipe
 - c. Manhole and clean-out locations
 - d. Gate and air/vacuum release valves

- e. Length and size of steel casing pipe for road bores or open cut
 - f. Reference distances to sewer line from centerline of road or other visible permanent topography
 - g. Detail information for all road, creek, and railroad crossings
14. Show match lines with station number reference
 15. Cross-reference the plan sheets at road intersections and where sewer lines intersect.

STANDARD DETAIL DRAWINGS

Standard details must be included in the drawings if any of the items listed below are used:

1.	Trench Section Method A	HWUS001A.DWG
2.	Trench Section Method B	HWUS001B.DWG
3.	Trench Section Method C	HWUS001C.DWG
4.	Gravity Sewer: Ditch or Stream Crossing	HWUS003.DWG
5.	HDPE Force Main: Ditch or Stream Crossing	HWUS004.DWG
6.	Force Main Air & Vacuum Release Valve	HWUS005.DWG
7.	Typical 6" PVC Sewer Laterals	HWU006.DWG
8.	Plan Views – Single and Dual Sewer Taps	HWU007.DWG
9.	Standard Precast Manhole	HWU008.DWG
10.	Shallow Precast Manhole	HWU009.DWG
11.	Precast Manhole with Drop Inlet \geq 6' Depth	HWU0010.DWG
12.	Manhole Base (Cast in Place)	HWU0014.DWG
13.	Cased Gravity Sewer or FM crossing roadway	HWU0015.DWG
15.	Casing detail	HWU0016.DWG

WASTEWATER SYSTEM SPECIFICATIONS

1.5 GENERAL

The work to be accomplished under these specifications is the furnishing of all labor, materials and equipment required for the construction of sanitary sewer and appurtenances as shown on the drawings and more fully described herein.

1.5.1 DEFINITIONS

Henderson Water Utility means the utility having jurisdiction and supplying water and/or sewer service and abbreviated herein as HWU.

Contractor means the party who has been retained by HWU or others to perform the construction work.

Engineer means an Engineer in responsible charge working under contract to HWU or in the employ of HWU, or an Engineer in responsible charge working in the employ of a developer under an Infrastructure Development Agreement.

Owner means HWU or a developer working under an Infrastructure Development Agreement.

1.5.2 SAFETY

All work shall be carried out in accordance with all applicable rules and regulations of the Kentucky Labor Cabinet, Division of Occupational Safety and Health, and HWU Safety Policies.

1.5.3 PRODUCT DELIVERY, STORAGE AND HANDLING

Care shall be exercised in transporting and handling to avoid damage to pipe and fittings, and all appurtenances. Materials shall be stored in an enclosure or under protective coverings if required by the engineer to prevent damage. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris.

Contractor shall be responsible for all materials furnished and shall replace at his own expense all materials found defective in handling after delivery. Contractor shall report to HWU immediately upon finding defects in any material supplied by HWU. Contractor shall furnish all materials and labor required for replacement of installed materials discovered defective or damaged.

HWU reserves the right to reject any materials that do not comply with these standards.

1.5.4 NOTIFICATON

The Contractor shall give the Owner or Owner's representative a minimum of 48 hour notice before starting construction. Where a public roadway must be closed, notify all safety agencies and the general public in accordance with local and state regulations. Where a private driveway must be closed, provide the resident a minimum 48 hours' notice. Maintain continuous access to non-residential private driveway crossings to the maximum extent possible.

1.5.5 INSPECTION

The Owner's Engineer shall make periodic observations during construction to provide final certification that the improvements were installed in conformance with HWU standards and the approved construction drawings. In addition to observation by the Engineer, a final inspection will be made prior to putting the facilities in service. Final inspection will be made prior to acceptance of any

facilities and only after all construction is complete. The Contractor shall provide labor and materials as required to complete the punch list developed during final inspection. Access to the construction site and construction records shall be provided to inspectors at all times.

During construction, the Contractor shall notify the Owner upon installation of any fitting, tap, cleanout or other appurtenance, and shall not cover up such items until GPS coordinates are established for such items, either by Owner's personnel or by a Kentucky Registered Licensed Surveyor employed by the Contractor. Coordinates must be referenced to the Kentucky State Plane Coordinate System NAD 83. If items are covered before GPS coordinates are obtained, the Contractor may be required to excavate to allow coordinates to be obtained.

In lieu of GPS coordinates, the Contractor may choose to provide a complete set of "As-Built" plans including two copies of full-size (24" x 36") bound drawings for the entire completed facilities. Both plan and profile of the sewer lines and facilities shall be included on the as-built drawings. In addition, one copy of the final as-built drawings including, plan and profile, in digital *.DWG or *.DXF format shall be provided. These digital files must be readable and the coordinates of the file shall be referenced to the Kentucky State Plane Coordinate System NAD83.

1.5.6 MATERIALS OR EQUIPMENT TO BE FURNISHED ("OR-EQUAL" CLAUSES)

Where material or equipment is specified by a trade or brand name, it is not the intention of the Owner to discriminate against an equal product of another manufacturer, but rather to set a definite standard of quality or performance, and to establish an equal basis for the evaluation of products. Where the words "equivalent" or "equal to" are used, they shall be understood to mean that the article referred to shall be the equivalent of, or equal to some other things, in the opinion or judgment of the Engineer. The Engineer will consider other products on the basis of materials of construction, weight, function, size (it must fit the space provided), service history and electrical and mechanical characteristics.

Where these specifications state one or more model numbers and manufacturers followed by the words "or approved equal" the meaning is that the product specified is acceptable and that while there may be other products that are acceptable the only way to be assured is to submit the desired substitution and receive an affirmative answer. The Engineer will consider the factors previously described in making the determination.

Unless otherwise specified, all materials used in the work shall be the best of their respective kinds and shall be in all cases fully equal to approved samples. The Engineer shall have the right to require the use of such specifically designated material, article, or process. The Engineer, where practical, may require submission of actual samples of materials or products. If for lack of data only one name is shown, it shall be deemed as only establishing a standard of quality and/or performance.

1.5.7 SHOP DRAWINGS AND SUBMITTALS

Whenever materials are to be incorporated into the work, and are subsequently to be accepted by HWU, copies of information describing and depicting the details of all equipment, controls, materials and/or services to be provided, hereinafter referred to as "shop drawings", shall be submitted and approved as required in the applicable procurement documents, agreement or bid specifications.

Shop drawings for all equipment and materials must show the following information at a minimum:

- a) Manufacturer's cut sheets or other detailed product information.
- b) Detailed dimensional drawings of each valve and fitting.

- c) Detailed description of materials of construction and applicable standards.

1.5.8 PERMITS, EASEMENTS, AND RIGHTS-OF-WAY

Unless stated otherwise, the Owner shall make application for, obtain and pay fees for all licenses, permits, easements, and rights-of-way, including railroad permits (where applicable). The Contractor shall be required to comply with all State and municipal ordinances, laws, and/or codes, which may apply to same.

1.5.9 CONTRACTOR'S CERTIFICATION

The Contractor shall certify, upon completion of project construction, that all work was completed in accordance with drawings and specification bearing Owner's approval. The certification must be signed and dated by the contractor.

2. MATERIAL SPECIFICATIONS

2.1.1 GRAVITY AND PRESSURE SEWER LINES – DUCTILE IRON PIPE

Ductile iron pipe shall be designed in accordance with the latest revision of ANSI/AWWA C150/A21.50 for a minimum 150 psi (or project requirements, whichever is greater) rated working pressure plus a 100 psi surge allowance (if anticipated surge pressures are other than 100 psi, the actual anticipated pressure should be used); a 2 to 1 factor of safety on the sum of working pressure plus surge pressure.

Ductile iron pipe shall be manufactured in the U.S.A. in accordance with the latest revision of ANSI/AWWA C151/A21.51. Each pipe shall be subjected to a hydrostatic pressure test of at least 500 psi at the point of manufacture. Ductile iron pipe shall have a standard laying length of eighteen feet (18'). Ductile iron pipe shall be manufactured by Clow Water Systems, US Pipe, or approved equal.

Pipe shall have standard asphaltic coating on the exterior. Pipe shall also have an interior lining of Induron Protecto 401™ Ceramic Epoxy or approved equal.

All areas of pipe and fittings including inside of bell and the outside of the plain end shall be lined with Induron Protecto 401™ Ceramic Epoxy or approved equal.

Specially lined pipe and fittings require careful handling from the outside of the pipe with straps or chains. No forks or hooks shall be used inside the pipe after the lining is applied.

The class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, country where cast, year in which the pipe was produced, and the letters "DI" or "DUCTILE" shall be cast or stamped on the pipe.

All pipe shall be furnished with Push-on Type Joints, such as Tyton® or Fastite®. Joints shall be in accordance with ANSI/AWWA C111/A21.11, of latest revision, and be furnished complete with all necessary accessories.

Fittings shall be manufactured in the U.S.A. and be ductile iron. Fittings shall conform to the latest revision of either ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. Fittings shall have a standard asphaltic coating on the exterior. Ductile iron fittings shall be manufactured by Tyler Union or approved equal.

Fittings and accessories shall be furnished with Mechanical Type Joints in accordance with ANSI/AWWA C111/A21.11, of latest revision.

Field Lok gasket shall be a boltless, integral restraining system and shall have a pressure rating based on the performance requirements of ANSI/AWWA C111/A21.11. Field Lok gasket shall be constructed with stainless steel locking segments vulcanized into the gasket to grip the pipe to prevent joint separation, and shall be manufactured by US Pipe (Field Lok 350®) or approved equal.

Ductile iron pipe restraints three (3) through sixteen (16) inch shall have a working pressure rating of 350 psi. Ductile iron pipe restraints eighteen (18) inch and up shall have a working pressure rating of 250 psi. Ductile iron pipe restraints shall be manufactured in the USA and shall be a wedge action restraining type with breakaway bolt design to ensure proper torque for installation. Ductile iron pipe restraints shall be for mechanical joint type, and shall have T-bolts, nuts, and gaskets that conform to AWWA C111, and a black e-coating to prevent corrosion. Ductile iron pipe restraints shall be Ebba Iron Sales, Inc. (1100 Megalug Series) or The FORD Meterbox Co., Inc. (UFR1400 Series) or approved equal.

