WATER DISTRIBUTION AND SANITARY SEWER SPECIFICATIONS

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1.01 Purpose

A. The purpose of this document is to set forth the uniform policies, procedures, design requirements, material requirements and construction standards of the Forsyth County Department of Water & Sewer as to comply with all applicable state and federal laws for the installation of water distribution systems and sanitary sewer systems. These standards and specifications shall apply to all water and sewer infrastructure installed within the service area of Forsyth County, including private systems. Private systems require approval by the State of Georgia, Department of Natural Resources, Environmental Protection Division in addition to Forsyth County approval. For infrastructure that will be owned and maintained by the Forsyth County Department of Water & Sewer, delegation rights are described in section 1.02 below.

B. The State of Georgia, Department of Natural Resources, Environmental Protection Division, in letters dated April 26, 2005 and August 31, 2005, approved the Forsyth County Department of Water & Sewer standard specifications for gravity flow sanitary sewers, water distribution systems, sanitary sewer lift stations and force mains, respectively. Copies of the letters approving the specifications are included in Appendix A.

1.02 Delegation

A. The Forsyth County Department of Water & Sewer shall review and approve the design and installation of water distribution systems and sanitary sewer systems that will be owned and maintained by the Forsyth County Department of Water & Sewer or that will discharge into said sanitary sewer system.

B. The State of Georgia, Department of Natural Resources, Environmental Protection Division, in letters dated August 22, 1990, August 22, 1991 and October 4, 1993, delegated to the Forsyth County Department of Water & Sewer the rights to review and approve the design and installation of additions to the existing Forsyth County Department of Water & Sewer water distribution system and sanitary sewer system. Copies of the letters delegating authority are included in Appendix A.

C. The delegation of review and approval to the Forsyth County Department of Water & Sewer is limited to the following.

1. Additions to the existing water distribution system.
2. Gravity flow sanitary sewer system additions up to 36 inches in diameter.
3. Sanitary sewer lift stations up to 700 gallons per minute flow rate.

1.03 Variance

Under special conditions beyond the control of parties involved, the Forsyth County Department of Water & Sewer may modify the specifications herein. All petitions shall be submitted to the Forsyth County Department of Water & Sewer in writing. The Director of the Forsyth County Department of Water & Sewer shall authorize any variance in writing.

The listed words or acronyms shall mean the following:

ACI: American Concrete Institute.

ANSI: American National Standards Institute.

ASTM: American Society for Testing and Materials.

AWWA: American Water Works Association.

AWS: American Welding Society

FCDWS: Forsyth County Department of Water & Sewer.

FCDWS Engineer: Forsyth County Department of Water & Sewer, Water & Sewer Engineer or authorized representative.

FCDWS Inspector: The Inspector assigned by FCDWS to inspect water & sewer infrastructure.

Forsyth County P & D : Forsyth County Planning and Development Department.

CRSI: Concrete Reinforcing Steel Institute.

Design Engineer: The engineer or surveyor under whose direction the development plans submitted for review were prepared. Design Engineer shall be a Georgia Licensed Professional Engineer having knowledge of water distribution system and sanitary sewer system design or Georgia Licensed Registered Land Surveyor having knowledge of sanitary sewer design.

Developer: Any person, firm, corporation, association or partnership or any agent thereof who undertakes or proposes to undertake the development of land so as to constitute a residential subdivision, apartment complex, condominium or commercial/industrial/ institutional establishment.

DFT: Dry Film Thickness.

Diameter: Nominal inside diameter of pipe excluding bituminous or epoxy bonded coating thickness.

DIP: Ductile iron pipe.

Easement: Non-profitable interest in land owned by another that entitles its holder to a specific limited use.

Force Main: Piping, valves and other components of a single pressurized line used to convey raw water, potable water or sewage. A force main conveying potable water may have a limited number of service connections.

FMR: Factory Mutual Research.

Georgia EPD: State of Georgia, Department of Natural Resources, Environmental Protection Division.

GFI: Ground Fault Interrupt.

gpm: Gallons per minute.

Gravity Sewer: Piping and other components used to convey sanitary sewage in a non-pressurized system.

Lateral: Pipe extending from a sewer main to a street right-of-way or easement for the purpose of servicing a property (lot). The lateral shall be six (6) inches in diameter, shall not contain a manhole and shall be less than 250 feet in length. It is installed with a 6" clean out.

Lift Station: All pumps, valves, wet wells, controls and other components used to pump sanitary sewage into a force main.

NEC: National Electrical Code, latest edition.

NEMA: National Electrical Manufacturers' Association.

NPRL: Non-Potable Reuse Line

Pavement: Any asphalt, concrete, gravel or dirt surface including curbs and sidewalks used by vehicles and/or pedestrians.

pcf: Pounds per cubic foot.

psi: Pounds per square inch.

PVC: Polyvinyl chloride.

Rock: Solid material being greater than one (1/2) cubic yard in size which by actual demonstration cannot, in the opinion of the FCDWS Engineer, be reasonably excavated with backhoe having a curling force rated at not less than 70,000 pounds (Caterpillar model 330, Kamatsu 400 or equivalent), in good condition and equipped with manufacturer's standard boom and rock points or similar approved equipment; and which must be systematically drilled and blasted or broken by power-operated hammer, hydraulic rock breaker or expansive compounds.

Rock Excavation: Removal of solid material, as the above specifies, and does not necessarily correspond to "rock" as implied by the names of geologic formations.

Sanitary Sewer System: Multiple pipes, manholes and other components that convey sewage and to which storm water, surface water, and ground water are not intentionally admitted.

SCADA: Supervisory Control and Data Acquisition system.

Service Connection: Fitting(s) connecting a service line or lateral from a property (lot) to a water main or sewer main.

Service Line: Pressurized pipe extending from a water main to a water meter or pressurized pipe extending from a water main to a fire hydrant.

Sewage: The combination of water-carried wastes from residential housing, institutional facilities, and commercial and industrial complexes together with such groundwater, surface water, and storm water as may inadvertently be present.

Sewer: A pipe or conduit that conveys sewage.

Sewer Main: Sewer to which one or more laterals are connected.

Sewer Outfall: Sewer to which one or more sewer mains are connected.

Sewer Trunk: Sewer to which one or more sewer mains or sewer outfalls are connected and discharges into a Water Reclamation Facility.

Suitable Soil: Soil that is free of organic and/or deleterious material, expansive clay and rock fragments larger than three (3) inches.

UL: Underwriters Laboratory

Utility Contractor: Georgia Licensed Utility Contractor in accordance with the Official Code of Georgia, Chapter 43.

Water Distribution System: Pressurized pipes, valves and other components that convey potable water.

Water Main: Pressurized pipe used to convey potable water from a force main to a service line.

WRF: Water Reclamation Facility.

WPP: Water Production Plant.

3.01 General

A. The design of water distribution systems and sanitary sewer systems shall conform to the specifications herein.

B. Concurrent with plan submittal, the Design Engineer shall provide a completed Water Distribution/Sanitary Sewer Addition Submittal form. The Water Distribution/Sanitary Sewer Addition Submittal form is included in Appendix B.

C. If the sanitary sewer system discharges to a private treatment plant or if it falls within the regulatory approval of GA EPD per Division I 3.04D, a Sanitary Sewer Extension Submittal as provided in Appendix C shall be completed for State approval.

3.02 Technical Review

A. Proposed water distribution system and sanitary sewer system plans shall be reviewed by the FCDWS under the supervision of a Georgia Licensed Professional Engineer for technical adequacy and conformance to applicable requirements to determine that the systems are suitable for construction.

B. With the submittal of a proposed development, the Design Engineer shall perform a feasibility study to determine whether the existing FCDWS water distribution system and/or sanitary sewer system has sufficient capacity. The following review shall be completed.

Water Distribution System

1. The latest 12 months of reported production from the supplying WPP shall be examined to determine an average monthly production rate. A proposed development, whose supply requirement would cause the WPP to exceed the Georgia EPD permitted production rate, shall not be connected to the FCDWS system.

2. Pressure and flow from the contributing water distribution system shall be examined to determine whether the additional supply requirement will adversely affect the surrounding system. Fire flow test and a water distribution system model using Water CAD ®, H_2O MAP Water, or similar modeling software must be conducted for the contributing water distribution system. A proposed development, whose supply requirement would

adversely affect the surrounding system, shall not be connected to the FCDWS system.

3. Where a subdivision or development is planned on a road that does not have existing County water, and County water is extended to serve the property, or when an upsized County water line is extended to serve a development, then the water main shall be extended along the entire frontage of the property where abutting County right-of-way.

Sanitary Sewer System

1. The latest 12 months of reported discharge from the receiving WRF shall be examined to determine an average monthly flow rate. A proposed development, whose discharge would cause the receiving WRF to exceed the Georgia EPD permitted flow rate, shall not be connected to the FCDWS system.

2. A capacity study shall be performed to determine whether the discharge from the development would exceed the capacity of the existing receiving sewers. A proposed development, whose discharge would exceed the capacity of the receiving sewers, shall not be connected to the FCDWS system.

3. Sanitary gravity sewer shall be designed according to the size of the service basin as per the Forsyth County Master Plan. Sanitary sewer must be sized to handle peak daily flow at a maximum 67% full. Sanitary sewer force mains shall be sized to provide a minimum velocity of 2.0 fps and a maximum velocity of 5.0 fps.

C. FCDWS review comments shall be marked on Technical Review Checklists and noted on development plans in the color red (Red Line Comments). Technical Review Checklists used during the FCDWS review are included in Appendix D.

3.03 Plan Processing

A. Water distribution system and/or sanitary sewer system plans shall be submitted to Forsyth County P & D.

B. The Design Engineer shall address FCDWS review comments. Plans containing the original Red Line Comments shall accompany each re-submittal to the FCDWS.

C. Construction of any kind shall not begin on a project prior to the issuance of a Land Disturbance Permit or a Utility Permit by Forsyth County Department of Engineering.

3.04 Approval by Regulatory Agencies

A. The Developer's Engineer shall address all deficiencies and resubmit plans in accordance with Division I, Sections 3.02 and 3.03. Plans shall not be approved until all deficiencies have been addressed to the satisfaction of the FCDWS Engineer.

B. Note that plan approval by the FCDWS Engineer shall not be construed, in any manner, to relieve the Developer of his responsibility for strict compliance with the specifications herein and any applicable laws and regulations.

C. Installation of water distribution systems and/or sanitary sewer systems shall not commence on any development until the FCDWS has granted final approval of water distribution system and/or sanitary sewer plans and Forsyth County Department of Engineering has issued a Land Disturbance Activity permit or a Utility Permit.

D. Projects that involve the following must be approved by FCDWS and by GA EPD:

1. Sewers within 2000 feet of the Chattahoochee River.
2. Sewers greater than 36" in diameter.
3. Pump Stations with capacity of 700 gpm and greater.
4. Sewers tributary to privately owned treatment facilities.

E. Note that other agencies may have regulatory authority and the Developer is responsible for obtaining other agency approval. Other agencies could be, but are not limited to, State of Georgia Department of Natural Resources, State of Georgia Department of Transportation, United States Army Corps of Engineers, United States Environmental Protection Agency, Georgia Power Company and Southern Natural Gas.

3.05 Period of Plan Approval

The approval period of water distribution system and/or sanitary sewer system plans shall be six (6) months. Approved plans that are not initiated or are inactive for a six (6) month period shall become invalid. Should an approved plan be invalidated, the FCDWS Engineer shall determine whether the plan is still valid or whether a new system design is required.

4.01 General

A. Components of water distribution systems and sanitary sewer systems, to be owned by the FCDWS, should be situated within streets' rights-of-way.

B. The following water distribution system and sanitary sewer system components, to be owned by the FCDWS, shall be situated within an easement that is granted to the FCDWS, when a street right-of-way is not available.

1. Force main.
2. Water main.
3. Water meter/check valve assembly.
4. Fire hydrant.
5. Sewer main.
6. Sewer outfall.
7. Manhole.
8. Lift station site area.
9. Access road.
10. Other components required by the FCDWS.

C. A structure or obstruction shall not encroach into an easement.

4.02 On-Site Easement

A. "On-site" easements are those easements falling within the boundaries of the current phase of the development that are shown on the plat and are recorded through the process of recording the final plat and through recording a FCDWS easement document. The easement document may reference the final plat as an exhibit drawing.

B. Developer shall grant to the FCDWS, the exclusive right to construct, reconstruct, operate, maintain, repair, replace, improve, alter, remove, relocate and inspect water distribution systems and/or sanitary sewer systems that are situated over, across and under the land wherein the water distribution systems and/or sanitary sewer systems lie on the Developer's property.

4.03 Off-Site Easement

A. "Off-site" easements are those easements falling outside the boundaries of the current phase of the development and must be provided and recorded by the Developer on a FCDWS easement document for each property owner. Easements through property owned by the developer, including water and sewer lines that will be included in later phases of the same project, must be treated as routine off-site easements.

B. Off-site easements shall be negotiated and acquired by the Developer with the property owner.

C. Construction of the off-site water distribution systems and/or sanitary sewer systems should not begin until all off-site easements for system completion are acquired, recorded and received by the FCDWS Engineer. The easements shall be recorded per the standard easement agreement, as in Appendix E.

4.04 Easement Size

A. The minimum width of a permanent on-site/off-site easement associated with water distribution system and sanitary sewer system components should be 20 feet. Sanitary Sewer lines deeper than 16 feet require wider permanent easements as follows: 17’ through 22’ depths require 25 foot width; 23’ through 28’ depths require 30 foot width; 29’ through 33’ depths require 40 foot widths. Any depth greater than 33’ shall be reviewed on a case-by-case basis.

B. The minimum size of an easement associated with a water meter/check valve assembly shall be 15 feet by 30 feet.

C. Easement width or size may be increased or decreased at the discretion of the FCDWS Engineer, dependent on site conditions.

4.05 Easement Locations

In areas of a development where public sewer is not installed, the developer shall provide a utility easement (20’ minimum permanent, 50’ construction) in all areas designated by the FCDWS Engineer, for installation of sewer in the future.

5.01 General

A. The installation of water distribution systems and sanitary sewer systems shall be in accordance with the approved plans and specifications herein.

B. A set of plans stamped approved by the FCDWS shall be present on the job site whenever work is being performed on the water distribution system and/or sanitary sewer system.

C. Construction drawings must comply with the latest requirements of Forsyth County Code, Chapter 34, Article 5, Stormwater Management, the Georgia Stormwater Management Manual, and the Metropolitan North Georgia Water Planning District, and the Manual for Erosion and Sediment Control in Georgia.

D. All construction will comply with the Department of Labor, Occupational Safety and Health Administration, 29 CFR Part 1926, Subpart P, latest edition.