2.1.2 GRAVITY SEWER LINES - PVC PIPE

All PVC pipe for gravity sewer lines shall conform to ASTM D3034 or ASTM F679 as appropriate.

All PVC pipe for gravity sewer lines shall be SDR-35 or greater wall thickness.

The chemical resistance of the pipe and fittings shall be tested in accordance with ASTM D543.

All fittings shall be of the same material as the pipe and shall be consistent therewith in strength, dimensions and utility.

Pipe joints are to be made using an integral bell with elastomeric gasket and according to manufacturer's recommendations.

2.1.3 CASING PIPE FOR BORE

Casing pipe for gravity sewer lines installed by road boring where required on the drawings or bid documents shall be steel, plain end, uncoated and unwrapped, have a minimum yield point strength of 35,000 psi and conform to ASTM A252 Grade 2 or ASTM A139 Grade B without hydrostatic tests. The steel pipe shall have welded joints and be in at least 18-foot lengths. Pipe shall be straight along the centerline axis within 1/50 of the outside diameter. Pipe shall also be free from dents or humps having a depth greater than ¼ inch.

For highway and ditch crossings, casing pipe shall be a minimum of Schedule 20, with wall thickness of 0.375 for 24-inch and larger casings. For railroad crossings, casings shall have a minimum wall thickness as specified by the railroad company. For State or Federal highway crossings, Kentucky Transportation Cabinet standards will apply.

All pipes inside casing shall be supported with stainless steel liner skids, as manufactured by Cascade Waterworks Manufacturing, CSS series, or approved equal. A minimum of two spacers shall be provided with each length of pipe. For PVC pipe, spacers shall be provided at six-foot (6') intervals. For DI pipe, spacers shall be provided at ten-foot (10') intervals. All materials shall be furnished and installed at the Contractor's expense.

Provide casing end seals model "AM", as manufactured by Advance Products and Systems, Inc., (www.apsonline.com) or approved equal.

Field lock gaskets or retainer glands shall be installed within all encasement pipe and within one pipe length outside the casing on both ends. No joint restraint is required for PVC installations.

2.1.4 DITCH CROSSINGS

All piping at ditch crossings shall be ductile iron with retainer glands unless otherwise directed by the engineer.

2.1.5 SEWER FORCE MAINS

Unless otherwise specified on the project drawings, all force main pipe outside the limits of pump stations and valve pits shall be High Density Polyethylene Pipe (HDPE). HDPE pipe for force mains shall be 160 psi working pressure, dimensional ratio DR11, except that 4" and smaller shall be DR 9. All HDPE pipe shall conform to ASTM D1248 and ASTM D3350. HDPE fittings shall be molded or fabricated from sections of pipe with outlet ends machined to match the system piping.

2.1.6 MANHOLES

Reinforced concrete manholes shall conform to ASTM C478. The minimum inside diameter, except for the eccentric cone, shall be 48". Xypex admixture shall be used in all precast manholes. Manhole joints shall consist of "O" ring type conforming to ASTM 443 or 1-1/2" wide strip of "Kent Seal" bituminous mastic strip with non-shrink grout on the inside. Precast manhole bases shall conform to ASTM C478 with a steel finish flowline channel and ledge. A chemical resistant rubber compression diaphragm will be precast into the manhole wall for every pipe entering the manhole. The diaphragm shall meet ASTM C923. Poured in place manholes will use 3,500 psi concrete. Precast manhole base bedding shall be No. 5 crushed stone or Dense Graded Aggregate conforming to KYTC Specifications.

Heavy duty manhole castings shall be traffic type of grey cast iron, East Jordan Iron Works part number 00102494 or Neenah foundry part number 1015T41, or approved equal, all meeting ASTM A48 Class 35. Frames shall be attached to the manhole barrel by four, 5/8-inch anchor bolts and shall be set in a bed of mastic to provide a watertight seal between the barrel and frame. Unless indicated as watertight, manhole covers shall be of the solid, self-sealing type, with no holes except watertight pick notches. The surface between the frame and cover shall fit smoothly without rocking. Top of casting shall be level with pavement or sidewalk, and shall be a minimum of 1" above finished ground line in non-paved areas.

Where a sewer main enters a manhole two feet (2') or more above the invert, a drop shall be installed. Drop connections shall be made of flanged or mechanical joint ductile iron pipe. Internal drop assemblies shall be Reliner by Duron, Inc., or approved equal. Manholes with interior drops shall be minimum 60" diameter.

Manholes shall not have steps.

3. INSTALLATION

3.1 TRENCH EXCAVATION

Trenching shall be accomplished as described hereinafter. All excavation is “unclassified” and no additional payment will be made for rock excavation.

Unless otherwise directed by the Engineer, trenches in which pipes are to be laid shall be excavated in open cut to the depths shown on the plans. Excavation in earth shall undercut the pipe to a depth below the required invert elevation that will permit laying the pipe in a bed of granular material to provide continuous support for the bottom quadrant of the pipe. The bedding shall be as set out hereinafter.

Trenches shall be of sufficient width to provide free working space on each side of the pipe and to permit backfilling around the pipe, but unless specifically authorized by the Engineer, trenches shall in no case be excavated or permitted to become wider than 2 feet 6 inches plus the nominal diameter of the pipe at the level of or below the top of the pipe. If the trench does become wider than 2 feet 6 inches at the level of or below the top of the pipe, special precautions may be necessary, such as providing compacted, granular fill up to top of the pipe or providing the pipe with additional crushing strength as determined by the Engineer after considering the actual trench loads that may result and the strength of the pipe being used. The Contractor shall bear the cost of such special precautions as are necessary.

Prior to excavating the trench, Contractor shall pothole far enough ahead to reveal obstructions that may necessitate changing the line or grade of the pipeline, to avoid delays or the addition of avoidable fittings. Before laying the pipe, the trench shall be opened far enough ahead to reveal obstructions that may necessitate changing the line or grade of the pipeline.

Unless specifically directed otherwise by the Engineer, not more than 100 feet of trench shall be opened ahead of pipe laying work of any one crew, and not more than 100 feet of open ditch shall be left behind the pipe laying work of any one crew. Watchman or barricades, lanterns and other such signs and signals as may be necessary to warn the public of the danger of open trenches, excavation and other obstructions, shall be provided by and at the expense of the Contractor. Conformance to all state highway requirements shall be the responsibility of the Contractor when encroachment on state right-of-way is necessary.

When directed by the Engineer, only one-half of street crossings and road crossing shall be excavated before placing temporary bridges over the side excavated for the convenience of the traveling public. All backfilled ditches shall be maintained in such a manner that they will offer no hazard to the passage of traffic. The convenience of the traveling public and property owners abutting shall be taken into consideration. All public or private drives shall be taken into consideration and shall be promptly backfilled or bridged at the direction of the Engineer. Disposal of excavated materials shall cause as little interference with the work as possible, and in every case the disposition of materials shall be satisfactory to the Engineer. Trenches in which pipes are to be laid shall be excavated in open cut to the depths shown on the approved plans, cut sheets or as specified by the Engineer.

Where conditions exist that may be conducive to slides or cave-ins, proper and adequate sheeting, shoring and bracing shall be installed to provide safe working conditions and to prevent damage to work. Trenches shall be kept free of water during the laying of the pipe and until the pipeline has been

backfilled. All excavation shall be in accordance with OSHA and/or KOSHA regulations. Where a trench box is used, the excavation shall be made such that the box rests on undisturbed soil fully above the top of the installed pipe to a maximum of two (2) feet or the maximum allowed by other regulation, whichever is less, to avoid disturbing the pipe bedding when the box is pulled forward. Where sheeting or shoring is used, it shall be fully removed with the completion of backfilling unless otherwise approved in writing by HWU. Adequate and proper shoring of all excavations shall be the entire responsibility of the Contractor.

Dewatering of trenches shall be considered a part of trenching, at no extra cost to the Owner. Dewatering of trenches shall include ground water and storm or sanitary sewage. Suitable pumping and other dewatering equipment are to be provided by the Contractor, to insure the installation of the pipeline structure in a dewatered trench and under the proper conditions. Dewatering shall include all practical means available for prevention of surface runoff into trenches and scouring against newly laid pipe. Discharge water from dewatering operations shall be suitably handled and/or treated to prevent the discharge of sediment or other pollutants to storm sewers or waterways.

Wherever pipelines are in, or cross, driveways and streets, the Contractor shall be responsible for any trench settlement which occurs within these right-of-ways within one (1) year from the time of final acceptance of the work. If paving shall require replacement because of trench settlement within this time, it shall be removed and/or replaced by the Contractor at no extra cost to the Owner. Repair of settlement damage shall meet the approval of the Engineer, and the agency having jurisdiction over the roadway.

3.2 LAYING OF PIPE

3.2.1 Laying Requirements

All pipe shall be laid to lines, cover or grades shown on the Drawings.

All pipe shall be visually inspected for cleanliness, soundness and proper jointing.

All pipe shall be laid with: Proper alignment; evenness of width and depth of joints; perfection in jointing; and care of the pipe in handling.

The allowable pipe deflection at joints shall not exceed one-half the manufacturer's allowed deflection.

Precautions must be taken to prevent flotation of the pipe prior to putting the pipeline into operation.

In wet, yielding or mucky locations where pipe is in danger of sinking below grade or floating out of grade or alignment, or where the backfill materials are of such a fluid nature that such movements of the pipe might take place during the placing of the backfill, the pipe must be weighted or secured permanently in place by such means as will prove effective. If crushed rock fill beneath the pipe is necessary for stability, it will be paid for at the unit price bid per ton of such material in place except in cases where instability is caused by neglect of the Contractor.

A manhole will be required at the termination of any gravity sewer installation.

No pipe shall be laid resting on solid rock, blocking or other unyielding objects. Jointing before placing in the trench and subsequent lowering of more than one section jointed together will not be allowed.

When locating near water lines, the horizontal separation between water and sewer lines should be at least 10 feet measured from the outside edge of each pipe wall. Should location conditions prevent a

horizontal separation of 10 feet, HWU may allow a deviation on a case-by-case basis. Such deviation may be allowed if the sewer is laid in a separate trench or if it is laid in the same trench with the water main located at one side on a bench of undisturbed earth. In either case, the elevation of the crown of the sewer must be at least 18 inches below the bottom of the water main.

Whenever sewer lines must pass below water mains, the sewer lines shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. Should location conditions prevent the sewer line from being buried to meet the above requirements, HWU may allow a deviation on a case-by-case basis. Such deviation may be allowed if the sewer line is constructed with ductile iron pipe with protective internal coating of "Protecto-401" or equivalent epoxy coating with one full length of sewer pipe centered on the water main.

The excavation for force mains shall be carried to the depths indicated on the plans or as directed by the Engineer to provide proper bedding and release of air from the pipe to prevent "air-locking" or the trapping of air or gases at high points. Unless directed otherwise, force mains shall be laid so that the top of the pipe is no less than 42 inches deep. Should the Contractor fail to follow the correct profile, the Engineer may require removal and relaying of the force main, or installation of air release valves and pits, without additional compensation.

3.2.2 PIPE BEDDING

Standard Bedding – Sewer pipe shall, as a standard practice, be laid using bedding of No. 9 crushed limestone that shall be placed a minimum depth of four-inches (4") below the bottom of the pipe barrel.

In no case shall the pipe be supported directly on solid rock. When rock is encountered in the trench bottom, bedding shall consist of size No. 9 crushed limestone only.

3.2.3 SPECIAL PIPE BEDDING - UNSTABLE SOILS

Unstable soils shall be stabilized by over excavating to allow a bedding of No. 3 crushed stone below the 4" of No. 9 crushed stone bedding.

All bore pits and any over digging related to such shall be stabilized with #3 stone and backfilled with No. 9 stone to sub-grade.

3.2.4 INSTALLATION AND JOINTING

Jointing of push-on type Ductile Iron Pipe and PVC pipe rubber gasket couplings shall be accomplished in accordance with the manufacturer's specifications.

Pipe shall not be laid in water or upon frozen sub grade at any time or condition when, in the opinion of the Engineer, conditions are unsuitable.

3.2.5 BACKFILLING

Backfilling of pipeline trenches shall be accomplished in accordance with the details set forth hereinafter.

In all cases, walking or working on the completed pipelines, except as may be necessary in tamping or backfilling, will not be permitted until the trench has been backfilled to a point one foot (1') above the top of the pipe. The filling of the trench and compaction of the backfill shall be carried on

simultaneously on both sides of the pipe in such a manner that the completed pipeline will not be disturbed and injurious side pressures do not occur. The methods of backfilling shall be as follows:

Method "A" - Backfilling in Open Terrain:

The lower portion of the trench, from the bottom of the trench to a point six (6) inches above the top outside surface of the pipe, shall be backfilled with No. 9 stone.

The upper portion of the trench above the No. 9 stone shall be backfilled with material which is free from large rock. Incorporation of rock with any individual piece having a volume exceeding eight (8) cubic inches is prohibited. Backfilling this portion of the trench may be accomplished by any means approved by the Engineer, but the incorporation of unsuitable material (trash, large rock) is prohibited. The trench backfill may be heaped over the top of the trench or leveled as directed by the Engineer. Material for backfilling the upper portion of the trench is not a separate pay item.

Method "B" - Backfilling Under Sidewalks and Unpaved Driveways:

The entire trench shall be backfilled with No. 9 crushed stone.

Method "C" - Backfilling Under Streets, Roads and Paved Driveways:

The lower portion of the trench to a point six inches (6") below the base of the pavement or concrete sub-slab shall be backfilled with No. 9 crushed stone or fine gravel. Backfill for the lower portion of the trench is not a separate pay item.

The upper portion of the trench, from the top of the No. 9 stone to the base of the pavement or concrete sub-slab, shall be backfilled with a base course of dense graded aggregate. At such time that pavement replacement is accomplished, the excess base course shall be removed as required. Material for backfilling the upper portion of the trench is not a separate pay item.

Before final acceptance, the Contractor will be required to level off all trenches or to bring the trench up to grade. The Contractor shall, at his expense, also remove and legally dispose of all excess earth or other materials from roadways, right-of-ways and/or private property. Hazardous materials shall be handled and disposed of in accordance with all local, state and federal requirements.

If pavement is not placed immediately following trench backfilling in streets and highways, the Contractor shall be responsible for maintaining the trench surface in a level condition at proper pavement grade at all times. The Contractor shall be liable for any damage to persons or property resulting from the Contractor's failure to maintain the trench surface.

Flowable fill shall be allowed as an alternate method for backfilling of utility cuts and trenches, with approval of the Engineer.

3.2.6 CONCRETE CRADLE, ANCHORS, THRUST BLOCKS OR ENCASEMENTS

Concrete cradle, anchors or encasement of sewer lines and/or fitting shall be placed where shown on the plans, required by the specifications, or as directed by the Engineer. Concrete shall be 2,500 psi and shall be mixed sufficiently wet to permit it to flow under the pipe to form a continuous bed. In tamping concrete, care shall be taken not to disturb the grade or line of the pipe or injure the joints.

3.2.7 CONNECTIONS TO EXISTING LINES:

Connections to existing gravity sewer lines shall be made with new or existing manholes as indicated on plans. Connections of new sewer to existing sewer lines by tapping into the side of the existing sewer shall not be permitted unless specifically approved by the HWU.

Service line connections shall be factory-built Y or T branches if not otherwise indicated.

3.2.8 LOCATOR TAPE AND WIRE

Tracer wire and locator tape shall be furnished and installed with all force mains. The tracer wire shall be taped or suitably held over the top center of the pipe and shall be #12 single strand copper wire with THW insulation or approved equal. All splices shall be made with the aid of DBR Direct Bury Splice Connectors as manufactured by 3M Electrical Products Division to insure continuity and insulation of the copper wire from the soil. Tracer wire shall be securely connected at flange bolts to all valves, fittings and air/vacuum release valves to provide a suitable electrical connection. The electrical continuity of tracer wire between valves and fittings shall be verified and defects found shall be corrected prior to acceptance by the Engineer.

A metallic locator tape shall be buried in the trench eighteen to twenty-four inches (18" – 24") over the top of the pipe and a minimum of twelve inches (12") below the finished grade. The words "Caution Sewer Line Below" shall be repetitively printed along the length of the tape.

3.2.9 BYPASS PUMPING

Construct and maintain all temporary bypass systems and be responsible for all bypass pumping of sewage that may be required to prevent backing up of sewage and allow proper installation, inspection, rehabilitation, testing or drainage during sewer replacement or reconnections to existing sewers. Ensure that no damage will be caused to private property because of bypass pumping operations. Primary bypass pumps shall be critically silenced when used in residential settings or areas where excessive noise levels would create a disturbance.

Where no alternate sanitary sewer route is available or when twenty-four hours of storage is not feasible, redundant bypass pumping shall be installed.

The design, installation, and operation of the temporary pumping system shall be the Contractor's responsibility. The Contractor shall demonstrate or employ the services of a subcontractor who can demonstrate to the Engineer that he specializes in the design and operation of temporary bypass pumping systems.

The Contractor may be required to provide on-site manual oversight of all bypass pumping operations 24 hours per day, 7 days per week when the bypass pumping system is in operation. To the maximum extent possible, Contractor shall phase and coordinate his work so as not to require bypass pumping overnight.

In the event that sewage accidentally discharges into the separate storm sewer system or street, immediately stop the overflow, notify the Engineer, and take the necessary action to clean up and disinfect the spillage and all residual contamination to the satisfaction of the Engineer. If sewage is spilled onto public or private property, wash down, clean up and disinfect the spillage and all residual contamination to the satisfaction of the Engineer.

Locate bypass pumping suction and discharge lines to not cause interference with the use of streets, private driveways and alleys. In cases where the suction and or discharge lines are required to be buried for vehicle / pedestrian traffic, cost for this work is incidental and includes complete restoration of any surface features disturbed.

3.3 FIELD QUALITY CONTROL

After the lines or system have been brought to completion, and prior to final inspection, the Contractor will be required to clean all dirt, debris and trash from lines and manholes.

During the final inspection, the Engineer will inspect each individual line, from manhole to manhole, either by use of lights or other means at his/her disposal to determine whether the completed lines are true to line and grade as laid out or as shown on the plans.

3.4 TESTING REQUIREMENTS

All lines or sections of lines that are found to be laid improperly with respect to line or grade, that are found to contain broken or leaking sections of pipe or are obstructed in such a manner that they cannot be satisfactorily corrected otherwise, shall be removed and replaced.

All piping shall be tested for deflection thirty (30) days after installation by a mandrel test. The mandrel test shall be performed by the Contractor in the presence of the Owner's engineer (or HWU's inspector) using a rigid ball or mandrel with a diameter equal to 95 percent of the inside diameter of the pipe. The mandrel shall be pulled through the pipe by hand with no mechanical assistance. The section of sewer pipe fails if for any reason the mandrel cannot pass through the section of sewer pipe.

All parts of the system shall bear the load imposed by the backfill. For Reinforced Concrete Pipe, if cracks one-hundredth (1/100) of an inch develop in the pipe within one (1) year from the date of final acceptance of the work, the Contractor will replace the cracked pipe at his/her expense.

Prior to acceptance all sewers will be tested for leakage. After laying, backfilling and compacting, the Contractor shall test the sewer in the presence of the Engineer.

House sewers will be considered part of the main to which they are connected and no adjustment of test time shall be allowed to compensate for the smaller diameter of house sewers.

The pressure gauge used shall be supplied by the Contractor, shall have minimum division of 0.25 psi, and shall have an accuracy of 0.10 psi. Accuracy and calibration of the gauge shall be certified by a reliable testing firm at six-month intervals or when required by the Engineer. In addition, the Engineer may compare the Contractor's gauge with a municipally owned gauge at any time.

Leakage shall conform to ASTM C828, which shall be as follows:

3.4.1 Preparation of the Line

Contractor shall flush and clean the line prior to testing to wet the pipe surface and clean out debris. A wetted interior surface will produce more consistent test results.