5.02 Utility Contractor

A. All contractors, wishing to be approved to perform work resulting in connection to FCDWS's water or sanitary sewer system, will be required to furnish FCDWS satisfactory proof of insurance and a utility contractor license

B. All workers engaged in the construction of water or sewer pipes and appurtenances must be employed by the Utility Contractor as required by the Georgia Secretary of State

C. The contractor shall provide the FDWS Engineer with a full listing of all products and materials intended for installation in order to verify compliance with these specifications

5.03 FCDWS Installation

A. The installation of residential water service lines and meter boxes shall be performed by the Developer's Utility Contractor, and inspected by FCDWS.

B. Developer shall install services in subdivisions, and on commercial /industrial developments where a fire line is installed or other water main works, or any meter greater than 2" in size.

C. FCDWS will install service for ¾" – 2" meters, where no mainline work is being done by the Developer's Utility Contractor.

D. Water meters will not be sold, or water service established, to more than three (3) parcels when they access public right-of-way by way of easement or common driveway.

E. If multiple easements abut one another, no more than three (3) meters will be installed on each side of the easement or common driveway

F. Water meters will be sold for parcels of record, located on a road not maintained by Forsyth County, only if sufficient right-of-way is available on the public right-of-way to set the meters. The property owner will be required to provide evidence that proper easements were obtained to allow for the water service to extend from the meter location to the property to be served.

G. The easement must be recorded in the office of the Clerk of Superior Court of Forsyth County Georgia, and a copy of the recorded easement must be validated by the FCDWS Engineer before an application can be accepted for a water meter purchase.

5.04 Insurance Requirements

A. Utility Contractors performing work on FCDWS funded or partially funded projects shall comply with current FCDWS insurance and bonding requirements, in accordance with the F. C. Purchasing Dept.

B. Companies such as railroads, electric power suppliers, natural gas suppliers, etc. may require Utility Contractors to furnish insurance, in addition to FCDWS requirements when crossing their respective easements. The Utility Contractor shall provide such insurance as required.

5.05 Inspection

A. A FCDWS Inspector, under the supervision of a Georgia Licensed Professional Engineer, shall inspect water distribution systems and sanitary sewer systems during all phases of construction to ensure the systems are being constructed in accordance with the plans approved by the FCDWS and specifications herein.

B. The Developer/Contractor shall provide the FCDWS Engineer a 24-hour notice prior to commencing construction on a water distribution system and/or sanitary sewer system.

C. The Developer/Utility Contractor shall, at all times, permit and facilitate inspection of work by the FCDWS. The presence of a FCDWS Inspector or

FCDWS Engineer on the site of work shall not be construed to, in any manner, relieve the Developer/Utility Contractor of their responsibility for strict compliance with the approved plans and specifications herein.

D. The FCDWS Inspector shall not change or modify the approved water distribution and/or sanitary sewer system plans or specifications herein without approval from the FCDWS Engineer.

E. The FCDWS Inspector shall inform the Developer/Utility Contractor when construction is deficient from the approved plans and specifications herein. Deficiencies shall be addressed in a timely manner as determined by the FCDWS Inspector. Construction activities and other pertinent information shall be recorded on an Inspection Report included in Appendix F.

F. Any pipe which has its alignment, grade, or joints disturbed after installation shall be taken up and re-laid

G. The Forsyth County P & D shall perform inspections relating to electric power supply, footings, and other building-related items.

H. Deficiencies not addressed in a timely manner shall be justification for the FCDWS to stop work on a project. The FCDWS Engineer or FCDWS Inspector shall issue a Stop Work Order to the Developer/Utility Contractor in writing. Continued work on a project after being issued a Stop Work Order shall be justification to inform the appropriate legal counsel or Forsyth County Government Agency for necessary enforcement actions.

5.06 Testing

A. Water distribution systems and sanitary sewer systems shall be subjected to and pass mandrel, televising, and pressure testing as applicable. Testing shall be performed at the expense of the developer.

B. The FCDWS shall be given a 24-hour notice prior to any testing. A FCDWS Inspector shall witness all testing.

C. Testing for the compressive strength of concrete and density of compacted soil shall be performed at the expense of the Developer by FCDWS approved geotechnical and material testing companies. Materials not meeting required

specification shall be removed, replaced and retested for compliance at the expense of the Developer.

E. Results of tests performed by testing companies shall be provided to the FCDWS Engineer. Testing forms used by the FCDWS are included in Appendix G.

5.07 Repairs to pipe

A. Repairs to pipe must be made using a solid sleeve mechanical joint fitting. Split or “wrap around” type sleeves are unacceptable alternatives.

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6.01 General

Provided the Developer has complied with the terms of these Policies and Procedures and the installed water distribution system and/or sanitary sewer system is in accordance with the approved plans and specifications herein, the FCDWS shall allow the Developer/Owner to connect the new system(s) into the FCDWS system(s).

6.02 Notice of Connection to Existing Systems

A. Prior to connection, the FCDWS shall have approved all construction and of the Developer's water distribution system and/or sanitary sewer system.

B. The FCDWS shall be notified at least 24-hours in advance of connecting to the FCDWS systems.

C. A FCDWS Inspector shall be present during connection of the Developer's systems to the FCDWS systems. Prior to installation, a FCDWS Inspector shall approve all materials supplied by the Developer to be used in making the connection.

D. Upon completing a water distribution and/or sanitary sewer connection, the Developer's systems shall be valved off and/or immediately plugged, respectively, until Final Acceptance.

F. Should an unauthorized connection or connection without the presence of the FCDWS Inspector be made to the FCDWS systems, the Developer shall be subject to a fine and/or refusal of service. Under any circumstance, the Developer shall expose and thoroughly clean all piping and components of the connection for inspection by the FCDWS. Non-compliant connections and/or damage to the FCDWS system shall be repaired/replaced in conformance with the approved plans and specifications herein at the expense of the Developer.

7.01 General

Acceptance of the Developer's water distribution system and/or sanitary sewer system shall be at such time as the Developer has met all terms and conditions of the specifications herein, and has obtained approval of a final plat or as-built plan.

7.02 Final Inspection

Prior to final acceptance, a FCDWS Inspector shall perform a final inspection of the water distribution system and/or sanitary sewer system after all pavement is installed. The final inspection shall determine the proper installation of valve and meter boxes, the integrity of manholes, and the presence of debris in sewers and curb markings. Results of the inspection shall be recorded on a Final Field Report and is included in Appendix H. Deficiencies encountered shall be immediately addressed and an additional final inspection shall be required.

7.03 Warranty

The Developer shall warrant the development's water distribution system and/or sanitary sewer system and hold the FCDWS harmless against all costs, expenses and losses, including, without limitation, incidental and consequential damages, resulting from any defects in the Developer's water distribution system and/or sanitary sewer system, including without limitation, defects in material and workmanship, which are discovered or arise within a period of eighteen (18) months beginning on the date of final acceptance by the FCDWS. During that (18) month period, the developer shall be responsible for all repairs to the installed system.

7.04 Final Acceptance

A. Final acceptance of the Developer's water distribution system and/or sanitary sewer system by the FCDWS shall be when the final plat or as-built is recorded.

B. Upon issuance of final plat, or recording of as-builts, the Developer's new system(s) may be opened to the FCDWS system(s).

1.01 General

The design and plan preparation of water distribution systems and sanitary sewer systems shall conform to the specifications herein.

1.02 Licensed Professionals

A. Water distribution system and/or gravity flow sanitary sewer system design and plan preparation for a residential subdivision or parts thereof on a Developer's property shall be performed by a Georgia Licensed Professional Engineer who has sufficient knowledge to properly perform the design. Gravity flow sanitary sewer system design and plan preparation for a residential subdivision or parts thereof on a Developer's property may also be designed by a Georgia Registered Land Surveyor who has sufficient knowledge to properly perform the design.

B. Water distribution system and/or gravity flow sanitary sewer system design and plan preparation for property off-site of a Developer's property shall be performed by a Georgia Licensed Professional Engineer who has sufficient knowledge to properly perform the design. Gravity flow sanitary sewer system design and plan preparation for property off-site of a Developer's property may also be designed by a Georgia Registered Land Surveyor who has sufficient knowledge to properly perform the design.

C. Water distribution system and/or gravity flow sanitary sewer system design and plan preparation for commercial/industrial property shall be performed by a Georgia Licensed Professional Engineer who has sufficient knowledge to properly perform the design. Gravity flow sanitary sewer system design and plan preparation for commercial/industrial property may also be designed by a Georgia Registered Land Surveyor who has sufficient knowledge to properly perform the design.

D. Force main and sanitary sewer lift station design and plan preparation shall be performed by a Georgia Licensed Professional Engineer who has sufficient knowledge to properly perform the design.

E. As-built drawings of the installed water distribution system and/or sanitary sewer system shall be performed by a Georgia Registered Land Surveyor and/or Georgia Licensed Professional Engineer.

F. The professional performing the design and preparing the plans shall seal each plan sheet with their stamp and sign their name across the stamp.

1.03 Reference Documents and Standards

General methods of design and construction shall conform to the specifications herein and the following. When standards conflict with one another, the FCDWS Engineer shall determine the applicable standard.

A. Georgia EPD, Minimum Standards for Public Water Systems, latest edition.

B. Georgia EPD, Rules and Regulations for Water Quality Control, Chapter 391-3-6, latest effective date.

C. Water Environment Federation, Regulation of Sewer Use, WEF Manual of Practice No. 3, latest edition.

D. Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, generally referred to as the “Ten (10) States Standards for Sewage Works” 1997 or latest edition.

E. Gravity Sanitary Sewer Design and Construction, American Society of Civil Engineers Manuals and Reports on Engineering Practice No. 60, Water Environment Federal Manual of Practice No. FD-5, revised April 1982.

F. Utility Accommodations Policy and Standards, Georgia Department of Transportation, Office of Utilities, latest edition.

G. American Water Works Association Standards, latest editions.

H. Soil Surveys of Forsyth County, Georgia, by the United States Department of Agriculture, Soil Conservation Service.

I. American National Standards Institute Standards, latest editions.

J. American Society for Testing and Materials Standards, latest editions.

K. Occupational Safety and Health Administration regulations, latest editions.

L. Georgia Department of Transportation specifications and regulations, latest editions.

M. American Society of Mechanical Engineers standards, latest editions.

N. National Electrical Manufacturer's Association standards, latest editions.

O. American Concrete Institute standards, latest editions

P. Manual for Erosion and Sedimentation Control in Georgia, latest editions

1.04 Plan Requirements

A. Water distribution system and/or sanitary sewer system plans shall be comprised of the following sheets as required. Each sheet should be 24 inches by 36 inches in size.

1. Cover Sheet should include
    a. Detailed location map
    b. Index table
    c. Symbol legend
2. Site Plan Sheet
3. Grading Plan Sheet.
4. Storm Water System Plan Sheet.
5. Water Distribution System Plan Sheet
6. Water Distribution System Details and Construction Notes Sheet.
7. Sanitary Sewer System Plan Sheet.
8. Sanitary Sewer System Plan & Profile Sheet
9. Sanitary Sewer System Details and Construction Notes Sheet
10. Sanitary Sewer Lift Station Plan and Cross-Section Sheet
11. Sanitary Sewer Lift Station Details and Construction Notes
12. Soil Erosion and Sedimentation Control Plan Sheet
13. Soil Erosion and Sedimentation Control Detail Sheet.
14. Sanitary Sewer Easement Access Plan

B. Water distribution and/or sanitary sewer system plan sheets shall be prepared and include as a minimum the information detailed on the Technical Review Checklist included in Appendix D.

C. Concurrent with the initial submittal of water distribution system and/or sanitary sewer system plans to the FCDWS, a completed Water

Distribution/Sanitary Sewer Addition Submittal form shall be submitted. The FCDWS plan review process shall not commence until the Water Distribution/Sanitary Sewer Addition Submittal form is received. The Water Distribution/Sanitary Sewer Addition Submittal form is included in Appendix B.

1.05 Modifications to Plans

A. Water distribution system and/or sanitary sewer system plans approved by the FCDWS shall not be modified or deviated from during construction unless the FCDWS Engineer approves modifications or deviations in writing.

B. The division of approved plans into units and phases requires an approved phasing plan for the water and sewer system. No final plat will be accepted for recording that is not consistent with an approved phasing plan.

1.06 As-Built Drawings

A. As-Built Drawings of the installed water distribution system and/or sanitary Sewer shall be prepared and sealed in accordance with Division II, Section 1.02.

B. As-Built Drawings shall be completed upon connecting the development's water distribution system and/or sanitary sewer system to the FCDWS system.

C. As-Built Drawings shall show all street names, right-of-way widths, related easements, lot number, service addresses, vertical depth with respect to pavement, size and material of all water distribution system and/or sanitary sewer system components and location of the centerline, valves, and taps. For sanitary sewer and force main as-built drawings, as-built profiles shall be submitted.

D. As-Built Drawings should also contain a table showing linear footage of pipe by size (water & sewer), number of valves and fire hydrants, and number of sanitary sewer manholes.

E. As-Built Drawings shall be prepared using a survey that ties the development's water distribution system and/or sanitary sewer systems horizontally and vertically to the following state plane coordinate system or as amended by the FCDWS.

Horizontal Control: North American Datum 83 (NAD83) (HARN) 1994
Vertical Control: North American Vertical Datum of 1988 (NAVD88).
Grid Zone: Georgia West 1002 (US Survey feet)

F. The following certification shall be included on the As-Built Drawings and signed by the Design Engineer:

"I certify that the water distribution system and/or sanitary sewer system depicted by this As-Built Drawing was constructed in accordance with the plans approved by the FCDWS. The information submitted on this As-Built Drawing is to the best of my knowledge and belief, true, accurate and complete."

G. The Developer's water distribution system and/or sanitary sewer system shall not be considered complete until the As-Built Drawings have been reviewed and approved by the FCDWS Engineer. The approved As-Built Drawings shall also be submitted to the FCDWS Engineer in a digital format (AUTOCAD Version 14 or newer version) as described in Appendix J.

2.01 General

A. The following section shall be used as a guideline for the design of water mains and service lines that will supply residential, apartment, commercial and industrial complexes.

B. The FCDWS may require the above referenced complexes to have multiple connection points to existing water mains.

C. The following certification shall be made by the Design Engineer and included with Water Distribution System construction notes:

"I certify that the proposed water distribution system has been designed in accordance with the FCDWS Specification document titled "Standard Specifications for Water Distribution Systems and Sanitary Sewer Systems", including all amendments.

D. Water Conservation

1. All new multi-family buildings are required to be served by individual water meters or sub-metered for billing based on volume of water used.
2. All new drive through car washes, including in-bay and conveyor washes, must be equipped to recycle water

2.02 Hydraulics

A. Design flow shall be based on the following fire flow demands.

1. Residential Area: 750 gallons per minute.
2. Commercial/Industrial Area: 1,500 gallons per minute.

B. The following range of supply pressures shall be assumed when sizing system components, unless the static pressure determined during fire flow test is greater than 150 psi (section 3.02).

Pressure (min.): 20 psi.
Pressure (max.): 150 psi.

C. Design flow shall also account for irrigation flows. Irrigation flows are to be estimated at 20 gpm per lot, or by actual irrigation flows if known.

2.03 Water Line Material and Size

A. Water mains and associated fittings shall be Class 350 ductile iron with a minimum diameter of eight (8) inches.

B. Water main pipe assembly shall be push-on joint unless indicated otherwise.

C. Thrust Restraint

1. Plugs, Caps, Tees and Bends shall be provided with two forms of thrust restraint. Calculations must be included for force mains greater than 12 inch diameter.

2. Thrust restraint at fitting shall be accomplished by cast-in place concrete blocking installed to dimensions as shown on thrust block detail, and shall be placed against undisturbed soil. Thrust restraint shall also include one of the following:

   a. Restrained joint pipe and fittings
   b. Mega-Lugs

3. In disturbed soil, thrust restraint shall be designed by Design Engineer and approved by FCDWS Engineer or Inspector.

4. Use detail No. 16.0 17.0, 18.0 and 19.0 when applicable.

D. Water main pipe assembly in a bore casing shall be restrained joint unless indicated otherwise.

E. Service line supplying a single fire hydrant within the right-of way shall be ductile iron with a minimum diameter of six (6) inches.

F. Service line serving one (1) residential lot shall be copper with a minimum diameter of three-quarter (¾) inch.

G. *Service lines serving two (2) residential lots shall be copper with a minimum diameter of one inch. A 1 inch Mueller B-25163 ball curb valve shall be supplied on each service line serving the two meters. The ball valve shall be fitted with a Mueller H-15347, ¾" x 1" wye. The wye and the copper service lines connecting to the wye shall be a minimum one inch diameter*

H. Service line serving commercial/industrial buildings shall be copper with a minimum diameter of three-quarter (3/4) inch and a maximum diameter of two (2) inches. Lines larger than 2" should be DIP.

2.04 Water Line Location

A. Situate water mains outside of pavement, within street right-of-way when possible, at five (5) feet beyond the back of curb, or where there is no curb, in the back (5) feet of the right-of-way or at location approved by the FCDWS Engineer.

B. Situate water mains on the north and west sides of streets when possible.

C. Water mains shall have a minimum ten (10) foot horizontal separation from any sewer.

D. Water mains constructed parallel to streams shall be located such that the nearest area of disturbed soil is outside of the stream buffer.

E. A service line supplying a single lot shall be located nearest a respective property boundary as practical.

F. A service line serving two (2) lots, from the water main to the meter, should be located in-line with the lots' common property boundary, where possible.

G. No connection shall be made for a service line in a location where the water main is under pavement

H. No water main or service line shall be constructed to serve on solid waste landfills.

I. No water main or service line shall be constructed to serve a structure that is constructed on or to be constructed on a solid waste landfill.

J. Each water main and service line shall be locatable.

K. Use Detail Nos. 1.0, 2.0, 3.0, 4.0 and 5.0 when applicable.

2.05 Fire Hydrant Location and Spacing

A. where no curb, at the back of the right-of-way.

B. In subdivisions with curb, hydrants will be set 2" off back-of-curb, except in cul-de-sacs where they should be 5' off back-of-curb.

C. A hydrant shall be situated at the end of each cul-de-sac or dead end street.

D. Fire hydrants servicing residential areas shall be spaced a maximum of 1000 feet as measured along the edge of pavement. No lot shall be greater than 500 feet from a fire hydrant.

E. Fire hydrants servicing commercial and industrial areas shall be spaced a maximum of 300 feet as measured along the edge of pavement.

F. Use Detail Nos. 9.0, 10.0, 11.0, 12.0 when applicable.

2.06 Valve Size and Location

A. Valves shall be of the same size as the pipe in which the valve is situated, unless noted otherwise.

B. A corporation valve shall be situated at the tap location into a water main of a three-quarter (3/4) inch or one (1) inch service line.

C. A 2 inch gate valve with a square operating nut shall be situated downstream of tapping saddle or tapping sleeve when tapping into a water main or force main to serve a 1-1/2 inch or two (2) inch service line. The gate valve shall be situated within a valve box.

D. Gate valves shall be situated in-line with water mains as follows, unless noted otherwise. The placement of gate valves under pavement shall be allowed only if shown on approved plans. Normally, valves should be located outside the pavement. A gate valve shall be installed at all phase lines.

1. Attach tapping gate valve immediately downstream of tapping saddle or tapping sleeve when tapping into water main or force main with a smaller water main or service line.

2. Situate gate valve immediately downstream of a tee when connecting into a water main.

3. Situate gate valve on each side of a three (3)-way connection or four (4)-way connection, outside of pavement.

4. Situate gate valve immediately upstream of a fire hydrant when hydrant is situated within street right-of-way, and where shown on plans.

5. Situate gate valve within street right-of-way when fire service extends beyond right-of-way.

6. Situate gate valve in water mains at a maximum spacing of 500 feet and at all intersections within commercial districts and not more than 800 foot intervals in other districts. Where system serves widely scattered customers, the valve spacing shall be 2,000 foot.

7. A slip type valve box shall be situated over a gate valve.

8. A valve shall be placed at dead-end water mains, if the street will continue. Cul-de-sacs shall terminate with a fire hydrant.

9. Situate gate valves in water mains at both ends of underwater crossings so that the section can be isolated for testing or repair. Valves shall be easily accessible and not subject to flooding. The valve closest to the supply source shall be installed in a manhole.

E. A curb stop shall be situated inside of meter box immediately upstream of three quarters (3/4) inch through two (2) inch water meter/check valve assemblies. For curb stops ¾" –1", a 90-degree angle curb stop is required w/meter swivel nut.

F. Use Detail No. 13.0, 14.0, 20.0, 21.0 when applicable.

2.07 Water Line Depth

A. Water mains and service lines to fire hydrants shall have a minimum suitable soil cover of four (4) feet. The depth of four (4) feet from finish grade to top of pipe shall be determined as follows.

1. As measured from edge of pavement (top back-of-curb) when the finish grade elevation of the pipe route is equal to or greater than adjacent pavement elevation.

2. As measured from finish grade elevation of the pipe route when the pipe route elevation is less than the adjacent pavement elevation.

3. Other depth approved by the FCDWS Engineer.

B. Water mains crossing under a creek or ditch shall have a minimum suitable soil cover of two (2) feet and be installed with watertight restrained joints and within steel casing from the top of bank to top of bank.

C. At above water crossings, water mains shall be adequately supported and anchored, protected from damage and freezing, and accessible for repairs or replacement.

D. Water mains shall have a minimum 18-inch vertical separation from any sewer house sewer, sanitary sewer, or storm sewer. At the crossings, one full length of pipe shall be located so that both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

E. Water mains shall be at least 10 feet horizontally from any existing or proposed sanitary sewer. When local conditions prevent a horizontal separation of 10 ft., the water main may be laid closer to a sewer (on a case-by-case basis) provided the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 in. above the top of the sewer.

F. Service lines under pavement shall have a minimum suitable soil cover of 3 feet as measured from top of curb or top of pavement.

G. Service lines outside of pavement shall have a minimum suitable soil cover of 1.5 feet as measured from the meter.

H. Water mains 18 inches in diameter and larger shall be checked for buoyancy when submerged in groundwater or situated within the 100-year flood zone.

I. Exiting water mains that will fall under the proposed road widening (deceleration lane, left turn lane, etc.) should be relocated outside of pavement, with valves set at each end of the relocation.

J. Water mains crossing under collector roads or greater designation shall be installed within steel casing from shoulder to shoulder.

K. Use Detail Nos. 1.0, 2.0, and 25.0 when applicable

2.08 Thrust Restraint

A. Thrust restraint shall be installed at all fittings, hydrants, valves and other locations deemed necessary by the FCDWS Engineer.

B. Thrust restraints at hydrants and valves shall be accomplished by installing a minimum of two (2) eyebolts on the hydrant or valve and tying to an adjacent fitting or concrete tie-back using three-quarter (3/4) inch threaded rod.

C. Thrust restraint at fittings shall be accomplished by cast-in place concrete blocking installed to dimensions as shown on thrust block detail, and shall be placed against undisturbed soil. Thrust restraint shall also include one of the following.

1. Restrained joint pipe and fittings

2. Mega-Lugs

D. In disturbed soil, thrust restraint shall be designed by Design Engineer and approved by FCDWS Engineer or Inspector.

E. Use Detail Nos. 16.0, 17.0, 18.0, 19.0 and 22.0 when applicable.

2.09 Water Meters and Backflow Prevention

A. All water usage including fire and irrigation shall be metered and have backflow prevention devices.

B. All water usage shall be metered using a single meter when possible.

C. All new multi-family buildings must have each individual unit metered for billing based on volume of use. Developments served by master meter shall provide sub-unit meters for individual units for the purpose of billing by volume of use.

D. Meters shall be sized according to the anticipated demand and Division III, Section 7 of this document.

E. Each meter shall have a testable backflow device consisting of double check valve assembly, or other device according to the Forsyth County Back-flow policy.

F. Water meters and backflow device sizes up to 2 inch shall be housed in meter boxes. Two Carson Industries, specification grade 1324, super jumbo boxes are required for the installation of 1 ½ inch and 2 inch meters and backflow devices. Three inch and larger meters must be installed in concrete vaults.

G. Water meters and backflow devices shall be situated within the street right-of-way or in an easement area.

H. Irrigation systems shall contain rain sensor shut-off devices.

I. Use Detail Nos. 3.0, 4.0, 5.0, 6.0, 7.0, 8.0 when applicable.

3.01 General

A. The following section shall be used as a guideline for the design of gravity flow sanitary sewer systems; pipe diameter not to exceed 36 inches.

B. The bypassing of raw wastewater onto the ground or into a receiving steam is prohibited

C. Sanitary sewer system design shall incorporate the following FCDWS Sewer Use Ordinances:

1. Ordinance number 6 – Sewer Use Ordinance (latest revision or replacement ordinance as applicable).

D. The following certification shall be made by the Design Engineer and included with Sanitary Sewer System construction notes:

"I certify that the proposed sanitary sewer system has been designed in accordance with the FCDWS Specification document titled "Standard Specifications for Water Distribution Systems and Sanitary Sewer Systems", including all amendments.

3.02 Design Flow Rates

A. Average residential flow rates, single-family and multi-family shall be 270 gallons per day per connection.

B. Peak residential flow rates, single-family and multi-family shall be 1,000 gallons per day per connection.

C. Industrial and commercial sanitary sewer flow rates shall be at a minimum per the schedule provided below or as approved by the FCDWS.

Forsyth County Sewer Capacity by Land Use

Proposed Land Use	Per Units	Required Sewer Capacity
Apartments	Unit	270
Auditorium, Food not Included	person, max capacity	10
Bar, Food not Included	Seat	50
Beauty/Barber Shop	Wet Chair	125
Bowling Alley, Food not Included	Lane	125
Campgrounds	Space	175
Carwash	Bay	750 (Note 1)
Church	Sanctuary Seat	5
Coin Laundry	Machine	400 (Note 1)
Commercial Laundry	Machine	640 (Note 1)
Country Club, Food not Included	1000 sq ft	100
Hospital	Bed	200
Hospital	Employee	25
Industrial, toilet waste and showers (Note 2)	Employee	35 (Note 2)
Industrial, toilet waste only (Note 2)	Employee	25 (Note 2)
Mobil Home Park	Space	270
Motel, Hotel, Food not Included	Unit	100
Nursing Home	Bed	125
Nursing Home	Employee	25
Office, Food not Included	1000 sq ft	50
Picnic Area, Park	Visitor	10
Picnic Area, Park with Showers	Visitor	25
Police, Fire Station, Food Included	Resident Employee	75
Police, Fire Station, no Food	Day Employee	25
Residence Single Family, Condo, Townhowmes	Unit	270
Rest Stop, Comfort Station	Employee	25
Rest Stop, Comfort Station	Visitor	5
Restraurant	Seat	50 (Note 5)
Restaurant, Fast Food	Seat	30 (Note 4)
Restaurant, 24 Hour Service	Seat	75
School, Daycare & Preschool	Student & Staff	8
School, Elementary & Middle	Student & Staff	12
School, High School	Student & Staff	16
Service Station	Employee	(Note 3)
Stores, Shopping Center, Retail, Food not Included	1000 sq ft	100
Swimming Pool	Swimmer	(Note 3)
Theater, regular, employees included	Seat	5

Notes:

2. For car washes and laundries where water saver or recycle devices are used, flow may be based on calculations by a Professional Engineer.
3. For Industrial uses, process flow is to be based on a Professional Engineer's calculations.
4. For service stations, swimming pools, or other uses not covered by this chart, flows to be based on a Professional Engineer's calculations. Calculations are to include a peaking factor and allowance for inflow and infiltration; must be approved by FCDWS.
5. Fast food is defined as an establishment that provides food service to customers in containers that are disposed of after use (paper, plastic, etc.)
6. Restaurants are defined as any establishment that provides food service to customers with dinnerware that require washing in order to be used more than once.
7. When an office is included in warehouse and is less than 25% total space, then fees are calculated with office space as 25%. For office space greater than 25% total space, fees are to be calculated for actual office area.
8. For existing water customers who tie onto sanitary sewer, capacity shall be calculated as the daily average flow, using the most recent 12 months of data, plus a twenty percent (20%) adjustment for inflow / infiltration

3.03 Hydraulics

A. Gravity sewer pipe should be designed to carry peak design flow at two-thirds full.

B. Gravity sewer pipe shall have straight alignment and consistent grade change between manholes.

C. Sanitary sewer design drawings should indicate the pipe material and diameter, per cent of pipe slope, manhole location, manhole reference number and station, invert elevations, pipe bedding, etc.

D. Sewers shall yield mean velocities of not less than 2.0 feet per second based on the Manning Formula using an "n" value of 0.013 or as approved by FCDWS Engineer.

E. Recommended and absolute minimum pipe slopes for gravity sewer based on the size of pipe to be installed are summarized in the following table. The minimum slopes for design purposes should be the “recommended” slopes.