Contractor shall plug all pipe outlets, including stoppers in laterals, to resist the test pressure.

3.4.2 Procedure

Calculate the test time for the section using the applicable time in air test table below.

Plug and brace the plugs in all openings in test section.

Add air until the internal pressure of the line is raised to approximately 4.0 psi gage. After this pressure is obtained, allow the pressure to stabilize (usually five minutes). The pressure will normally drop as the air temperature in the test section stabilizes. Before starting the test, the pressure may be reduced to 3.5 psig.

When the pressure has stabilized and is at or above the starting test pressure of 3.5 psi gage, start the test. Record the drop of pressure for the test time. If the pressure drops more than 1.0 psi gage during the test time, the line is presumed to have failed. If a 1.0 psig drop does not occur within the test time, the test is successfully completed.

3.5 AIR TEST

Table 1 shows allowable time (minutes) required for pressure drop from 3.5 to 2.5 psi when testing one pipe diameter only.

TABLE 1

Pipe Diameter (in)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time to Add for Longer Length (sec/ft)	100 ft	150 ft	200 ft	250 ft	300 ft	400 ft
				6	5:40	398	0.8548	5:40	5:40
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	10:08
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	15:50
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	22:48
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	35:37
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	51:17
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	91:10
30	28:20	80	21.3690	35:37	53:25	71:14	89:02	106:51	142:28

If the prevailing ground water is above the sewer being tested, air pressure shall be increased 0.43 psi gage for each foot the water table is above the crown of the sewer. If the level of the prevailing groundwater is two feet (2') or more above the top of the sewer pipe, an infiltration test will be required.

Infiltration Test: The Contractor may elect to use an infiltration test when the level of the current prevailing groundwater is two feet (2') or more above the top of the sewer pipe, including all service laterals, at the highest point of the section being tested. The inlet of the upstream manhole shall be securely sealed. The downstream sewer shall be completed and open to allow the sewer to drain. The Engineer shall approve the length of sewer to be tested at one time. The Engineer may require that each manhole span be tested separately. The amount of infiltration shall be measured by means of a weir located in the downstream manhole. The test head shall be maintained for a period of at least 24 hours before the weir measurement is made. Infiltration shall not exceed 200 gallons per inch diameter per mile of pipe per 24 hours. This infiltration test may not be performed until the sewer line and manholes are completed and all known leaks are repaired. The Contractor will be required to correct all conditions that permit visible infiltration and may be required to relay sections with such conditions that cannot be corrected, even though infiltration is within allowable limits.

The Contractor shall repair any damage to the pipeline and its appurtenances or to any structure resulting from the testing at his expense. If the section tested fails the test, it shall be repaired and retested at the Contractor's expense until the measure leakage is within the allowable limits as outlined in the air test table.

The test results of the air test shall be recorded by the Contractor defining the size of pipe, length of line, starting pressure, ending pressure, the time to drop 1.0 psig for each line. This test report shall be submitted to the Engineer.

3.6 FORCE MAIN TESTING

All force mains shall be given a hydrostatic test to 50 psi above the rated working pressure of the pipe, under which leakage shall not exceed 50 gallons per 24 hours per inch of diameter per mile of pipe. Loss of water pressure during testing shall not exceed 10 psi in a 24-hour period, 5 psi in a 10-hour period or 2 psi in a 4-hour period.

Where practicable, pipelines shall be tested between line valves or plugs in lengths of not more than 1,500 feet. Pipelines shall be tested before backfilling at joints except where otherwise required. The duration of the test shall not be less than two hours where joints are exposed and not less than 24 hours where joints are covered.

All pipe, fittings, and other materials found to be defective under test shall be removed and replaced at the contractor's expense.

Lines which fail to meet the test requirements shall be repaired and retested as necessary until test requirements are met.

All water required for tests shall be furnished at the Contractor's expense.

3.7 MANHOLE TESTING

All manholes shall be subjected to a vacuum test in accordance with ASTM C1244, except as specified otherwise herein. Other forms of testing of some manholes may be required, as deemed necessary by the Owner.

Manholes shall be tested after installation with all connections in place and shall include testing of the seal between the cast iron frame and the concrete cone, slab or grade rings. Plug pipe openings; securely brace plugs and pipe.

A vacuum of at least ten inches of mercury (10" Hg) shall be drawn on the manhole. Shut the valve on the vacuum line to the manhole and shut off the pump or disconnect the vacuum line from the pump.

The manhole shall be considered to pass the vacuum test if the vacuum reading does not drop more than 1" Hg (i.e. from 10" Hg to 9" Hg) during the minimum test times shown in Table 2.

TABLE 2

Depth of Manhole in Feet	Time in Seconds by Manhole Diameter		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
For any manhole deeper than 24 feet, add the following for each additional 2 feet of depth			
Per 2' increment	5	6.5	8

When vacuum drop is greater than 1 inch of Hg during test period, repair and retest manhole; when vacuum drop of 1 inch of Hg does not occur during test period, discontinue test and accept manhole.

When vacuum test exceeds 1-inch Hg drop in specified time after initial repair, repair and retest manhole repeatedly until test is passed.

4. WASTEWATER PUMP STATIONS

4.1 SCOPE

This specification applies to all labor, materials, equipment and services necessary for the construction of wastewater pump stations, equipment, and appurtenances as required by the drawings and the specifications.

When work within the scope of a project is performed by HWU (e.g., SCADA panels), this work shall include all the costs of labor, materials, equipment, etc., required to provide the agreed scope in accordance with the normal reimbursement policy of HWU. Typically, HWU costs are marked up 15% for overhead and administration.

4.2 DESCRIPTION

Submersible pump stations shall incorporate two or more solids-handling pumps. Electrical control design shall alternate pump operation so pumps get equal wear. Under extreme peak flow conditions all pumps shall run, overriding the alternation circuit.

The station shall at a minimum be a duplex configuration. In the duplex pump station, one pump shall be sized for peak flow conditions and the second pump designed for 100 percent backup. In pump stations with three or more pumps, all pumps but one shall be sized for peak flow conditions with one pump reserved for backup.

4.3 LIFT STATION WET WELL

The wet well shall normally be constructed of circular precast reinforced concrete manhole sections conforming to ASTM C478. The minimum inside diameter shall be 72". Xypex admixture shall be used in all wet wells and valve vaults. Joints shall consist of "O" rings conforming to ASTM 443 or 1-1/2" wide strip of "Kent Seal" bituminous mastic strip with non-shrink grout on the inside. Precast bases shall conform to ASTM C478. An access frame and cover made of heavy duty aluminum shall be precast into the concrete cover. The door size shall be large enough to allow removal of all pumps by lifting vertically out of the wet well. The doors shall have locking hasps and retractable lifting handles. Minimum clear opening shall be 24" x 24".

The wet well shall have a vent pipe, with a cross-sectional area of at least 60% of the cross-sectional area of the discharge force main. The vent pipe shall be cast into the lid, extend above the top of the station, and terminate with two 90-degree elbows to direct the open end back toward the top of the station, ending a minimum of twelve inches (12") from the top of the station. The vent pipe shall be steel with malleable iron screwed fittings or cast iron with cast iron flanged fittings.

4.4 VALVE VAULT

A precast concrete valve vault shall be provided adjacent to the wet well, a minimum 60 inches inside diameter, and shall conform to the same standards as wet wells. A four (4) inch drain pipe with a molded Tideflex® check valve shall be provided from the valve vault back to the wet well and the bottom of the valve vault shall be sloped to the drain. The valve vault shall have a precast concrete top with an aluminum hatch (min. 24" x 30") frame and cover cast into the top. Venting of the valve vault is not required.

A bypass pumping connection shall be provided outside the valve vault, on the downstream pump station piping, after the pump discharge lines manifold together. The bypass assembly shall include

gate valves to isolate the bypass discharge from the station, and the station discharge from the bypass connection. Provide a quick-disconnect coupling as shown on the Standard Drawing.

4.5 START-UP

The Contractor shall furnish the services of an engineer, representing the manufacturer or group of manufacturers for each equipment grouping or system, for checking the installation, making the necessary adjustments, placing the equipment in operation, and during acceptance tests. The representative shall be available for no less than one 8-hour day scheduled with the Owner to instruct operating personnel in the use, operation, and maintenance of the equipment during the initial operating period. All components and equipment shall be installed in accordance with the recommendations of the manufacturer and these specifications.

Operating tests shall be made on all equipment in the presence of the Owner and the Engineer or their representatives to demonstrate the entire facility to be complete, functional, and ready to be placed in operation.

Operating instructions shall be submitted to the Owner in order to thoroughly familiarize the operators in the correct procedures and functions for operating and maintaining the facility.

4.6 VARIABLE SPEED PUMPS

Where a variable speed pump installation is provided, the pump manufacturer/supplier shall furnish the pumps and associated variable frequency controlling system as sole-source responsibility. The manufacturer/supplier shall provide a written guarantee for the pumps and controls as a single unit installation relative to materials quality and durability, system performance, and coordinated completeness of the overall system.

Performance curves for the variable speed pumps shall be submitted to show families of curves for the ranges of pressures, flows, and speeds anticipated at the specific location of the pumps within the hydraulic system. A manufacturer's certification shall be provided for the applicability of the pump and motor for the project conditions. The Vendor shall also furnish a listing of recommended spare parts for each item of equipment supplied under this requirement.

4.7 PERFORMANCE TESTS

The Contractor shall perform field tests on all completed pump and control system assemblies to demonstrate their conformance to the specifications. A test log shall be presented to the Engineer upon the completion of each test that records the following:

1. Flow, in gallons per minute.
2. Pump discharge pressures as measured by calibrated gauges, converted to feet, of the liquid pumped and corrected to pump datum as defined by Hydraulic Institute.
3. Calculated velocity heads at the discharge flanges and total head, all tabulated in feet.
4. Applied voltage and amperage measured for each phase.
5. Megger readings for all power cables.