Slope Requirements

Diameter	Absolute Minimum	Recommended Minimum
8-inch	0.40%	0.70%
10-inch	0.29%	0.50%
12-inch	0.22%	0.40%
14-inch	0.22%	0.40%
15-inch	0.15%	0.30%
16-inch	0.15%	0.30%
18-inch	0.12%	0.24%
20-inch	0.12%	0.24%
21-inch	0.10%	0.20%
24-inch	0.08%	0.16%
27-inch	0.07%	0.14%
30-inch	0.06%	0.12%
36-inch	0.05%	0.10%

F. Sewers with slopes less than the recommended minimum may be accepted on a site by site basis. Sewers less than absolute minimum shall be unacceptable.

G. The over sizing of pipe to meet minimum grade requirements shall be prohibited.

H. A lateral at a terminal manhole shall have a minimum slope of 2.00 %.

I. The maximum slope of a gravity sewer should be 15.0%. When approved by the FCDWS Engineer, slopes greater than 15% may be used with the addition of concrete anchors (dead man) at each joint and pipe material shall be ductile iron. Concrete anchors must be designed and sized by a Georgia Professional Engineer. The FCDWS Engineer shall approve all anchor designs.

J. When increasing the size of gravity sewer pipe, pipe crowns should be matched at manholes.

K. Angle formed by alignment of influent and effluent sewer pipe at manhole shall be greater than (>) or equal (=) to 90º.

L. The surcharging of manholes shall be prohibited.

3.04 Sewer Material and Size

A. Sewer outfall, sewer main and lateral pipe and associated fittings shall be 350/psi ductile iron (or DIP Class as approved by FCDWS Engineer), SDR 26 PVC or other material approved by FCDWS Engineer.

B. Sewer pipe assembly shall be push-on joint unless indicated otherwise.

C. Transition couplings are not permitted. When DIP is required, line shall be DIP from manhole to manhole.

D. Sewer outfalls and sewer mains shall have a minimum diameter of eight (8) inches.

E. Laterals and clean-outs shall have a minimum diameter of six (6) inches, and shall be of same material as mainline.

F. Sewers of PVC should not exceed eighteen (18) inches in diameter.

G. Sewers eighteen (18) inches in diameter and larger shall be checked for buoyancy when submerged in groundwater or situated within the 100-year flood zone.

3.05 Sewer Location

A. Situate sewer outfalls and mains at the centerline of a right-of-way when possible or at the centerline of an easement.

B. Sewer outfalls and mains should have a minimum ten (10) foot horizontal and eighteen (18) inch vertical separation from any water main.

C. Lateral from the sewer main to the structure being served shall be located nearest the center of the property as practical. A separate lateral shall service each property.

1. A clean out shall be installed on each lateral where the service line crosses the public right-of-way or sanitary sewer easement. The clean out shall be stubbed up 5' above grade and capped.
2. Lateral locations should be determined to limit or eliminate installation in paved areas that are subject to traffic
3. Clean outs located in paved areas should be at such an elevation that surface water will drain away from the clean out cap
4. Clean outs installed in pavement should be contained in an approved, traffic rated box

D. When possible, route laterals to manholes rather than direct connection into sewer main and as follows.

1. Lateral connections into an in-line manhole should be limited to two (2).

2. Lateral connections into a terminal manhole should be limited to three (3).

3. Invert of a lateral connection at a manhole should be installed at an elevation not greater than (2) two feet above the invert of the manhole.

E. Sewer outfalls, mains and laterals constructed parallel to streams should be located such that the nearest area of disturbed soil is outside of both the State and County stream buffer.

F. Sewers should not be installed under or over any lake, reservoir or detention pond.

G. No sewer system or service lines shall be installed or constructed on any known solid waste landfill found in the records of Forsyth County

H. No sewer system component shall be constructed to serve a structure that is constructed on or to be constructed on a solid waste landfill.

I. Mylar marking tape, or detection wire, shall be installed one foot above all non-ferrous pipe and properly connected to fittings and valves so that the pipe can be located with a pipe detector after burial.

J. Use Detail No. 38.0, 39.0 and 40.0 when applicable.

3.06 Sewer Depth and Structural Integrity

A. Sewer outfalls and mains shall have a minimum suitable soil cover of four (4) feet or other depth approved by the FCDWS Engineer.

B. Sewer main shall be situated at a depth as to allow lateral to be constructed at a minimum two (2) percent slope from sewer main to probable structure location on each lot to be served assuming lateral is three (3) feet in depth at probable structure location.

C. Vertical connection of a lateral into a sewer main shall be prohibited.

D. Top of pipe shall be two (2) feet below any stream bottom or ditch when crossed or paralleled. Pipe constructed under creeks shall be DIP and installed inside a steel casing from top-of-bank to top-of-bank.

E. DIP shall be used for the following conditions:

1. Where depth of soil cover is less than four (4) feet after sewer installation.

2. Cover less than (7) feet in paved area.

3. Where depth of soil cover is greater than sixteen (16) feet after sewer installation or where future soil cover will be greater than sixteen (16) feet.

4. Inside drops greater than (0.2) feet.

5. Where sewer crosses over or under a storm drain pipe, within 2 feet.

6. On all outside drops.

7. Where sewer crosses over or under a water main, within 2 feet.

8. In fill areas.

9. Creek crossings

10. Other locations deemed necessary by the FCDWS Engineer

F. When a sewer crosses under a stream, a minimum of two (2) cast-in-place concrete collars shall be installed on the pipe, down gradient from the stream.

G. Use Detail Nos. 48.0 when applicable.

3.07 Manhole Location and Spacing

A. Provide a manhole at each change in grade, pipe size, alignment, intersection and at terminal point of sewer.

B. Space manholes a maximum of 400 feet of continuous run for pipes 16 inches in diameter and smaller.

C. Space manholes a maximum of 500 feet of continuous run for pipes 18 inches in diameter and larger, or as approved by FCDWS Engineer.

D. Manholes situated within the 100-year flood elevation zone should have top of cover elevations above the 100-year flood elevation, where practical.

E. Manholes situated within the 100-year flood elevation zone and/or the groundwater table shall be checked for buoyancy.

F. Manhole inverts shall be constructed to provide a smooth transition between influent and effluent piping.

G. Minimum drop across manhole is 0.2 foot.

H. Maximum inside drop in manhole is 2 vertical feet. Outside drops must be constructed according to the requirements as shown on Forsyth County Standard Detail No. 44

I. Manholes situated in pavement shall have top of covers level with finished grade using concrete riser rings. No brick risers allowed.

J. Manholes situated in non-paved areas shall have top of covers a minimum of eighteen (18) inches above finished grade, and shall be with water-tight gaskets and bolt-down covers.

K. Manholes constructed under an approved phasing plan that serve the initial phase, but are located in the street of a future phase, must be installed to prevent future disturbance of the ring and cover and inflow. This must be accomplished by either paving a 4-inch thick, 4-foot by 4-foot concrete pad around the ring and cover bounded by at least a single row of type C silt barrier. An alternative to the concrete pad is to install the manhole top at least eighteen (18) inches above grade, bounded by at least a single row of type C silt barrier.

L. Use Detail No. 41.0, 42.0, 43.0, 44.0, 45.0, 46.0 and 47.0 when applicable.

4.01 General

The following section shall be used as a guideline for the design of force mains where the pipe diameter does not exceed 36 inches.

4.02 Hydraulics

A. Force mains shall be sized to allow for a minimum velocity of 2 ft/s and a maximum velocity of 5 ft/s.

B. Surge analysis shall be provided for systems operating at pressures greater than or equal to 100 psi TDH or at force main velocities greater than or equal to 4 ft/s. Based upon the results of a surge analysis, cushioned check valves and/or other forms of surge control may be required by the Forsyth County Engineer.

C. Sanitary sewer force mains should not flow down grade into a receiving manhole.

D. Combination air release/vacuum valves shall be installed in force mains at all high points of elevation and spaced along apparent flat routes as determined by the FCDWS Engineer.

4.03 Force Main Material and Size

A. Force mains and associated fittings shall be ductile iron or other material approved by the FCDWS Engineer with a minimum diameter of four (4) inches.

B. Force main pipe assembly shall be push-on joint unless indicated otherwise.

C. Force main pipe assembly in a bore casing shall be restrained joint unless indicated otherwise.

D. Each bend in force main pipe shall be restrained per section 4.07.

4.04 Force Main Location

A. Force mains shall be situated outside of pavement within a street right-of-way near the boundary of the right-of-way or centered within an easement.

B. Water distribution and raw water force mains shall be located on the opposite side of pavement from a sewer when possible and/or shall have a minimum ten (10) foot horizontal separation from any sewer. Where force main cannot maintain ten (10) foot horizontal separation from waterline, the force main must be encased in concrete per Detail 15.0.

C. Force mains constructed parallel to streams should be located such that the nearest area of disturbed soil is greater than 25 feet from the stream bank, or outside stream buffer if greater than 25'.

D. Force main shall be painted green on 60% of the circumferential area of the assembled pipe.

E. No force main shall be installed or constructed on any known solid waste landfill found in the records of Forsyth County

F. Mylar marking tape, or detection wire, shall be installed one foot above all non-ferrous pipe and properly connected to fittings and valves so that the pipe can be located with a pipe detector after burial.

G. Force main shall be wrapped in polyethylene encasement whenever the force main is in close proximity to a steel gas main. Polyethylene encasement shall be identical to the pipe color (green). The length and location of encasement shall be as directed by FCDWS.

H. Force mains shall be installed inside a steel casing for all creek crossings, and where crossing a street designated as a collector road or higher.

4.05 Force Main Depth

A. Force mains shall have a minimum suitable soil cover of four (4) feet. Depth from finish grade to top of pipe shall be determined as follows.

1. As measured from edge of pavement when pipe route existing/finish grade elevation is equal to or greater than adjacent pavement elevation.

2. As measured from pipe route existing/finish grade elevation when the route elevation is less than the adjacent pavement.

3. Other depth approved by the FCDWS Engineer.

B. Force main crossing under a creek or ditch shall have a minimum suitable cover of three (3) feet, and shall be installed in a steel casing

C. Force mains shall have a minimum eighteen (18) inch vertical separation from any sewer.

D. Force mains eighteen (18) inches in diameter and larger shall be checked for buoyancy when submerged in groundwater or situated within the 100-year flood zone.

4.06 Valve Size and Location

A. Valves shall be of the same size as the pipe in which the valve is situated, unless otherwise noted.

B. Plug valves shall be situated in line with sanitary sewer force mains as follows.

1. Situate plug valves in-line with sanitary sewer force main at a maximum spacing of 2,000 feet.

2. 3’ outside of pump station fencing.

4.07 Thrust Restraint

A. Plugs, caps, tees and all bends shall be provided with two forms of thrust restraint. Thrust restraint calculations must be included for force mains greater than 12” in diameter.

B. Thrust restraint shall be accomplished by cast-in place concrete blocking installed to dimensions as shown on thrust block detail, and shall be placed

against undisturbed soil. Thrust restraint shall also be included one of the following:

1. Restrained joint pipe and fittings

2. Mega-Lugs

C. In disturbed soil, thrust restraint shall be designed by Design Engineer and approved by FCDWS Engineer or Inspector.

D. Use Detail No. 16.0, 17.0, 18.0 and 19.0 when applicable.

4.08 Combination Air Vacuum/Release Valves

A. Combination Air Vacuum/Release Valves with backwash kits shall be installed at high points along the force main and intermediate locations for the purposes of vacuum breaks and surge protection.

B. Sizing analysis shall be performed and included with County submittal.

C. Use Detail No. 20.0 and 21.0 where applicable.

5.01 General

A. This section shall be used as a guideline for the design of aerial pipe that pertains to water distribution piping and sanitary sewers.

B. Requirements of Division II, Sections 2, 3 and 4, where applicable, shall apply to the design of aerial piping.

5.02 Aerial Pipe Material

A. Aerial pipe shall be ductile iron. Where pipe supports cannot be placed 20 feet apart, steel pipe shall be used.

B. Aerial pipe assembly shall comply with manufacturers' recommendations.

C. Aerial pipe fittings shall comply with manufacturers' recommendations and specifications herein.

5.03 Aerial Pipe Support

A. Aerial pipe supports shall be situated on suitable soils. Prior to support design, soils beneath proposed aerial pipe route shall be examined by a soils testing company for bearing capacity and suitability for construction. A soils report shall accompany the proposed aerial route design. Report to be prepared by geotechnical engineer approved by FCDWS.

B. Aerial pipe support spacing for steel pipe shall not exceed 30 feet. Aerial pipe support spacing shall be based on results of the soil's bearing capacity and spacing recommendations of the pipe and fitting manufacturers.

C. Aerial pipe supports shall be comprised of concrete piers monolithically poured atop concrete spread footings. Spread footing size shall be based on results of the soil's bearing capacity and reactive forces within the aerial pipe. A spread footing/pier structural design shall be submitted with considerations for soils & site conditions, to be approved by FCDWS Engineer.

D. All aerial support designs and footing designs must be sealed by a licensed engineer in the State of Georgia.

E. Contractor shall have a geotechnical engineer on-site during construction of pier footings. The geotechnical engineer must be approved by FDCWS. Geotechnical engineer shall certify and submit report on aerial pier footings.

F. Use Detail No. 29.0 and 30.0 when applicable.

6.01 General

A. Lift stations will only be permitted when gravity sewer is unavailable to the property. Unavailability shall generally be interpreted to mean more than 5,000 feet, but this distance can be increased or decreased by FCDWS based upon actual field conditions, and the size of the project involved.

B. The developer shall furnish, install and dedicate to Forsyth County the entire lift station/force main system. The system will be designed by the developer's engineer (designer) and shall be sealed by an engineer registered in the State of Georgia. The design must be reviewed and approved by the FCDWS Engineer.

C. The designer shall consult with the FCDWS during the design of the system. The system shall be designed with all components sized to meet the ultimate flows adjusted for peaks.

D. The County may pay for the cost of the additional main(s) and additional pump station capacity as betterment.

E. Generally a pump station will not be allowed to be installed downstream from an existing pump station with its flow going to the existing pump station. FCDWS may, at its discretion, require that a gravity line be installed to carry flow from the existing pump station to the proposed pump station thus eliminating the existing pump station. FCDWS may, at its discretion, allow the developer to move some or all of the existing equipment and reuse it. If the reuse of equipment is allowed, the developer must coordinate with the County and assume complete responsibility for the handling of all flows during the transition period.

F. All pump stations shall be provided with standby power to service the station's full load demand. This shall include running one pump and other auxiliary equipment (e.g. – lights, etc.)

G. Generally Gorman-Rupp self priming centrifugal suction lifts should be used when depth of station will allow the pumps and manifold piping to be placed at finish grade, while insuring suction and re-prime lifts. When this condition cannot be met, submersible pumps should be used.

6.02 Submittals

A. Pump Station Design Submittal to include:

1. Pump curve from manufacturer showing system curve and operating point (flow, TDH, NPDH, static head and C-factor)
2. Pump submittal with shop drawings and specifications
3. Air Relief Valve Sizing
4. Wet well sizing calculations showing TBSS = 10 minutes and wet well operating elevations
5. Wet well buoyancy analysis
6. Emergency storage calculation
7. Valve information and shop drawings
8. Surge calculations
9. Generator submittal with specifications and shop drawings, along with automatic transfer switch specifications and shop drawings
10. Telemetry and SCADA equipment submittal
11. Single line electrical drawing showing power distribution for station
12. Site development plan and profile, and construction details
13. Gravity system and connection to lift station
14. Force main design showing connection to existing system (Length, type, diameter, valve locations)
15. Plan of the sub-basin which drains to the lift station to include contours and projected flow calculations for the entire sub-basin
16. Stamped by a professional engineer registered in the State of Georgia

6.03 Acceptable Pump Manufacturers

1. Gorman-Rupp - Above-ground suction lift
2. Flygt - Submersible

6.04 Site Layout

A. A minimum 6” thick concrete pad (above-ground suction lift: 26’ X 26’ minimum, submersible: 31’ X 41’minimum) with 6” crusher-run base shall have a 0.5% fall away from station in all directions. Concrete shall extend 6” past post all the way around perimeter fence. Reinforcing steel shall be used in the slab. Asphalt is not acceptable for the pad.

B. Access road and turn around to be paved 12’ width minimum. Concrete or asphalt to Forsyth County road standards is acceptable. If access road is over 25’ in length, it must have a turn around at least 15’ long and 15’ away from the station fence.

C. A buffer shall be placed around each lift station site. The buffer will extend 30 feet outside the fenced in station. FCDWS, at its discretion, may require a larger buffer dependent on the proximity of structures, type of development, size of pump station, or other factors which may indicate a need for additional buffer. This buffer is required in residential subdivisions, and shall be indicated on the final plat. In addition, a permanent easement, dedicated to Forsyth County, shall be provided to include the required fenced in area and access road, with an additional 6-inches extending beyond the fence on all sides.

D. Fence is to be 8 feet high 9 gauge fabric (chain link type) with top rails and tension wires; 3 strands 12 gauge galvanized barbed wire at top on angled extension arms on 6" spacing w/ 4 point barbs; 4" diameter gate corner posts; posts in 3' concrete minimum spaced 10' apart, 14' wide gate. Architectural Brown PVC fence slats shall be inserted on all sides of fence. The gate shall be secured by the FCDWS with a keyed lock conforming to the FCDWS standard. "No Trespassing" signs to include lift station name, address and emergency phone numbers shall be installed on all fenced sides conforming to the FCDWS standard.

E. Provide fresh water for wash down (50 foot of ¾" hose supplied with nozzle installed). Yard hydrant shall be Simmons 800 Series freeze proof with RPZ back flow preventer installed in a meter box with two (2) cutoffs with drains on each end.

F. Water meter to be installed at the right-of-way.

G. Install an exterior hinged light pole with 120 V ballast, 150 W high pressure luminaire, photoelectric control with heat and impact resistant lens. Pole is to be Architectural Brown and is to be supplied with lowering winch.

H. Site plan to show finished grade contour lines (2' intervals) in and around lift station access road.

I. Earth slopes around the pump station created by "fill" that are steeper than 3 to 1 must be stabilized with "rip-rap." All fill slopes shall be compacted to not less than 95% of maximum density. A certified letter of compaction shall be provided to the inspector prior to final inspection.

J. Site plan to show all existing and proposed utilities. All utility meters must be properly mounted outside of fenced station. *If gas is required gas pipe must be buried underground.*

K. On submersible stations the force main must have a cut-off valve positioned after the check valve. Self priming lift pump stations must come with built in cut off valves. On long force mains, situate a plug valve every 2,000 ft. to isolate sections of the force main in the event of a pipe failure. (In no case will the mounting of check valves inside the wet well be acceptable.)

L. All pump stations shall have a plug valve installed on the force main. Plug valve shall be no less than 3' outside the pump station. A valve key shall be provided to FCDWS.

M. All pump stations shall be equipped with a by-pass flange located on the force main 2' within the pump station fence and a minimum 18" tall.

N. Pump stations with 6" diameter force mains and greater shall install a Krohne Optiflux 2000 flow meter with an IFC300F Signal Converter (Remote Mounted) or an approved equal.

O. Forsyth County will investigate each proposed pump station for possible odor problems. If the detention time in the force main is calculated to be more than 24 hours or if odors are a problem during the one year warranty period, the developer will be required to install either a rented or purchased chemical feeder to combat odors and subject to County approval. The developer will be required to pay a fee to the County equal to the anticipated 5 year cost of renting and maintaining said equipment.

P. Use Detail Nos. 50.0 to 61.0 where applicable.

6.05 Wet Well/Check Valve Vault

A. Lift stations shall have a minimum 6' diameter (or equivalent rectangular area) concrete wet well with access hatch to be sized by the pump supplier to allow adequate clearance to easily remove the pumps. Access hatch to be provided with safety grate.

B. The wet well shall be sized to prevent excessive cycling of pumps. Starts shall be limited to one start per ten minutes.

C. Storage shall be provided above the high-level alarm equal to three (3) hour at design flow. Storage volume is calculated to be that volume between the high-level alarm and the lowest point of overflow (including basement elevations regardless of back-flow valves in service lines). Said storage may

consist of any combination of line capacity, manhole capacity, and wet well volume. No corrugated metal pipe may be utilized for storage.

D. Check valve vaults for all submersible stations shall be 6' X 6' pre-cast concrete with (1) 48" X 48" double leaf aluminum 300 psf hatch with safety grate for 4" and 6" piping. Vault size shall be 8' X 8' for piping 8" and above.

E. All piping in the wet well and check valve vault to be flanged with restrained mechanical coupling and rodded.

F. Wet well penetrations shall utilize "Link-Seal" devices.

G. Wet well including walls, floor and ceiling shall be lined with Tnemec Series 436 Perma-Shield H_2S Chemical resistant Mortar to a thickness of 125 mils followed by a top coat of series 435 Perma-Glaze of 15 mil or approved equal.

H. Steps are to be removed and grouted from wet well and check valve vault before station is accepted by FCDWS.

I. Gravity discharge piping into wet well shall be fitted with a tee and 4' extension so flow will not discharge directly onto pumps or suction piping.

J. On submersible pump stations the access ladder for the check valve vault shall be an OSHA approved type ladder with safety extension.

K. All submersible pump stations shall be equipped with a minimum of one (1) 4.5" diameter, 0 to 250 psi, glycerin filled pressure gauge with a diaphragm isolator and ball valve located downstream of the check valve.

6.06 Above Ground Lift Stations

A. General

1. Generally Gorman-Rupp self priming centrifugal suction lifts should be used when depth of station will allow the pumps and manifold piping to be placed at finish grade, while insuring suction and re-prime lifts. When this condition cannot be met, submersible pumps should be used.

2. Lift stations and associated components shall be manufactured and/or supplied by Gorman Rupp or other manufacturer approved as equal by the FCDWS Engineer.

3. Material requirements specific to lift stations are included in this section.

B. Pumps

1. Lift stations shall be equipped with a minimum of two (2) above ground centrifugal pumps of the same size capable of passing a 3" solid, unless FCDWS approves in writing a pump carrying 2 ½" solid. The pumps shall be belt driven, "Super T"-series type or "V" – series type.

2. Pumps shall be sized so that the system curve intersects the middle one-third portion of the pump operational curve. Each pump shall have the discharge capacity to overcome the development's discharge and have run times ranging from two (2) to five (5) minutes.

3. Each pump shall be equipped with an automatic air release valve assembly. Valves shall open automatically during pump priming or re-priming cycle and shall close automatically at pump full flow to eliminate re-circulation of liquid to the wet well.

4. Each pump shall be equipped with compound suction and discharge pressure gauges mounted on a resilient panel. Pressure gauges shall be as follows.

    a. Four (4) inches in diameter.
    b. Glycerin filled for "no shock".
    c. Graduated from -34 ft to 34 ft water column.
    d. Equipped with stainless steel shut off valves and fittings.

C. Pump Motors

1. Each pump shall be equipped with a "WEG Brand" motor utilizing three-phase power or other approved Gorman Rupp supplied motor. Single phase power supply to pump motors shall be prohibited.

2. Motors having a 50-horse power rating or larger shall be equipped with soft start.

3. Motors shall be sized so that each pump may overcome peak discharge from the development.

4. Motors shall be non-overloading over the entire power range.

5. Pump motors shall have the following features.

   a. Power control electrical enclosure: NEMA 1 stainless steel. Enclosure to house motor starters and circuit breakers, 3-inch main entrance conduit, and two (2) spare 1-inch conduits to ground and to generator.

   b. Alternator to select each pump/motor to be lead pump. Contacts transfer upon de-energizing, alternating pumps at end of pump cycle.

   c. Three position pump sequence selector switch for automatic alternation or manual selection of lead pump.

   d. Hand-Off-Auto switch to control mode of each pump selected. H-O-A switch shall be provided with required contacts to SCADA.

   e. High temperature protection circuitry to override level control system and turn off pump motors to protect against excessive temperatures. An indicator light shall be located on front of control panel. Pump shall remain locked out until pump motor is manually reset.

   f. Pump run lights to indicate which pump is in operation.

   g. Elapse time indicator on each motor to indicate total run time in hours and tenths of hours.

   h. Motor overload reset buttons to permit resetting of each motor without opening control panel door.

D. Suction and Discharge Piping

1. Piping shall be minimum 4-inch diameter, flanged, ductile iron.

2. The following shall be provided on the suction side

a. Provide a flanged customer connection on each suction line drilled to a standard 125# template.

b. Provide long radius 90º reducing elbow at each pump. Elbow shall be no smaller than 3-inch by 4-inch diameter.

c. Provide long radius 90º reducing elbow at intake of each suction line. Elbow shall be 2-inches in diameter larger than the suction line. The elbow shall be aligned to the center of the wet well.

3. The following shall be provided on the discharge side.

a. Provide a flanged customer connection on discharge side drilled to a standard 125# template.

b. Provide a check valve at each pump suitable for sewer applications. For operating pressures greater than or equal to 100 psi TDH or at force main velocities greater than or equal to 4 ft/s, cushioned check valves shall be installed. Depending on the results of a surge analysis, additional elements for surge control may be required by the Forsyth County Engineer.

c. Provide a 3-way non-lubricated, taper type, plug valve providing drip tight shutoff.

d. Provide plug valve in force main no more than three (3) feet outside of the pump station fence.

E. Enclosure

1. Construction and Design

a. A minimum of four (4) lifting eyes arranged on the corners shall be provided to ease handling and installation onto a concrete pad furnished by the contractor.

b. Enclosure walls and roof shall be seamless, one-piece sprayed fiberglass panels laminated to form a structural composite as follows: 1/8” thick fiberglass outside surface, 3/4” thick ura-foam polyurethane

core, 1/2" thick marine-grade plywood, and 3/32" thick fiberglass inside surface. Marine-grade plywood shall replace foam at all cutout openings and penetration points. RTU shall be mounted on the ½" thick marine grade plywood.

c. Each wall panel shall overlap at the corner and form an internal connection joint using stainless steel hardware. All panel joints shall be thoroughly sealed with silicone caulk. The enclosure shall have a minimum R-10 insulation factor and shall be capable of withstanding 150 mph wind loads.

d. All exterior surfaces shall be stucco textured (green, tan, or gray colored) isopthalic gel coat finish incorporating ultraviolet inhibitors.

e. All interior surfaces shall be sprayed white isopthalic gel coat finish offering the same characteristics as the exterior surfaces.

f. The roof panel shall be an arched, one-piece design incorporating the same materials of construction as the side walls. The roof shall be removable as a unit, allowing for complete access to the pumping equipment with a crane. The pitch of the roof shall be sufficient for good moisture drainage and withstand a minimum snow load of 40 pounds per square foot.

g. After the pumping equipment is installed, the fully assembled station enclosure shall be positioned on the concrete mounting pad and sealed with butyl autoglass tape as furnished by the pump station manufacturer. The interior base flange shall be drilled, positioned, and

h. fastened to the pad using expansion anchors on 24" maximum centers.

2. Enclosure Functional Equipment:
   a. The interior of the station shall be illuminated by factory-installed 120 volt, 40 watt, two (2) lamp fluorescent light fixtures providing two (2) watts illumination per square foot. The lighting circuit shall be protected by a thermal-magnetic circuit breaker.

   b. Two (2) self-contained, un-powered, thermally actuated fresh air intake vents shall progressively open or close exterior louvers as a result of

thermal expansion or contraction of a wax-like material contained in an enclosed plunger actuator.

c. Two (2) sets of un-powered thermally actuated exhaust vents shall be supplied for each engine used.

d. A critical grade spiral muffler and flexible exhaust pipe shall be supplied for each engine. The pump station enclosure shall incorporate provisions for installation of the exhaust equipment through the wall panel.

e. The pump control panel for the Auto-Start Pump Station shall be shipped completely pre-wired to the pumps, motors, and engine(s) through conduit secured to the pump base. Upon installation, the contractor shall remove any temporary shipping hardware and brackets and anchor the control panel permanently to the concrete station pad.

f. A battery back-up 12 volt DC emergency lighting system shall provide 50 watts of illumination for 1½ hours in the event of power outage. The system shall be fully self-contained for automatic operation of two (2) sealed beam lamps powered by a maintenance-free pure lead 12 volt battery. An automatic solid state battery charger with integral transfer circuit shall maintain the battery in a constant state of readiness. A charge rate pilot light and test switch shall be provided. The charging circuit shall be protected by a thermal-magnetic circuit breaker.

g. A high capacity station heater shall be provided for the protection of the pumping equipment. The heater shall maintain an inside/outside differential temperature of 60 degrees F while operating on the supplied fuel (natural gas; LPG) to the station. The heater shall be provided with an adjustable thermostat.

h. The station enclosure shall be furnished with two extra-wide doors. A double-hung door design with 3-point locking hardware, door closer and hinges on each section shall allow complete access to the 6’0” x 6’8” full door opening without the need for a center sill.

i. A wall-mounted duplex GFI utility receptacle providing 120 volt AC power shall be installed and pre-wired through PVC conduit with the station lighting. An additional duplex GFI receptacle shall be provided on the exterior wall of the enclosure. The receptacle shall be protected by thermal magnetic circuit breaker.