4.8 ELECTRICAL

4.8.1 Standard Compliance

All electrical material and equipment provided by the Contractor shall be new and free of defects. All work performed under these specifications shall be carried out by skilled workers regularly engaged in the performance of such duties. The entire electrical installation shall not be less than that required by the latest edition of the electrical code locally enforced in the Project area. The Contractor shall obtain all permits required by local ordinances, and after completion of the Work, shall give the Engineer a certificate of final inspection and approval from the local electrical inspector. Any expenses connected with such inspection and certificate shall be borne by the Contractor.

Electrical material and equipment shall be designed in accordance with the latest requirements of applicable standards such as NEMA, ANSI, IEEE, and where listings are available for such items shall be approved by the Underwriters Laboratories, Inc. Equipment, components, material, etc., rated by other standards and agencies, including but not limited to IEC, VDE, and DIN, will not be considered equal to NEMA, ANSI, IEEE, and UL. Electrical items shall be standard catalogued products of manufacturers regularly engaged in the manufacture of such products, unless otherwise noted. Acceptable manufacturers for Motor Control Centers are: Cutler-Hammer, Square-D, Siemens and General Electric.

All devices, equipment, and materials not definitely specified or noted that are required for complete installations shall be manufactured for the purpose intended and shall be installed in conformance with good accepted practice for the conditions encountered. All hardware such as straps, supports, bolts and nuts shall be of rust or corrosion-resistant material unless otherwise noted.

4.8.2 Electric Power Service and Metering

When required and as instructed by the Owner, the Contractor shall request 3-phase power service from the utility company and shall make arrangements for the utility company to bill the Owner directly for any installation charges, other than those associated with power metering, for the service.

The Contractor shall provide all labor and materials required for a complete installation to meter electrical power usage in accordance with the power company's requirements. Meter location shall be as shown on the Plans or as instructed by the Owner. Contractor shall contact the appropriate power company regarding new or revised installation. Contractor shall furnish and install meter socket and coordinate power hook-up by power company.

The Contractor, at his expense, shall provide power and all necessary temporary wiring as required to perform his work. After completion of the permanent electrical connections, the Contractor shall be required as a part of this work to secure all utility services from the respective utility companies and shall pay all monthly bills until acceptance of the equipment is made by the Owner. Upon acceptance, the Contractor shall have the utility company transfer their billing to the Owner's name, and shall coordinate with the Owner for appropriate personnel to register/sign for the service to be transferred to the Owner's name.

4.8.3 Grounding

Non-current carrying metal parts of electrical items such as cabinets, enclosures, frames, etc., and the neutral conductor shall be grounded in accordance with the National Electrical Code unless additional

grounding requirements are indicated. Grounding conductors shall be copper, sized as noted. Special grounding system features shall be provided as indicated.

All conduit runs installed for lighting and power loads shall contain a grounding conductor throughout the entire length of the run forming a part of the grounding system. The grounding system shall be electrically continuous throughout the electrical system and shall be connected to earth ground at the point of power service and as otherwise indicated.

Ground rods shall be copper-welded steel type, ¾ inch diameter, 20'-0" total length, minimum. The top of the ground rods shall be driven to 1'-0" (minimum) below finished grade unless otherwise indicated and shall be electrically connected with suitable cast-type ground clamps or exothermic welding.

Resistance to ground of each ground rod shall not exceed 25 ohms when measured during dry weather. In the event this value is not obtained, one additional rod or rod section equal to that tested shall be driven. Should the additional rod or section fail to achieve the required value, the Engineer shall be immediately notified. A written record of all resistance measurements and test dates shall be submitted to the Engineer prior to completion of the Project.

4.8.4 Lightning and Surge Protection

Lightning protector units shall be provided for power circuit protection at the main service connection point and elsewhere as noted on the Plans. Lightning protectors shall be Surge Suppression Inc., or approved equal, for three and single-phase circuits, respectively.

4.8.5 Testing and Equipment Servicing

Entire installation shall be free from improper grounds and short and open circuits. Make tests on conductors as required before energizing circuits. Make tests to ensure that the entire system is in proper operating condition and that adjustments and apparatus setting of circuit breakers, fuses, control equipment and apparatus have been made. Correct defects discovered during tests.

Equipment shall be turned over to the Owner in fully operational and lubricated condition. Instruct Owner on proper usage, care and maintenance of entire electrical system including all special systems or apparatus.

4.8.6 Main Service and Disconnect

A main electrical service complete with service pole shall be provided near the station. The service and disconnect shall be housed in a NEMA3 weatherproof enclosure with a locking hasp on the outside door. A main fusible type, NEMA 4, multiple pole disconnect switch shall be mounted on the service pole. The disconnect switch shall be capable of being locked in either position. The service shall be sized to allow all pumps to run simultaneously and continuously. The wiring between the main service to the station main control panel shall be run underground through conduit. The service shall be grounded via a rigid conduit encased wire attached to a 5/8-inch x 10 feet long copper ground rod.

4.8.7 Emergency Power Receptacle

On the side of the main electrical service panel, furnish an all-weather 600-volt, 200 AMP rated four prong twist lock male receptacle, wired into the center feed of the main power transfer switch supplying the station. Owner to verify location.

4.8.8 Electrical Control Panel

The control panel shall be duplex type and shall have a NEMA 4 all aluminum weatherproof enclosure. A locking hasp shall be provided on the outside door. A circuit breaker and a magnetic motor starter with overload protection and separate temperature sensitive motor thermal overload protection system shall be supplied for each pump motor. In addition to overload protection, anti-single phase protection shall be provided for each motor starter in stations served by three-phase power. Starters for motors 30 HP and larger shall be autotransformer type. Transformer shall be closed transition 2-coil construction with taps for 50, 65, and 80% starting voltage, and be designed for medium duty per NEMA Standard IC-1-14.21. Starters shall have auxiliary contacts to operate both pumps on override condition. An interlock relay shall be provided to automatically reconnect the control circuit in case of circuit breaker trip on one pump. H-O-A switches run lights, and elapsed time four digit hour meters shall be supplied for each pump. A terminal strip or block shall be provided for connecting the pumps and control wires. Additional terminals shall be provided to connect high water alarm, heat sensors, ultrasonic level measurement instruments and seal failure alarm. If the station is fed by a three-phase electrical service, a 5 KVA minimum dry type transformer shall be supplied to provide 120 volt single phase power for the control circuits and for a 30 AMP convenience outlet circuit.

A 120-volt duplex grounded convenience outlet shall be mounted inside the panel and wired into the 20 AMP convenience outlet circuit.

A high level alarm circuit shall be provided to a terminal block inside of the panel.

A pump seal failure alarm panel with one light per pump shall be mounted on the inside of the control panel. The seal failure alarm shall be wired in parallel with the high level alarm circuit.

The alarm seal failure, and pump control circuit shall be wired into a terminal strip and appropriately labeled for incorporation into HWU SCADA system.

4.8.9 Conductors

Single conductors installed in raceways shall be copper with AWG sizes as noted, and shall have 600-volt rated, type THW, THHN/THWN or XHHW, 75 degrees C (minimum) insulation. Conductors requiring special consideration shall have insulation material and ratings noted on the Plans and as required by the National Electrical Code. Type TW insulation shall not be used for any purpose in this Contract except ground wire identification only.

Lighting and power conductors shall be minimum size No. 12 AWG, with AWG No. 8 and larger to be stranded, and AWG No. 10 and smaller to be solid unless otherwise noted. Conductors shall be stranded where movement, vibration, or other flexing occurs in order to prevent conductor fatigue. Control conductors may be AWG No. 14 stranded, and inputs to remote telemetry units (RTU) may be 16 gauge, unless otherwise noted.

Insulation colors shall be: Green for ground; white for neutral; and black for single phase line conductor. "Stinger" phase conductor of 120/240 V systems shall be orange as per NEC 215.8. Unless otherwise noted, a uniform insulation color scheme for all new three-phase systems shall be established as black for phase A, red for phase B, and blue for phase C. Control circuit insulation shall be yellow. Conductors size AWG 10 and larger may be black with entire exposed ends taped with "Scotch #35", or equal by Plymouth, in accordance with color schemes mentioned herein.

Direct buried grounding system conductors shall be bare copper, sized as noted.

4.8.10 Splices and Terminations

600-volt system conductors shall be spliced with “Ideal Wire-Nuts”, or equal by T & B, for AWG Number 10 and smaller for dry areas, and machine crimped or bolted connectors with “Scotch 88,” or equal by Plymouth, full coverage tape for all other splices. Soldered and taped splices will not be acceptable. Terminations shall be made with mechanical lugs or other acceptable termination features of the equipment supplied.

Control conductors and RTU inputs shall terminate on box clamp, binding post screw, or set screws only. Soldered, taped, and free-standing connections will not be acceptable.

4.8.11 Conduits

All conduit shall be heavy-wall, rigid galvanized type bearing the Underwriters Laboratories, Inc., label of approval, except for buried conduits, which may be Schedule 80 PVC. Conduit minimum size shall be 1 inch. Steel conduit and fittings installed through concrete shall be manufactured with an exterior 40 mil thick polyvinyl chloride bonded jacket “Plasti-Bond” by Robroy, or approved equal. Fittings for rigid steel conduit shall be threaded types made up with conductive waterproof compound. Poured liquid sealed fittings shall be provided as required by the National Electrical Code.

All conduit shall be clean and free from dents, scars, or other deformities. Connections shall be made up watertight, and bushings shall be provided where smooth hubs are not encountered. Changes in directions shall be made with symmetrical bends or conduit boxes. Field-made bends shall be made with an approved conduit bending apparatus. Conduit runs shall be installed parallel or perpendicular to structural members. Conduit hangers and supports shall be provided at intervals recommended by the manufacturer and the National Electrical Code.

Underground conduit runs shall be installed at least 1’-6” below finished grade unless other depths are indicated. Plain earth used for backfill shall be free from objectionable material such as rocks, glass, metal, wood, etc., and shall be tamped to surrounding earth density.