F. Liquid Level Control

1. Pump motors shall be controlled by an air bubbler.

2. The air bubbler shall be equipped as follows.

   a. Two (2) air pumps equipped with a manual selector switch.

   b. One (1) in-line airflow indicator and one (1) 3-inch PVC air bell for wet well mounting.

   c. One (1) spare air pump shall be provided. Bubbler system piping shall be ½-inch diameter schedule 80 PVC with cleanout.

3. The air bubbler controller shall be “Electronic Pressure Switch 2000” and shall include integral components to sense pressure conditions. The controller shall be equipped as follows.

   a. Level control electrical enclosure: NEMA 1 stainless steel.

   b. EMI and RFI suppression.

   c. DC-current power supply and 108 – 132/60/1 AC-current.

   d. Function in temperature range of 0^{o} F through 131^{o} F.

   e. Control range from zero (0) to twelve (12) feet with a repeat capacity of +/- 0.1 feet.

   f. High water alarm visible indicator on control panel. Maintain alarm signal until manual reset.

   g. High water alarm audio indicator. Maintain alarm signal until manual reset of silence circuit.

4. A backup high level alarm float switch shall be connected directly to the auto-dialer and RTU.

G. Standby Engine

1. Type
   a. Standby engine shall be a four (4) cylinder or six (6) cylinder Zenith or Nissan, (LPG/natural gas) fueled water cooled type, and shall have continuous duty power rating suitable for the horsepower requirements of the pump, after derating to factors set forth under performance. Engine shall be cooled by an integral water cooling system capable of maintaining safe engine operating temperature under expected operating loads, and subject to the expected maximum ambient temperatures in the pump station enclosure.

2. Equipment

   a. The engine shall be equipped with all controls and components required for manual and automatic operation when used with the engine controls and DC level control system described in these specifications. Such components shall include, but not be limited to, the following:

      1. 12 Volt dc electrical system including starter and alternator
      2. Storage battery, 84 ampere-hour capacity minimum
      3. Elapsed running time meter
      4. Sensors for engine temperature, oil pressure, and overspeed
      5. Muffler designed to limit engine noise to a level acceptable in a residential area
      6. Switch for manual operation of the cranking motor, mounted on or near the engine
      7. Alternator Ammeter

   b. Engine electrical equipment shall be wired to a terminal board on the engine and pre-wired to the base secured control panel.

c. Because the engine shall be required to operate during emergency situations, the following minimum performance standards shall be used for engine selection:

1. Engine speed shall be controlled by an electronic, governor-controlled throttle which shall maintain the preset speed over the range of expected pumping loads. This speed shall not be less than 1800 rpm to insure adequate cooling, nor more than 3000 rpm so that internal engine wear is held to a minimum. This governed speed shall not be acceptable if it is greater than that speed at which the engine torque and horsepower curves intersect. Engine manufacturer's published performance curves shall be submitted for review to support engine selection.

2. The engine shall develop approximately 95 percent of manufacturer's published performance after a reasonable run-in period

3. For selection of engine size, engine performance shall be derated according to manufacturer's specifications to allow for decreased performance if installed at elevations more than 1000 feet above sea level.

4. For selection of engine size, engine performance shall be derated according to manufacturer's specifications to allow for decreased performance in an ambient temperature of 100-degrees f, which can reasonably be expected in the pump station

5. Engine rating shall be further reduced to conform to engine manufacturer's recommendations for continuous service applications

d. Brake horsepower requirements of pump shall not exceed calculated engine horsepower after derating for power available after run-in, temperature compensation, and altitude compensation.

H. Spare Parts

1. One (1) cover plate O-ring
2. One (1) rotating assembly O-ring
3. One (1) mechanical seal.
4. One (1) set of rotating assembly shims.
5. One (1) air compressor or air pump for bubbler system

I. Use Details Nos., 56.0 and 57.0 where applicable.

6.07 Submersible Lift Stations

A. General

Where TDH or other factor makes an above-ground suction lift pump impractical, then a submersible pump station should be used. Pumps shall be Flygt submersible.

B. Submersible pumps shall be explosion proof and equipped with thermal switches, float leakage sensor, and a lower bearing temperature monitor that shall be connected to a CAS (Control and Status) monitoring unit. The CAS shall be designed to be mounted in the control panel.

C. Pump Design

1. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two parallel stainless steel guide bars extending from the top of the station to the wet well mounted discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump/motor unit shall bear on the sump floor directly or on a sump floor mounted stand.

A. Power and pilot cable supports shall be provided and consist of a wire braid sleeve with attachment loops or tails to connection to the under side of the access frame.

D. Pump Construction

1. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, 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.

2. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing 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 bolt torque limit. Rectangular cross sectioned rubber, paper or synthetic gaskets that require 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.

E. Cooling System

1. Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the pumpage, through the cooling system. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped

with two flanged, gasketed and bolted inspection ports of not less than 4"Ø located 180° apart. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104°F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.

F. Cable Entry Seal

1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

G. Motor

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180˚C (356˚F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) with an 80°C temperature rise and capable of at least 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 end 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 shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

2. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 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 at least 65 feet.

3. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

H. Bearings

1. The pump shaft shall rotate on at least three grease-lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.

2. The minimum L_{10} bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed. The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

I. Mechanical Seal

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be

independent of the impeller hub. The seals shall operate in an lubricant reservoir that hydro dynamically 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 corrosion resistant **tungsten-carbide** seal ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant **tungsten-carbide** seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance or adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. For special applications, other seal face materials shall be available.

2. Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.

3. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified**:** 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. No system requiring a pressure differential to offset pressure and to affect sealing shall be used.

4. 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 continuously while non-submerged without damage while pumping under load.

5. Seal lubricant shall be FDA Approved, nontoxic.

J. Pump Shaft

1. Pump and motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel ASTM A 572 Grade 50 and shall be completely isolated from the pumped liquid.

K. Impeller

1. The impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, multiple vaned, double shrouded non-clogging design having long throughlets without acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. 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 an acrylic dispersion zinc phosphate primer.

L. Wear Rings

1. 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 Nitrile rubber coated steel or brass ring insert that is drive fitted to the volute inlet.

2. This pump shall also have a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.

M. Volute

1. Pump volute(s) shall be single-piece 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.

N. Protection

1. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. Should high temperature occur, the thermal switches shall open, stop the motor and activate an alarm.

2. A lower bearing temperature sensor shall be provided. The sensor shall directly contact the outer race of the thrust bearing providing for accurate temperature monitoring. A leakage sensor shall be provided to detect water in the stator chamber. The Float Leakage Sensor (FLS), a small float switch, shall be used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and activate an alarm.

3. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS SHALL NOT BE ALLOWED

4. The thermal switches, FLS and the lower bearing temperature monitor shall be connected to a CAS (Control and Status) monitoring unit. The CAS shall be designed to be mounted in the control panel.

6.08 Control Panel (Submersible Pump Stations)

A. General

1. The control panel shall be supplied by the submersible pump supplier.

2. The control system shall be designed to operate the required number of pumps specified on the drawings at the power characteristics shown on the plans.

B. Enclosure

1. The enclosure shall be a 14 gauge, NEMA 4X rated enclosure (derated to NEMA-3R if holes are cut in the cabinet for the purpose of mounting alarm horns, lights, vent fans, etc.) manufactured from 304 stainless steel. The enclosure shall be a wall mounted or as required on drawings with a minimum depth of 12”, sized to adequately house all the components. The door gasket shall be formed in place, seamless to assure a positive weatherproof seal. The door shall open a minimum of 180 degrees.

C. Inner Dead Door

1. A polished, aluminum dead front shall be mounted on a continuous aircraft type hinge. It shall contain cutouts for mounted equipment, and provide protection of personnel from live, internal wiring. Cutouts for breaker handles shall be provided to allow operation of breakers without entering the compartment. All control switches, indicator pilot lights, elapsed time meters, duplex receptacle, and other operational devices shall be mounted on the external surface of the dead front. The dead front shall open a minimum of 150 degrees to allow access to equipment for maintenance. A 3/4" break shall be formed around the perimeter of the dead front to provide rigidity.

D. Back Plate

1. The back plate shall be manufactured of 12-gauge steel and be finished with a primer coat and two (2) coats of baked on, white enamel. All hardware mounted to the sub panel shall be attached with machine thread, tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified.

E. Power Distribution

1. The panel power distribution shall include necessary components and be completely wired with stranded tinned copper conductors rated at 90 degrees C, type DLO. All conductor terminations shall be as recommended by the device manufacturer.

F. Circuit Breakers

1. All circuit breakers shall be heavy-duty thermal magnetic or motor circuit protectors similar and equal to Square D Type FAL. Each motor breaker shall be adequately sized to meet the pump motor operating characteristics and shall have a minimum of 14,000 amps interrupting capacity at 480 VAC. Heavy-duty breakers shall control the control circuit.

2. Circuit breakers shall be indicating type, providing "on-off-trip" positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position indicating "trip."

3. Thermal magnetic breakers shall be quick-make and quick-break on manual and automatic operation and have inverse time characteristics secured through the use of bimetallic tripping elements supplemented by a magnetic trip.

4. Breakers shall be designed so that an overload on one pole automatically trips and opens all legs. Field installed handle ties shall not be acceptable.

5. Each control panel shall be furnished with 4 – 20A, 120V, 1P spare breakers for the GE Panamterics flow monitoring device and the exterior light. If an on-site generator is furnished, then additional breakers will be required in the mini-power zone for the heater and battery chargers.

G. Motor Starters

1. Motor starters shall be NEMA FVNR type for motor with full load currents of 40amps or less. Motor starters above 40 amps shall be solid state - soft start motor starters to provide smooth, stepless acceleration through the use of silicon controlled rectifiers. By gradually applying voltage to the motor a soft start condition will accelerate the motors to full speed. The adjustable current-limit feature the starters shall limit currents to 25% - 70% and starting torque to 6% - 49% respectively of full voltage values. Adjustable ramp shall be for 1 - 30 seconds. A ramp down signal may be required and must be available on the starters. Motor protection shall be provided by calculation of temperature rise of the motor and starter and shut the motor down in case of an out of tolerance condition.

3. The reduced voltage solid state starter shall include the following features:

    a. Built-in overload protection
    b. Adjustable kick start control
    c. Programmable overload settings: 31-100% of rated current for the unit
    d. Built-in run bypass contact
    e. Multiple trip class settings (5, 10, 20 and 30)
    f. Overload Options including Jam, Phase Loss, and Phase Reversal

3. The RVSS shall be furnished with 2 sets of normally open auxiliary contacts for run, stop, and fault.

H. Level Controller System

1. The pump control device shall be provided as a liquid level control device. The device must be capable of controlling any mix of constant speed and variable speed pumps. It shall be capable of alternating the pumps, and shall provide lag pump delays and high and low level alarms.

2. The device must be field configurable from the front of the unit, and require no special tools or software to set-up or operate. It shall be a microprocessor-based device and not require a battery to maintain the operating program. All set-up values shall be stored in non-volatile memory.

3. A numerical level display must be provided on the front of the unit. It shall have a 3 digit, 7 segment LED display and show levels in feet and tenths of feet.

4. An isolated analog input (4-20mA) with zero and span adjustments must be provided for the wet-well level input.

5. All electrical connections, for power or I/O, must be by quick-disconnect, phoenix-style connectors.

6. An RS232 serial port with the Modbus protocol shall be provided for SCADA. Modbus RTU or ASCII modes must be menu selectable. RTS and CTS hardware connections along with all necessary programming must be in place to fully interface with commonly used radio or telephone modems. Programming must be in place to collect and transmit the station status, and to allow for the remote control of the pumps. The pump On/Off levels, high level alarm, and low-level alarm setup values must be viewable and changeable from a remote location. Pump elapsed time meters must be viewable and re-settable from a remote location. Pump elapsed time meter values must be stored in non-volatile memory during a power outage.

7. The Controller must have provisions for float back-up control built into the unit.

8. The Controller must contain an internal power supply to power the level input transducer.

9. The pump controller shall be an SC2000 by Stacon or approved equal.

I. H-O-A (Hand/Off/Automatic) Switches

1. A three-position H-O-A switch shall be provided for each motor. The switch shall be NEMA 4X rated with 10 amp contacts. A position indicating legend plate shall be provided. The H-O-A switches shall be mounted on the dead front door. H-O-A switch shall be provided with required contacts to SCADA.

2. The H-O-A in the hand position will allow the pump to run and bypass all safety shutdowns except for the overloads. In the automatic position the pump controller will control the pumps while monitoring all shutdowns and stop the pump.

J. Float Switches

1. Back up float switches shall be provided for High level and low -level conditions in the wet-well. Float switches shall be non-mercury type. Provide intrinsic safe barrier for float switches. High and low level floats shall be connected to the SCADA system and the auto-dialer and shall provide an alarm. The high level float switch should call for a pump to run and the low level float (4" below pump off) should stop the pumps if running.

K. Run Indicators

A green run pilot indicator shall be mounted on the dead front door.

L. Elapsed Time Meter and Amp Meter

1. An elapsed time meter shall be mounted on the dead front door. The meter shall operate on 120 VAC, shall indicate in hours (6 digits) and tenths and shall not be re-settable. There shall be an amp meter for each pump.

M. Moisture and Thermal Measurement

1. A plug-in, solid state control and status relay with indicating LED's shall be provided to measure motor thermal overload and moisture in the pump housing. Any moisture or thermal condition shall signal failure and stop the pump. An illuminated light on the pump controller shall also indicate the failure mode.

N. Heater

1. An internal 100-watt heater shall be provided to maintain temperature above the dew point. The unit shall be thermostatically controlled.

O. Trouble Light

1. An internal trouble light shall be installed to illuminate the internal portion of the enclosure.

P. Alarm System

1. The alarm light shall be a weatherproof, shatterproof, red light fixture with a 40-watt bulb to indicate alarm conditions. The alarm light shall be turned on by the alarm relay.

Q. Lightning-Transient Protection

1. Each complete suppression unit shall be UL listed as a secondary surge arrestor and bear CSA certification and meet ANSI/IEEE C62-11-1987; suitable for indoor and outdoor applications; suitable for use in service entrance location; meet requirements of NEC Article 280; rated at 650V phase-to-ground maximum.

R. Additional Requirements

1. For stations with a permanently mounted generator there will be an automatic transfer switch exterior to the control panel. Inside the control panel there will be a main breaker. No emergency breaker will be required.

2. Automatic transfer switch, if required, will be furnished by generator supplier.

S. Transformers

1. Control transformers shall be provided to produce the 120 VAC and/or 24 VAC for control circuits. Transformers shall be fused on the primary and secondary circuits. The secondary circuits shall be grounded.

T. Mini-Power Zone

1. When a permanently installed emergency, standby generator is used, a mini-power zone is to be supplied by the control panel manufacturer. This will include a 7.5 KVA transformer plus bolt-on breakers for the generator's crank case heater and trickle battery charger and for an external light.

U. Phase Monitor

1. A line voltage rated, adjustable phase monitor shall be installed to sense low voltage, loss of power, reverse phase, and loss of phase. Control circuit shall de-energize upon sensing any of the faults and shall automatically restore service upon return to normal power. The phase loss sensor shall include output contacts for use as follows: 1.) interlock to disable pump motors upon loss of phase; 2.) Station alarm upon loss of phase; 3.) Remote alarm via telemetry alarm system upon loss of phase.

V. Drawings

1. A final, record electrical/control drawing encapsulated in mylar shall be attached to the inside of the front door. A list of all legends shall be included.

2. The Engineer shall provide half size laminated record drawings of all site/civil piping plans that shall be attached to the inside of the front door. A list of all legends shall be included.

W. Panel Markings

1. All component parts in the control panel shall be permanently marked and identified as they are indicated on the drawing. Marking shall be on the back plate adjacent to the component. All control conductors shall be identified with wire markers at each end, as close as practical to the end of the conductor.

X. Testing

1. All panels shall be tested to the power requirements as shown on the plans to assure proper operation of all components. Each control function shall be activated to check for proper indication.

Y. Spare Parts

1. Extra fuses (10%) for each type.
2. One (1) Pump Controller
3. One (1) Pressure Transducer
4. Two (2) Float Switches
5. One (1) Phase Monitor
6. One (1) Moisture and Thermal Sensor
7. One (1) Motor Starter

Z. Use Details Nos. 51.0, 52.0, 53.0 and 54.0 where applicable.

6.09 Maintenance and Equipment Enclosure: (Submersible Pump Station)

A. An equipment and maintenance enclosure shall be provided and shall be built within 10-15 ft of the wet well. Guidelines for the design of the building include the following:

1. The enclosure should be architecturally compatible with nearby structures. In most cases, concrete block enclosures are acceptable.
2. An over sized double-door should be provided at a convenient location for the removal and replacement of equipment. The doors must be heavy duty steel with appropriate hardware and lock.
3. The enclosure shall house the auxiliary power transfer switch, surge suppressor, SCADA RTU unit, and main power disconnect. The pump control panel shall be hung on the exterior of the building, on the closest side facing the wet well. There shall be sufficient space for maintenance operations inside. An 8-foot by 10-foot enclosure is typically adequate for small pumping stations.
4. Adequate lighting shall be provided in work areas for night operations, both inside the building and on the exterior.
5. The building shall have adequate ventilation to prevent buildup of corrosive and potentially dangerous gases. This includes a ventilation fan system.
6. A thermostatically-controlled heater shall be provided in the building.
7. The enclosure must be at a minimum constructed of concrete block and painted inside and out with two coats of paint. The roof shall be covered with asphaltic mold retardant shingles. The ceiling must be insulated and covered with plywood and painted. The enclosure must be supplied with adequately sized gutters and down-spouts.

6.10 Generator (Submersible Pump Stations)

A. General

1. The standby generator shall be rated for continuous standby service for the stations full load demand (i.e. single pump-duplex station, two pumps – triplex station, etc.) This shall include running all pumps with staggered startups. Generators rated 100 kw and below are to be installed to operate on natural gas. If gas is unavailable, a letter of exception must be obtained by FCDWS. Generators above 100 KW shall be diesel.

2. Acceptable generator manufactures:
   a. Cummins
   b. Caterpillar
   c. Kohler

3. The entire generator set shall be warranted for a period of five years from the date of commissioning. Generator manufacturer shall furnish service and maintenance of packaged engine generator system for one year from Date of Substantial Completion.

B. Extra Materials

1. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal toolbox.

2. Provide two additional sets of each fuel, oil, and air filter element required for the engine generator system.

C. Dry Contacts

1. Dry contacts shall be provided for all signals required to be monitored by the SCADA RTU.

D. Weather-Protective Housing

1. Weather-protective Housing: Reinforced steel housing allowing access to control panel and service points, with lockable doors and panels. Include fixed louvers, skid mounted fuel tank, battery rack, and silencer.

E. Day Tank

1. Where natural gas is unavailable a 24-hour double-walled sub-base day tank unit with dual integral pumps and level control shall be provided. No underground storage will be allowed. Include flexible fuel line connections, fuel gauge, check valve, leak detection alarm contact for remote use and indicating light.

F. Circuit Breaker

1. Provide a generator mounted circuit breaker, molded case or insulated case construction, Sized to the Amp rating as indicated on the drawing, 3 pole. Breaker shall be Square D or equal and utilize a thermal magnetic trip. steel NEMA 1 enclosure mounted on a separate support stand vibration isolated from the engine/generator arrangement. Bus bars, sized for the cable type shown on drawing, shall be supplied on the load side of breaker.

G. Controls

1. Generator Mounted Control Panel. Provide a generator set mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation, cycle cranking, AC metering with phase selector switch, shutdown sensors and alarms with horn and reset, adjustable cool down timer and emergency stop push-button. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Generator shall include 2 sets of normally open auxiliary contacts for run and common fault. Components shall be housed in a NEMA 1/IP22 enclosure with hinged door. The panel itself shall be mounted on a separate support stand isolated from the engine / generator arrangement. Panel / breaker arrangements mounted on the generator set in such a way that access to the AC Generator terminal box is restricted in any way whatsoever are not acceptable.

2. Provide the following readouts:
    a. Engine oil pressure
    b. Coolant temperature
    c. Engine RPM
    d. System DC Volts

e. Engine running hours
f. Generator AC volts
g. Generator AC amps
h. Generator frequency
i. Control Panel Annunciation - Provide the following indications for protection and diagnostics:
j. Low oil pressure
k. High water temperature
l. Low coolant level
m. Overspeed
n. Overcrank
o. Emergency stop depressed
p. Approaching high coolant temperature
q. Approaching low oil pressure
r. Low coolant temperature
s. Low voltage in battery
t. Control switch not in auto. position
u. Low gas pressure
v. Battery charger ac failure
w. High battery voltage
x. Two (2) Spare
y. Remote Annunciator

H. Remote Annunciator Panel

1. The Annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn. Provide alarm indication for "generator ground fault" on solidly grounded we systems of more than 150 volts to ground and circuit breakers rated 1000 amp or more, to meet NEC.

I. Field Quality Control

1. Provide full load test utilizing portable test bank, if required, for two hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.

2. During test, record the following at 20 minute intervals:
   a. Kilowatts.
   b. Amperes.
   c. Voltage.

d. Coolant temperature.
e. Room temperature.
f. Frequency.
g. Oil pressure.

3. Test alarm and shutdown circuits by simulating conditions.

4. Provide copy of test results to Engineer.

5. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

J. Start-Up and Testing

1. Coordinate all start-up and testing activities with the Engineer and Owner. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following: Verify that the equipment is installed properly. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote Annunciator, etc. Test all alarms and safety shutdown devices for proper operation and annunciation.

2. Check all fluid levels. Start engine and check for exhaust, oil, vibrations, etc. Verify proper voltage and phase rotation at the transfer switch before connecting to the load. Connect the generator to building load and verify that the generator will start and run all designated loads in the plant. Perform a 4 hour load bank test at full nameplate load using a load bank and cables supplied by the local generator dealer. Observe and record the following data at 15 minute intervals: Service meter hours, Volts AC - All phases, Amps AC - All phases, Frequency, Power factor or Vars, Jacket water temperature, Oil Pressure, Ambient temperature, Operation and Maintenance Manuals, Provide three (3) sets of operation and maintenance manuals covering the generator, switchgear, and auxiliary components. Include parts manuals, final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

K. Training

1. Provide one day of on-site training to instruct the owner's personnel in the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals, and emergency service procedures. Training shall be conducted by a certified manufacturer's representative.

L. Use Detail No. 55.0 where applicable.

6.11 Telemetry System

A. General

1. Remote terminal units (RTUs) shall be provided for each pump station in the system and shall be installed as shown on the plan drawings or as otherwise directed by the Engineer. The RTU and associated SCADA equipment may be purchased from the J.K. Duren Company, Inc. Roswell, GA 770-992-5405 or approved vendor.

B. Hardware

1. The master and the RTUs should be the same hardware with I/O selected per device. The unit shall be field expandable for the addition of alarm, status, control and analog inputs and/or outputs. All firmware shall be non-volatile with automatic restart after power failure. An on board watchdog timer shall be included.

2. Basic input/output capabilities of the unit shall include ten (10) digital inputs, ten (10) digital outputs, four (4) analog input and two (2) analog outputs. Digital input shall be optically isolated and meet IEEE 2.5KV surge suppression. Digital outputs shall be Relay Form A250 VAC, 6 Amp load! 125 VAC; 20 VDC, 5 Amp load @ 30 VDC. Interface of digital output to field devices shall be through isolated relay contacts. Contacts shall be rated for 3 amperes at 240 VAC.

3. The RTU shall consist of the following:
    a. NEMA 4X Fiberglass Enclosure
    b. Control Power Circuit Breaker
    c. Controller with 3 communication ports
    d. DATARADIO

e. 75 Watt Heater with Thermostat
f. Duplex 120 VAC receptacle
g. Power Supply with battery backup
h. Control relays with LED indicators
i. Input Power Protection unit EDCO Model HSP 121BT-1RU
j. Radio Protection unit POLYPHASER model IS-50UX-C1
k. Keypad display
    1. Level in wet well
    2. Communication status
    3. Pump status [run, required, stop]
    4. Time in second since last communication
    5. High-level alarm
    6. Pump hours [32 bit register]
    7. Intrusion alarm status
    8. Power failure

C. Diagnostics

1. Unit shall also include internally mounted LEDs for indication of power on, CPU run, carrier detect, receive data, request-to-send and transmit data.

D. Power Requirements

1. The RTU shall be powered by a 12-volt power supply. A sealed 7 Amp/Hr gell cell 12-volt battery and charger shall be supplied to power the entire RTU during emergency power outage conditions.

E. Communication Capabilities

1. The SCADA System shall be capable of supporting the following communication types: Ethernet, dedicated telephone, dial-up, fiber optics, VHF, UHF, 20 MHz trucking and RS 232/RS485. Different communications types shall be capable of concurrent operation. Modification of communications type shall require only a modem change and minor communications database configuration changes.

F. Radio System

1. The telemetry signals shall be transmitted/received over a radio system operating in a half-duplex mode on a single VHF FM radio frequency. The

radio equipment shall be manufactured by DataRadio and shall be Intergra-TR with built in diagnostics, or approved equal.

2. The radio telemetry system supplier shall provide the antenna for each site as required to achieve the overall communications requirements of the system. Antennas shall be directional or omni-directional as required and suitable for outdoor environments. They shall be of all aluminum construction and rated to withstand as least 100 MPH winds with ½ inch radial ice.

3. Adequate lengths of RG213A/U coaxial cable shall be provided for connection of the antenna to the radio transceiver at each site. Splicing of cable shall not be allowed. The transmission line shall be terminated only in connectors rated for the required service. A lightning arrestor shall be placed between the transceiver and coaxial cable.

4. Unless specifically stated, the antennas shall be attached to existing structures, such as tanks or buildings. Particular attention shall be given to the correct installation of the antennas to give adequate protection from nearby lightning strikes by providing a low resistance DC path to ground. Instructions for installing these antennas shall be given to the contractor so as to insure reliable operation.

5. Contractor shall furnish all mounting masts or poles as required to support the antennas at the elevations and orientations required. Masts and poles shall be suitable for outdoor environmental conditions, provide adequate support and protection for transmission lines and be provided complete with all necessary mounting accessories.

6. Minimum acceptable technical and physical specifications of the directional antenna shall be as follows:

   Type----------3 element Yagi, with a forward gain of at least 7 dB
   Front to back ratio------20 dB
   Lightning Protection---Direct ground
   Feed point method-----Weatherproof gamma match for coaxial feed line

G. RTU Outputs to SCADA

1. Continuous Well Level (4-20 mA Analog signal)
2. High level alarm (Backup float switch)

3. H-O-A Switch Status
4. Automatic Transfer Switch Status
5. Generator Status (run / fail)
6. Diesel low fuel (not required for natural gas generator)
7. Diesel leaking fuel (not required for natural gas generator)
8. Power Fail
9. Pump Run
10. Outputs from CAS - Bearing / Stator Temp and Moisture sensors / Phase Monitor (Submersible only)
11. Pump Fail (Submersible only)
12. Phase Fail – High Temp (Above-ground lift station only)
13. Backup Engine Failure (Above-ground lift station only)
14. Analog - Flow rate (When required)

H. Interface Display

1. The RTU interface at the pump station shall display the following:
    a. Communication Status
        1. Normal
        2. Failure
        3. Time since Last Communication
    b. Status of Pumps
        1. Off
        2. Required
        3. Run
        4. Failed to Start
    c. Power Status
    d. Battery Backup Voltage
    e. Phase Monitor

I. Auto Dialer

1. An auto-dialer shall be included and mounted inside the pump control panel enclosure. The alarm unit shall be a RACO Verbatim with the following options: analog signal input option, 6 Hour Batter Back-up, 8 channel monitoring, expanded vocabulary, and the capability of “recording” custom messages into an internal speech synthesis integrated circuit chip.

2. The following channels shall be monitored:
    a. Channel #1 – High Level Alarm
    b. Channel #2 – Low Level Alarm (Submersible only)
    c. Channel #3 – Phase Fail
    d. Channel #4 – Pump 1 Fail
    e. Channel #5 – Pump 2 Fail
    f. Channel #6 – Generator/Engine Fail
    g. Channel #7 – ATS Emergency Position
    h. Channel #8 - Spare

3. Also, a type RJ11 telephone jack shall be included inside the pump control panel to permit the use of a portable telephone. This jack shall be connected to the telephone line in parallel with the telemetry alarm system.

J. Bell South Connection

1. A Bell South account shall be established and billed in the name of the developer/contractor. The initial charges for installation shall be billed to the developer. The account shall be transferred over to Forsyth County at the end of the 1-year maintenance period.

7.01 General

A. Low pressure sewer may be installed in areas shown for low pressure sewer in the sewer master plan, in projects where existing septic developments are converted to public sewer, or in other areas if approved in writing by the director of FCDWS. The developer shall furnish and install complete factory-built and tested Grinder Pump Station(s), each consisting of grinder pump(s) suitably mounted in a basin constructed of high density polyethylene (HDPE) for simplex stations and HDPE or Fiberglass Reinforced Polyester Resin for duplex stations, NEMA 6P electrical quick disconnect (EQD), pump removal system, shut-off valve, anti-siphon valve, check valve, each assembled in the basin, electrical alarm panel, and all necessary internal wiring and controls. Component type grinder pump systems that require field assembly will not be acceptable, due to the potential problems that can occur during field assembly. For ease of serviceability, all pump and motor/grinder units shall be of like type and horsepower throughout the system.