All conduit routed from the pump control panel and SCADA Panel to the pump pit shall include an expansion proof seal at the control panels. Seals shall be poured with flexible sealant as per the National Electrical Code. Control panel or SCADA panel conduit shall include an expansion proof seal at the pump pit exit junction box to prevent the migration of wetwell vapors and moisture from the wetwell to the panels. Each conduit entering the pump control panel or SCADA panel from the wetwell shall be equipped with a conduit body immediately adjacent to the pump or SCADA control panel. Where power or control cables exit conduits, conduit bells and strain relief devices shall be provided. Electrical and Control wiring shall exit the pump pit via conduit and terminate on terminal block within an appropriately sized NEMA 4X stainless steel junction box enclosure either mounted on the side of the pump pit or on the top of the wetwell slab, as shown on the drawings. If the top of pump pit is not sufficiently above grade for side mounting of junction box, it may be mounted on the top and to one side of the hatch. Electrical and control wiring shall continue through the junction box and exit via conduit to appropriate control panels.

All conduits shall be installed with smooth bends. Splices in junction boxes below grade shall not be acceptable. Conduits shall be cleaned of all dirt, debris and moisture before wire and/or cable is pulled. Suitable mounting frames required for controllers, disconnects, etc., shall be provided.

4.8.12 Cable Connectors and Supports

Conduit runs into the wetwell for cable protection shall be positioned to suit field conditions to achieve an unobstructed passage for removal and installation of pumping units and shall provide close accessibility to allow removal of the cable connector by maintenance personnel from outside and above the wetwell.

Cables entering conduit protection and as otherwise noted shall be fitted with connectors sized to suit the cable and conduit installed. Connectors shall be plastic body and threaded cap type with neoprene or equal internal gas-tight compression gland.

Cable grips shall be provided as strain relief for cables and shall be wire mesh offset eye, closed mesh type, all fabricated with 304 stainless steel and shall be sized to suit the cable installed.

4.8.13 Receptacles

Duplex convenience receptacles shall be rated 15 amps, 125 volts, 2-pole, 3-wire, grounding type, specification grade, NEMA configuration 5-15R, ground fault interrupting type, unless otherwise noted. Where installed in damp locations, receptacles shall be installed in weatherproof enclosures.

Special receptacles shall be provided as noted and shall have electrical ratings, pole configuration, and number of poles as shown or required. Enclosures, receptacle types, and other special features shall be suitable for the duty and conditions encountered.

4.8.14 Switches

Safety switches shall be provided where indicated and elsewhere as required by the National Electrical Code. Safety switches shall be heavy-duty type, with voltage, current, fuses, number of poles, and enclosure types as noted. All switches requiring security including main power service, transfer, and switches installed out-of-doors, shall be provided with padlock hasps; Owner will furnish padlocks. NEMA 3R switches installed out-of-doors, in corrosive areas, or in wet or damp areas shall be thoroughly cleaned of surface films after installation and given one coat of Indurall rapid dry epoxy primer H-1175 and two final coats of Indurall two-part epoxy paint "Perma-Clean", or approved equal, in color approved by the Engineer.

4.8.15 Fuses

Unless otherwise noted, fuses provided for motor protection and other general purpose loads shall be dual-element type, "Buss Fusetron", by Shawmut or approved equal, with voltage and current ratings as required.

Control circuit fuses shall be "Buss FNM" for 120-volt circuits and "Buss KTK" for 480-volt circuits, or equal by Shawmut. Unless otherwise noted, control circuit fuses shall be installed in terminal strip mounted switch action fuse blocks rated for 15 amps at 600 volts.

4.8.16 Circuit Breakers

Branch and feeder circuit breakers shall be thermal-magnetic, molded case, industrial type, unless otherwise noted, and shall be listed by the Underwriters Laboratories, Inc. for not less than 14,000 amps symmetrical interrupting at 480 volts. Voltage, trip and frame current ratings, and number of poles shall be as indicated or required. Circuit breakers shall have trip-free operating handles with trip current rating permanently molded therein.

Circuit breakers provided as an integral part of combination motor starters may be as specified herein or may be magnetic only type manufactured specifically for motor protection duty and set for the actual motor nameplate data.

Circuit breakers provided to serve 120-volt lighting, receptacles, and other small loads shall be rated by Underwriters Laboratories, Inc. for not less than 10,000 amps symmetrical interrupting, and otherwise shall be as specified herein. Multiple circuit breakers shall be factory assembled and sealed. Tandem-type breakers and bailed-tied handles of single-unit breakers are not acceptable for this work.

4.8.17 Motor Starters

Starters shall be sized in whole increment NEMA designation with voltage rating poles and enclosure as noted or otherwise required. Starters shall be approved by the Underwriters Laboratories, Inc. Ambient temperature compensated overcurrent protection shall be provided in each ungrounded phase of the circuit and shall be sized to suit the motor provided. Auxiliary equipment including contacts, selector switches, pushbuttons, lights, control power transformer, fuses, etc. shall be provided as noted or otherwise required.

Starters shall be designed and rated in accordance with NEMA Table 2-321-1. Ratings by IEC, VDE, DIN, etc., will not be considered for this work. Terminal temperature rise rating shall not exceed 122 degrees F (50 degrees C). Operating coils and overcurrent sensors shall be readily and independently replaceable in the field without requiring complete starter exchange.

Starters indicated as being combination type shall be circuit breaker type motor circuit protector combination type set to suit the motor provided.

Starters shall be magnetic type, full voltage, non-reversing, NEMA Size 1 minimum with wiping style contacts, unless otherwise noted.

4.8.18 Variable Speed Controls

Pumping stations designed for variable speed pumping shall be two-pump, pump-down, continuous near linear transition flow type unless otherwise noted. Separately mounted NEMA 4X enclosed units with adequate structural support racks shall be provided for the variable-speed drive electronics and the pump motor controllers. Where required by the equipment manufacturer, a building or other approved shelter shall be provided as a part of the work in order to utilize NEMA 12 type enclosures.

The control panel shall house the speed processing components. These components shall be of solid-state electronic design. The following minimum features shall be provided on the control panel:

- a. Hand-off-automatic switching for each pump.
- b. Manual speed set for each pump.

Pump motor controllers shall be variable frequency, 18 pulse width modulated, voltage source design. Internal controller circuitry shall be solid-state electronics. The following minimum features shall be provided:

- a. Controller horsepower rating shall be a minimum of 1.15 of the pump motor nameplate rating.
- b. Speed turn-down of 10:1 (minimum).
- c. Internal speed monitoring without remote feedback.
- d. Hand-off-automatic switch.

- e. Manual speed set.
- f. Reset pushbutton.
- g. Digital speed readout, RPM.
- h. Internal adjustment settings for:
 - 1) Acceleration rate.
 - 2) Deceleration rate.
 - 3) Speed limit.
 - 4) Overcurrent protection.
- i. Ambient temperature rating 0-40 degrees C.
- j. Controller overheat shut-down with alarm indication.
- k. Motor overheat shut-down.
- l. Voltage, phase, and frequency input to suit the characteristics of the power supply system at the station location.

4.8.19 SCADA System

HWU shall furnish and install the SCADA system at the locations shown on the plans or as directed by the Engineer. The SCADA system components shall consist primarily of the following, however individual components may change with technology:

- a. SCADA Enclosure: A SCADA Enclosure consisting of a 24" by 24" by 10" NEMA 4 all aluminum weather-proof enclosure shall be furnished and installed by HWU. The liquid level indicator, PLC or RTU, radio controls, and battery backup shall be installed in the SCADA panel.
- b. Ultrasonic Liquid Level Sensor: The liquid level control unit shall be a Siemens/Milltronics MultiRanger 200 with Siemens/Milltronics EchoMax XPS-15F Ultrasonic Transducer (Order Number XPS15F61D011) or approved equal. The control unit shall be mounted in the SCADA panel by HWU.
- c. Radio Telemetry: A radio transmitter/receiver unit shall be wired into the SCADA panel. The radio transmitter/receiver shall be a iCOM Model IC-F420 or approved equal. Radio frequencies shall be tuned to RX: 451.4875 MHz and TX: 456.4875 MHz. Cables shall be provided to connect the radio transmitter/receiver to the PLC or RTU.
- d. Control Equipment: A PAC or RTU shall be utilized as determined by HWU. The PAC shall be a GE-IP Model Rx3i with a 7-slot Backplane (IC695CHS007), 120/240 VAC Power Supply (IC695PSA140), CPU (IC695CPK330), Analog Input Module (IC694ALG223), Discrete Input Module (IC694MDL240), and Discrete Output Module (IC694MDL330) or approved equals. The RTU shall be Zetron Model 1708 or approved equal.
- e. Battery Backup: A 12 volt DC, 2.5 AMP battery backup system shall be wired into the SCADA panel. The battery backup shall be capable of providing one hour of operation for the PLC or RTU and radio transmitter in the event of a power outage.

4.9 MOUNTING PLATES

There shall be furnished and installed on the panel prior to shipment ½" thick aluminum mounting plates. These plates shall be drilled and tapped to accept ¼" stainless steel mounting bolts for securing plates to panel and panel to pedestal. A sufficient number of gas tight cord grips for all cables shall be

factory installed inside the control panel. Mounting plates shall be U.S. FOUNDRY MP2AL, or approved equal.

4.10 PANEL MOUNTING

The control panels shall be positioned per drawings for general location. All field adjustments shall be approved by the Engineer. Control panels shall not be set on top of wetwell structures. Control panels shall be installed on a four (4) inch thick minimum concrete pad extending a minimum of 8 inches past each end/side of control panel post and in front and rear of control panel. Provide ¼ inch chamfer on all exposed edges of concrete.

Control panel mounting shall be on Unistrut, sized to provide adequate clearance around all panels, disconnects and other items. The bottom of the control panel(s) shall be set to a minimum of 42" from top of slab. Isolate dissimilar metals with rubber gaskets.

4.11 LIFT OUT RAIL SYSTEM

Each pump shall have a lift out rail system consisting of a flanged ductile iron discharge base, cast iron pump attaching and sealing plate, cast iron pump guide plate, and cast-iron elbow. All exposed nuts, bolts, and fasteners shall be of 300 series stainless steel. No fabricated steel parts shall be used. All rail systems shall be non-sparking and adhere to Class 1, Division 1, Group C & D locations.

Mating flanges shall be metal-to-metal with machined mating surfaces to prevent leakage and recirculation.

Fiberglass systems with stainless steel hardware are also acceptable.

4.12 ELBOW

The discharge elbow shall bolt onto the base and have standard 125 pound flanges. Rail systems requiring piping increasers to attach larger discharge pipe which might interfere with pump installation and removal will not be considered equal.

4.13 SEALING

A sealing plate shall be attached to the pump. A simple downward sliding motion of the pump and guide plate on the guide rails shall cause the unit to be automatically connected and sealed to the base. The open face of the sealing plate shall have a dove-tailed groove machined into the face to hold a sealing O-ring. The O-ring shall provide a leak-proof seal at all operating pressures. Any leakage will not be acceptable.

4.14 GUIDE RAILS

Two rail pipes shall be used to guide the pump from the surface to the discharge base connection. The guide rail shall be 2-inch schedule 40 stainless steel pipe. When sealed, the weight of the pump shall bear solely on the discharge base and not on the guide rails or floor of the sump. Rail systems which require the pump to be supported by legs which might interfere with the flow of solids into the pump suction will not be considered equal. The guide rails shall be firmly attached to the access hatch frame. Systems deeper than 21 feet shall use an intermediate guide for each 21 feet of wetwell depth.

Fiberglass systems with stainless steel hardware are also acceptable.

4.15 LIFTING CHAIN

An adequate length of stainless steel lifting chain shall be supplied for each pump for removing the pump. An aluminum, fabricated hook shall be provided for each chain. These hooks shall be secured to the top rail support plates with stainless steel bolts and nuts. The stainless steel chain shall be of adequate strength and length to permit raising the pump for inspection and removal. The chain shall be sized for a safety factor of two (2) times the pump weight.

4.16 DISCHARGE PIPING – STATION PIPING – VALVES - ACCESSORIES

Piping within the station and valve pit shall be flanged joint Class 53 cement lined ductile iron with proper bolts and gaskets. All concrete anchor bolts used for any part of this station installation shall be stainless steel. All flange bolts shall be stainless steel. All valves shall be cast-iron meeting AWWA standard D-509. Gate valves shall be flanged non-rising stem type complete with hand wheel operator. Check valves shall be flanged swing check valves with outside lever and spring. Gate valves shall be installed on the discharge side of the check valves.

Discharge piping shall have the surface prepared by SSPC-SP10 Near White Blast Cleaning. Ductile iron pipe shall be shop prime with one coat of Pota-Pox @ 4 to 6 mils dry film thickness (DFM). Finished paint shall be: First Coat, Tnemec Series 446 Perma-Shield MCU@ 6.0 to 8.0 mils DFT; Finish Coat, Tnemec Series 446 Perma-Shield @ 6.0 to 8.0 mils DFT.

4.17 TOP RAIL SUPPORT PLATES

One (1) each aluminum top rail support plate shall be provided for each installed pump. This plate shall be fabricated of aluminum plate and shall contain expandable rubber bushings to accept the 2-inch stainless steel guide rails. These rubber bushings when completely tightened shall provide for a tight, vibration free guide rail installation. Notched openings in the rail support plates shall provide for horizontal adjustment. All fasteners shall be stainless steel.

4.18 DISCHARGE PIPING

All piping shall be installed plumb and without strains or binds. Piping shall be properly supported. A minimum of two (2) mechanical joint long sleeves shall be used between the wetwell and valve vault. Any fabricated pipe supports used shall be stainless steel or aluminum.

4.19 GATE VALVES – PUMP DISCHARGE

All gate valves for pump discharge service shall be flanged AWWA type with resilient seat and hand wheel operators.

4.20 CHECK VALVES – PUMP DISCHARGE

All check valves for pump discharge service shall be flanged AWWA type with outside springs and levers. In some cases, where special air or oil cushioned check valves are shown on the plans, these shall be APCO or approved equal.

4.21 PIPE FITTINGS – FLANGED

All flanged pipe fittings shall be ductile iron, cement lined AWWA type. Flange bolts shall be stainless steel.

4.22 PIPE FITTINGS – MECHANICAL JOINT

All mechanical joint pipe fittings shall be ductile iron cement lined with restrained joint connections. All mechanical joint fittings shall be properly blocked as required.

4.23 COMBINATION AIR RELEASE VALVES

Where shown on the drawings, each combination two-inch (2") air valve shall automatically release air and gas from a filling system, admit air into an emptying system and continuously release accumulated air and gas in a pressurized flowing system. The valve shall have a conical body shape, funnel shaped lower body, nylon seal plug assembly, rolling resilient seal, stainless steel internal metal parts, and upper flushing inlet and lower body drain. The body and all fasteners shall be stainless steel. The valve shall be APCO model 445 C with backflushing attachments or approved equal.

4.24 PRESSURE GAUGES & GAUGE TAPS

A minimum of three ¾" N.P.T. taps shall be supplied in the valve vault as shown on the plans. Each tap shall be supplied with a type 304 stainless steel nipple and bronze ball valve.

One (1) 3 ½" diameter liquid filled pressure gauge with stainless steel diaphragm seal shall be supplied. A tamper proof strap shall be installed between the gauge and seal to prevent the seal from being broken. The gauge shall be Ashcroft or approved equal. The gauge shall be sized to allow the gauge to operate in its mid-range. A gauge protector shall be installed between the seal and gauge.

4.25 ACCESS HATCHES FOR WETWELL AND VALVE VAULT

Furnish two (2) aluminum access hatches at each pump station. Hatches shall be sized to allow removal of all pumping equipment. The hatches shall be of non-skid design and designed to handle a weight of 300 pounds per square foot. A recessed, vandal proof locking device shall be provided. A positive hold open bar shall be provided to secure the hatch in the open position.

All hinges and hinge bolts shall be stainless steel. All hinge bolt nuts shall be tack welded to prevent removal of bolts. All fasteners used on the hatches shall be non-corrosive.

All areas of hatch frames that will be in contact with concrete shall be coated with bitumastic paint.

All valve vault hatches shall be trough frame type with a 1 ½" pipe drain coupling and the same features as described above. They shall be equal to U.S. FOUNDRY type T.P.S.

All single door wetwell hatches shall be equal to U.S. FOUNDRY type A.P.S. All double door wetwell hatches shall be equal to U.S. FOUNDRY type A.P.D.

All wetwell hatches shall be furnished with factory installed stainless steel bolts for securing the guide rail support plates, float mounting bracket, chain hooks and cable strain reliefs. Holes for these bolts shall be drilled and tapped at the factory. Bolts as required shall be threaded into the hatch frame from the concrete side and secured with stainless steel nuts.

4.26 HATCH NET

The pump access hatch shall include a fall-through prevention system, Hatch Net 121, by Safe Approach, Inc., or approved equal. The net is to be factory installed and easily retractable within the inside opening of the aluminum access.

4.27 SHUT-OFF GATE VALVE & CHECK VALVE

A shut-off, flanged gate valve shall be installed for each pump outside the wetwell in the valve pit. A flanged check valve with outside spring and lever shall be installed in the valve pit. Valve sizes shall be as shown on the plans.

4.28 PUMP BASINS – WETWELL AND VALVE VAULT

Pump station basins shall be precast reinforced concrete pipe in conformance with ASTM C478(LR) constructed as shown on the drawings.

4.29 FINAL COMPLETION

Final Completion shall be defined as the point when all of the following requirements have been fulfilled:

- A. All submittals and documentations have been submitted, reviewed and approved.
- B. Operations and Maintenance Manuals have been submitted on all equipment items.
- C. The complete system has successfully passed all testing requirements.
- D. All fees, permits and reports have been satisfactorily completed.
- E. All Owner's staff personnel training programs have been completed.
- F. Beneficial use by the Owner has occurred.

4.30 CLEAN-UP

After final operation tests, the interior and exterior of the station shall be cleared of all trash and debris and left in final operating condition. Final grading of the site and restoration of surfaces with grass shall be in strict accordance with the applicable plans.

5. SUBMERSIBLE PUMPS AND APPURTENANCES

5.1 GENERAL PRODUCT REQUIREMENTS

Provide new products that comply with the requirements of the specifications and that are undamaged. Provide products that are complete with all accessories, trim, finish, safety guards and other devices and details needed for complete installation and for the intended use and effect.

Pumps and control systems shall be manufactured by Hydromatic, Cornell, Flygt, KSB or approved equal.

The equipment items furnished shall comply with all governing federal and state laws regarding safety.

5.2 VENDOR'S RESPONSIBILITIES

The Vendor shall notify Owner, in writing at time of submission, of deviations in submittals from requirements of specifications and project drawings.

The Vendor shall begin no work, and have no material or products fabricated or shipped which require submittals until return of submittals with Owner's stamp and initials or signature indicating review.

5.3 DEFINITIONS

When the term "pump" is used, it shall be deemed to mean a pump or pumps, complete with, but not limited to, drive motor, accessories, appurtenances and all associated equipment.

5.4 CONTRACT DRAWINGS

The contract drawings are intended to show a general arrangement of pumping equipment, controls, connected piping, and valves. The pump manufacturer shall furnish each pump complete with motor and all components necessary for the intended function of the unit and shall be held entirely responsible for the compatibility of all components furnished.

5.5 MANUFACTURER

All pumps shall be of an approved design and make, and products of manufacturers who have built equipment of similar type, size, and capacity.

The Vendor shall submit, upon request, any additional information that the Engineer and/or owner may deem necessary to determine the ability of the proposed manufacturer to produce the specified equipment.

Pumps shall be products of manufacturers who can produce evidence of their ability to promptly furnish all interchangeable replacement parts as may be needed at any time within the expected life of the pumps.

Approval of manufacturers or suppliers will not be given until all information required by the specifications or requested by the Engineer has been submitted and found acceptable.

There shall be provided at no cost to the Owner, the services of an accredited representative of the pump manufacturer who shall supervise the testing of each pumping unit and give operating and maintenance instruction to the Owner's personnel. Pumping equipment shall be tested for performance according to curves and other approved data. Failure of the equipment to perform as curves indicate and with other approved data shall be sufficient cause for rejection. As one condition necessary to acceptance of any pumping unit, the supplier shall submit a certificate from the

manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the Owner's operating personnel have been suitably instructed in the operation and maintenance of the unit.

5.6 CERTIFIED FACTORY TESTING

Prior to shipment, each pump shall be factory tested for performance. A certified test curve is to be provided to the engineer showing that each pump meets or exceeds the duty point. All tests shall be run in strict accordance with the Hydraulic Institute, Inc. Normally, certified curves will be required only for pumps 25 hp or greater in size; however, HWU reserves the right to request certified curves for smaller pumps.

5.7 MAINTENANCE AND OPERATIONS MANUAL

The pump manufacturer shall submit an Operations and Maintenance Manual containing all information necessary for proper operation and maintenance of pumping units as well as location of the nearest permanent service headquarters. There shall be four (4) copies of each manual submitted to HWU, for each pumping station, when pumps are delivered. These shall be detailed in instructions to the Owner's personnel. They shall be attractively bound for the Owner's records.

The Operation and Maintenance manuals shall be complete with required drawings for each item of equipment furnished or modified under this requirement.

Equipment manufacturer's manuals shall be written for average journeymen mechanics without prior knowledge of the specific equipment.

In addition to maintenance and operations requirement provisions, the manufacturer's printed recommended installation practice shall also be included. If not part of the Operations and Maintenance Manual, separate written installation instructions shall be provided, serving to assist the Owner's Contractor in equipment installation.

The Operation and Maintenance Manual shall include detailed diagrams and instructions for complete assembly and disassembly.

5.8 GENERAL NON-CLOG SUBMERSIBLE PUMP CONSTRUCTION REQUIREMENTS

All pumps shall be designed and built for the specified operation without overheating, without excessive vibration or strain and requiring only generally acceptable maintenance.

The pumps shall be non-clogging sewage pumps capable of operating in a partially or entirely submerged condition. The design shall be such that pumping units will be automatically connected to the discharge piping when lowered into place on the discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for this purpose and no need for personnel to enter the pump well.

Major pump components shall be gray cast iron, ASTM A48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming into contact with wastewater, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

All openings in the pump impeller and volute case shall be large enough to pass a three (3) inch diameter sphere. The discharge flange shall be as shown on the plans.

5.9 MOTOR

The pump motor shall be of the sealed submersible type. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in either an oil filled or an air filled watertight chamber, NEMA design B. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 311°F (155°C). The stator shall be dipped and baked three times in Class F varnish and shall be heat-shrink fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 104°F (40°C) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer O-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection type devices are not acceptable. The motor and pump shall be designed and assembled by the same manufacturer.

A heat sensor thermostat shall be attached to and imbedded in the winding and shall be connected in series with the motor starter contractor coil to stop motor if temperature of winding overheats. The thermostat shall reset automatically when the motor cools to a safe operating temperature. Two heat sensors shall be used on 3 phase motors. The common pump, motor shaft shall be of 416 stainless steel.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.20. The motor shall be designed for operation up to 104°F (40°C) ambient and with a temperature rise not to exceed 176°F (80°C). A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

The pumps and motors shall be made by the same manufacturer and shall be designed to operate in a sewage pumping station pumping raw sewage.

5.10 BEARINGS

The motor shall have two heavy duty ball bearings to support the pump shaft and take radial and thrust loads and a sleeve guide bushing directly above the lower seal to take radial load and act as flame path for the seal chamber. Ball bearings shall be designed for 50,000 hours B-10 life. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single roller bearing. The lower bearing shall be a two-row angular contact bearing to compensate for axial thrust and radial forces. Single-row lower bearings are not acceptable.

5.11 MECHANICAL SEAL

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide steel ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction or rotation for sealing.

Shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, are not acceptable. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load. The seal lubricant shall be FDA approved, nontoxic.

A double electrode shall be mounted in the seal chamber to detect any water entering the chamber through the lower seal. Water in the chamber shall cause a red light to turn on at the control panel. This signal shall not stop the motor but shall act as a warning only, indicating service is required.

5.12 IMPELLER

The impeller(s) shall be of gray ductile iron, dynamically balanced, double shrouded non-clogging design having a long throughlet without acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Whenever possible, a full vaned, not vortex, impeller shall be used for maximum hydraulic efficiency; thus, reducing operating costs. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. Impeller(s) shall be keyed to the shaft, retained with an expansion ring and shall be capable of passing a minimum 3 inch diameter solid. All impellers shall be coated with paint appropriate for the material to be pumped.

Vane inlet tips shall be carefully rounded to prevent stringy material from catching in vanes. Pump out vanes shall be used in front and back chamber. Impellers shall be dynamically balanced by grinding on shroud faces. No holes are to be drilled for balancing.

5.13 PUMP CASE

The pump volute case shall be single-piece of gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

The volute case shall be cast iron and have a flanged center line discharge. The discharge flange shall be as required on the plans and shall be standard with bolt holes straddling center line. A bronze wear ring shall be pressed into the case for guiding impeller neck and to prevent corrosion freeze up. The wear ring is to be held from rotating by locking with stainless steel set screw. The wear ring is required on all vane type impellers but not recessed vortex type impellers.

5.14 PUMP AND MOTOR CASTINGS

All castings shall be of high tensile cast iron and shall be treated with phosphate and chromate rinse. All fasteners shall be 302 stainless steel.

5.15 BEARING END CAP

The upper motor bearing cap shall be a separate casting for ease of mounting and replacement.

5.16 COOLING SYSTEM

Each unit shall be provided with an adequately designed cooling system. The cooling media channels and ports shall be non-clogging by virtue of their dimensions. Provisions for external cooling and seal flushing shall also be provided. The cooling system shall provide for continuous pump operation in liquid temperature of up to 104°F (40°C). Restrictions below this temperature are not acceptable.

5.17 PUMP SHAFT

The pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel C1035 and shall be completely isolated from the pumped liquid or stainless steel if not isolated from the pumped liquid.

5.18 WEAR RINGS

A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a stainless steel, cast iron, brass, or nitrile rubber coated steel ring insert that is drive fitted to the volute inlet.

The pump, if 6" discharge or larger, shall also have an impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.

5.19 PROTECTION

All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 257°F (125°C) the thermal switches shall open, stop the motor and activate an alarm.

5.20 PAINTING

The pump shall be painted after assembly with an alkyd enamel. The paint shall be a thickness of 3 to 4 mils.

5.21 ELECTRICAL POWER CORD

The electrical power cord shall be water resistant 600V, 60 degree Celsius minimum, and applied dependent on amp draw for size.

The pump shall be triple protected with a compression fitting and two epoxy potted areas at the power cord entry to the pump. A separation between the junction box areas of the pump and the motor by a stator lead sealing gland or terminal board shall not be acceptable.

The power cable entry into the cord cap assembly shall first be made with a compression fitting. Each individual lead shall be stripped down to bare wire, at staggered intervals, and each strand shall be individually separated. This area of the cord cap shall then be filled with an epoxy potting compound which will prevent water contamination to gain entry even in the event of wicking or capillary attraction. The power cord leads shall then be connected to the motor leads with extra heavy connectors having brass inserts with a screwed wire to wire connection, rather than a terminal board.

The connection box wiring shall be separated from the motor housing wiring by stripping each lead down to bare wire, at staggered intervals, and separating each strand. This area shall be filled with an epoxy potting compound.

The cord cap assembly where bolted to the connection box assembly and the connection box assembly where bolted to the motor housing shall each be sealed with a Buna N Rubber O-ring on a beveled edge to assure proper sealing.

The power cord and control cord shall be double sealed. The power and control conductor shall be single strand sealed with epoxy potting compound and then clamped in place with rubber seal bushing to seal outer jacket against leakage and to provide for strain pull. Cords shall withstand a pull of 300 pounds to meet U.L. requirements. The minimum cable length shall be 25' unless specified elsewhere.

Insulations of power and control cord shall be type SO or STOW. Both control and power cords shall have a green carrier ground conductor that attaches to motor frame.

5.22 IDENTIFICATION NAMEPLATE – ACCESSORIES

Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data. Technical information to be provided shall include:

Motor:

- horsepower
- voltage
- amperage and service factor
- number of phases
- rpm
- efficiency
- frame number

Pump:

- discharge flow rate and pressure design point
- rpm
- impeller number and trim diameter

The Contractor shall furnish with each type, kind or size of pumping unit, two sets of any special suitably marked high-grade tools, gauges and fixtures which may be needed to adjust, operate, maintain or repair the equipment. Such tools and accessories shall be furnished in neat, special steel cases fitted with locks and keys and delivered to the Engineer prior to the initial operation of equipment.

5.23 SERVICE DEPARTMENT

The pump supplier shall have a repair facility and service trucks with 4,000 lb. capacity winches and have been actively servicing pumps and controls for a minimum of 5 consecutive years. The service department shall be factory certified as well as a warranty service center. The service department shall also carry local stock of repair parts and replacement pumps.

5.24 ACCESSORIES

Standard accessories, including the necessary amount of power and control electrical cables and stainless steel lifting chain shall be provided as part of the bid.

5.25 WARRANTY

Contractor and supplier of pumps and equipment shall warrant and guarantee to the Owner that all work will be in accordance with the contract documents and will not be defective. This covers all materials and/or equipment from latent defects in materials, equipment and workmanship for one (1) year from the date of final completion of installation and startup. The date of startup shall be that date when the equipment or product is placed in service and shall be recorded by the Owner.

Contractor shall promptly make such repairs or replacement as may be required under the above specified guarantee.

When the Owner deems it necessary and so orders, replacements or repairs under this section shall be undertaken by the Contractor within twenty- four (24) hours after service of notice. If the Contractor unnecessarily delays or fails to make the ordered replacements or repairs within the time specified, or if any replacements or repairs are of such nature as not to admit of the delay incident to the service of a notice, then the Owner shall have the right to make such replacement or repairs and the expense thereof shall be paid by the Contractor or deducted from any moneys due the Contractor.

Pumps supplied by the Contractor shall have a five-year non-prorated warranty which covers defects in materials and workmanship. A prorated warranty or a warranty of less than five years shall not be acceptable, unless a complete spare pump/motor unit is furnished, at no additional cost to the owner.