B. At the completion of the warranty period, the County shall own, maintain and operate all system piping and valves within the right-of-way. The grinder pump station including all controls, valves and piping outside of the right of way shall be owned, maintained and operated by the Homeowner/Developer.

C. Low Pressure Sewer Design Submittal to Include:

1. Pump submittal with shop drawings and specifications
2. Manufacturer approved system hydraulic analysis (including by not limited to pipe sizes, flows, velocities, retention times, etc…)
3. Number and location of proposed valves and cleanouts,
4. Capacity calculations of receiving gravity system
5. Stamped by a professional engineer registered in the State of Georgia
6. Site development plan and profile, and construction details.
7. Plan of development topography demonstrating the inability to install a gravity sewer collection system.

D. Acceptable Low Pressure Sewer Manufacturers:

1. Barnes Pressure Systems
2. Environment One Corporation
3. Approved equal

Manufacturers shall have at least ten (15) years of experience in the design and manufacture of low pressure sewer systems as well not less than one hundred (100) successful installations utilizing grinder pumps of like type. An installation is defined as a minimum of twenty-five (25) pumps discharging into a common force main which forms a low pressure sewer system. In lieu of this experience clause, the supplier of alternate equipment will be required to submit a five (5) year performance bond for one-hundred (100) percent of the stipulated cost of the equipment as bid and as shown in the Bid Schedule. This performance bond will be used to guarantee the replacement of the equipment in the event that it fails within the bond period.

7.02 Product Requirements

1. The pumps shall be capable of delivering 15-28 GPM against a rated total dynamic head of 0 feet (0 PSIG), 9-25 GPM against a rated total dynamic head of 138 feet (60 PSIG) and a minimum head capability of 162 feet (70 PSIG). The pump(s) must also be capable of operating at negative total dynamic head without overloading the motor(s). Under no conditions shall in-line piping or valving be allowed to create a false apparent head.

2. The grinder pump manufacturer shall provide a part(s) and labor warranty on the complete station and accessories, including, but not limited to, panel and redundant check valve, for a period of twenty-four (24) months after notice of final acceptance, but no greater than twenty-seven (27) months after receipt of shipment. Any manufacturing defects found during the warranty period will be reported to the manufacturer by the Owner and will be corrected by the manufacturer at no cost to the Owner.

3. The tank shall be furnished with one EPDM grommet fitting to accept a 4.50" OD DWV or Schedule 40 pipe. Tank capacities shall be as shown on the contract drawings.

4. All discharge piping shall be constructed of 304 Series Stainless Steel or cast bronze and terminate outside the access way bulkhead with a stainless steel, 1 1/4 inch female NPT fitting. The discharge piping shall include a stainless steel or bronze ball valve rated for 200 psi WOG; PVC ball valves will not be accepted. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.

5. The access way shall include a single NEMA 6P electrical quick disconnect (EQD) for all power and control functions, factory installed with access way penetrations warranted by the manufacturer to be watertight. Plug-type connections of the power cable onto the pump housing will not be acceptable as a station disconnect due to the potential for leaks and electrical shorts. The access way shall also include a 2-inch PVC vent to prevent sewage gases from accumulating in the tank.

6. The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the stainless steel discharge piping or cast iron housing. The check valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Moving parts will be made of a 300 series stainless steel and flap rated for corrosion resistance, dimensional stability, and fatigue strength.

7. Each grinder pump installation shall also include one separate check valve for installation in the 1 1/4" service lateral between the grinder pump station and the sewer main, preferably next to the curb stop.

8. The pump discharge shall be equipped with a factory-installed, gravity-operated, flapper-type integral anti-siphon valve built into the discharge piping prior to the check valve.

9. All materials exposed to wastewater shall have inherent corrosion protection.

10. The grinder pump station shall be from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled, factory wired and tested grinder pump station shall be U.L. listed. Grinder pump stations without U.L. listing will not be acceptable.

11. All electrical cables penetrating or passing through the silhouette of the pump station must be guaranteed to be water-tight by the manufacturer and must be installed at the factory prior to shipment.

12. The discharge piping shall include a stainless steel or bronze ball valve with a minimum rated pressure of 150 psi. All valves shall be operable from ground level

13. All necessary controls, including motor and level controls, may be located in the top housing of the core unit. The top housing will be attached with stainless steel fasteners.

14. Level detection for controlling pump and alarm operation shall be accomplished by use of a detection device specifically designed for use in a sewage grinder station. Level detection device shall not require any regular preventative maintenance. The level detection device shall consist of two independent switches, one for each function (**High Water Alarm** and **On/Off** actuation). In addition, the device shall include a solid-state relay for directly controlling the pump motor.

15. Each grinder pump station shall include a NEMA 4X, UL listed ALARM PANEL suitable for wall mounting. The NEMA 4X enclosure shall be manufactured of thermoplastic or fiberglass to assure corrosion resistance. The enclosure shall include a hinged, lockable cover, padlock, and secured dead front.

16. The Alarm Panel shall include the following features: audio & visual alarm, push-to-run switch, and high level (redundant) pump starting control. The alarm sequence is to be as follows:

    a. When liquid level in the sewage wet-well rises above the alarm level, visual and audio alarms will be activated. The contacts on the alarm pressure switch will close. The redundant pump starting system will be energized.

    b. The audio alarm may be silenced by means of the externally mounted, push-to-silence button.

    c. Visual alarm remains illuminated until the sewage level in the wet-well drops below the "off" setting of the alarm pressure switch.

17. During a high level alarm condition on a duplex station, the appropriate light will illuminate to indicate which pump core requires servicing. The audio alarm shall be a printed circuit board in conjunction with an 86-90 dB buzzer with quick mounting terminal strip mounted in the interior of the enclosure. The audio alarm shall be capable of being deactivated by depressing a

push-type switch which is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure.

18. The grinder pump / core unit shall have two lifting hooks complete with nylon lift-out harness connected to its top housing to facilitate easy core removal when necessary. All mechanical and electrical connections must provide easy disconnect capability for core unit removal and installation. A push-to-run feature will be provided for field trouble shooting. All motor control components shall be mounted for ease of field service.

19. Pipe shall be high performance, high molecular weight, high density polyethylene pipe. The pipe material shall be a Type III, Class C, Category 5, P34 material as described in ASTM D 1248. Minimum cell classification values of the pipe material shall be 3 4 5 4 3 4 C as referenced in ASTM D 3350 - 84. The density shall be 0.941 - 0.957 gms/cm3 when tested in accordance with ASTM D 1505. Hydrostatic Design Basis shall be 1,600 psi at 23øC when tested in accordance with ASTM D 2837.

20. All grinder pump units will be delivered to the job site 100 percent completely assembled, including testing, ready for installation.

21. The manufacturer shall supply one (1) spare grinder core/pump for every 50 grinder pump stations installed, complete with all operational controls, level sensors, check valve, anti-siphon valve, pump/motor unit, and grinder.

7.03 Installation

1. Installation shall be accomplished so that 1" to 4" of access way, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the excavated hole must be large enough to allow for the concrete anchor.

2. A 6" inch (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit.

3. A concrete anti-flotation collar sized according to the manufacturer's instructions shall be required and shall be pre-cast to the grinder pump or poured in place. Each Grinder Pump Station with its pre-cast anti-flotation

collar shall have a minimum of three (3) lifting eyes for loading and unloading purposes.

4. A four (4) foot piece of four inch SCH 40 PVC pipe with water tight cap shall be provided to stub-out the inlet for the property owners' installation contractor, or as depicted on the contract drawings.

5. The contractor shall mount the alarm device in a conspicuous location, as per national and local codes.

6. Backfill of clean native earth, free of rocks, roots, and foreign objects shall be thoroughly compacted in lifts not exceeding 12" to a final Standard Proctor Density of not less than 85 percent. Improper backfilling may result in damaged access ways. The Grinder Pump Station shall be installed at a minimum depth from grade to the top of the 1 1/4" discharge line, to assure maximum frost protection. The finish grade line shall be 1" to 4" below the bottom of the lid, and final grade shall slope away from the Grinder Pump Station.

7.04 Start-Up and Field Testing

1. Upon completion of the start-up and testing, the manufacturer shall submit to the County the start-up authorization form describing the results of the tests performed for each grinder pump station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed and any installation deficiencies corrected.

2. The manufacturer/contractor shall supply four (4) copies of Operation and Maintenance Manuals to the County.

1.01 Pipe Classification

A. Ductile iron pipe shall conform to AWWA C 151 (ANSI A21.51) and shall be a minimum of pressure Class 350 or thickness Class 50 unless otherwise specified or shown on the plans. All pipes shall be furnished in nominal lengths of 18 to 20 feet. Pipe and fittings shall be cement lined in accordance with AWWA C104. Fittings shall be mechanical joint compact ductile iron and conform to AWWA C153 with rated working pressure of 350 psi or AWWA C 110 with rated working pressure of 250 psi. Final pipe class shall be determined based on specific structural calculations as they relate to conditions encountered during design. Pipe and fittings shall be furnished with a bituminous outside coating and an interior seal coat. Where pipe has been manufactured with a high speed cement lining, an interior seal coat shall not be required. Fittings may be furnished with a 6-mil minimum nominal thickness fusion bonded epoxy coating conforming to ANSI/AWWA C550 and C116/A21.16 in lieu of bituminous coating. Both pipe and fittings shall be furnished by the same manufacturer.

B. Joints shall be push-on-type for pipe and standard mechanical joints for fittings with the exception of hydrant fittings. Fittings for bends and hydrants shall be mechanical joint with retainer glands. Hydrant tees used in lieu of retainer glands and harness rods on fire hydrants shall be equal to ACIPCO A10180 or US Pipe U-592. Anchor couplings used in lieu of retainer glands and harness rods on fire hydrant leads shall be American A-10895 or approved equal. Joints shall conform to AWWA C111. Provide and install the appropriate gaskets, nuts, and bolts for mechanical joints. Nuts shall be steel with American Standard Regular hexagonal dimensions, all as specified in ANSI B 17.2.

   All bolts and all nuts shall be threaded in accordance with ANSI B 1.1, Coarse Threaded Series, Class 2A and 2B fit. Mechanical joint glands shall be ductile iron.

C. Where restrained joints are indicated, provide ACIPCO “Flex Ring” or “Lok Ring”, U.S. Pipe “TR Flex” or equal. Restrained joints 16 inches in diameter and smaller may be ACIPCO “Fast-Grip”, U.S. Pipe “Field Lok” or equal.

D. When flanged joints are indicated, provide gaskets for flanged joints made of 1/8-inch thick cloth reinforced rubber. Gaskets should be full-face type. Provide bolts for flanged connections. Bolts shall be steel with American Regular unfinished square or hexagonal heads. Nuts shall be steel with American

Standard Regular hexagonal dimensions, all as specified in ANSI B 17.2. All bolts and all nuts shall be threaded in accordance with ANSI B 1.1, Coarse Threaded Series, Class 2A and 2B fit.

1.02 Polyethylene Wrap

A. Where shown on the drawings ductile iron pipe and fittings shall be wrapped entirely in prefabricated, 8-mil polyethylene sleeves, which shall be slipped over the pipe during installation, overlapped where necessary, and secured with polyethylene tape to completely prevent the entrance of foreign matter. Such encasement shall be carried out in accordance with ANSI/AWWA Specification C 105/A 21.5-82, "American National Standard for Polyethylene Encasement for Ductile Iron Piping and Water and Other Liquids". The color of polyethylene sleeve shall be identical to the pipe color required by Section 1.03.

1.03 Field Application of Outside Green and Purple Pipe Coating

A. Ductile Iron Pipe and fittings supplied with black asphaltic paint shall be required to be color-coded at the trench site as per the general color codes requirements listed in the Utility Location and Coordination Council's Uniform Color Code. These requirements state that sewage force main pipe shall be green in color and reuse water lines shall be purple in color (Pantone 522C or 512C). All wrapped force mains must be painted accordingly.

B. The paint shall cover what corresponds to 60% of the circumferential area of the assembled pipe. The dry film thickness of the coating shall be a minimum of 1 mil and shall substantially cover the black asphaltic coating. Any distinguishing marks as to the plant of manufacture or product information should be positioned such that this area is not included in the area to be coated. The painted area shall be installed facing up toward the top of the trench.

C. The area to be painted shall be dry and free of any contamination that may cause the coating to disbond or discolor.

D. Manufacturers of paint coatings shall be the Induron Corporation (or equivalent).

1.04 Built-in Pipe and Fittings

A. Where indicated on the Drawings, or directed, pipe and fittings shall be carefully built in, connected to, or supported on concrete or brick masonry.

1.05 Unloading and Laying

A. Unload ductile iron pipe, fittings and accessories with hoists or by skidding. Under no circumstances are pipe to be dropped. Do not skid or roll pipe handled on skid ways against pipe already on the ground. Do not damage casting and linings; but, in the event should damage occur, make repairs or replacement to satisfaction of the Engineer/Inspector.

B. Use proper, suitable tools and appliances for the safe and convenient handling and laying of the pipe and fittings. Take care to prevent the pipe coating from being damaged, particularly on the inside of the pipe and fittings.

C. Pipe may not be "strung" along the job within highway right-of- ways without the approval of the Engineer/Inspector.

D. Carefully examine all pipe and fittings for defects just before laying and lay no pipe or fitting which is known to be defective. In the event that defective pipe is discovered after having been laid, remove and replace with a sound pipe or fitting in a satisfactory manner at Contractor's expense.

E. Thoroughly clean all pipe and fittings before being laid. Plug open ends of pipe with an approved plug during construction.

1.06 Ceramic Epoxy Interior Lining for Ductile Iron Pipe and Fittings

A. Where specified on the drawings, ductile iron pipe shall be lined with ceramic epoxy, or approved equal. The standard of quality is PROTECTO 401 Ceramic Epoxy, or approved equal.

2.01 Casing Pipe

A. The steel casing pipe shall be manufactured from steel conforming to ASTM A 139, Grade B and be new and un-used. Minimum size and thickness shall be as follows:

UNDER ROADS AND HIGHWAYS

Pipe Diameter (inches)	Casing Diameter (inches)	Wall Thickness (inches)
6	12	0.375
8	16	0.375
10	16	0.375
12	18	0.375
14	22	0.500
16	24	0.500
18	30	0.500
20	30	0.500
24	36	0.500
30	42	0.500

B. The materials for casing under State Highways shall be in accordance with the Georgia Department of Transportation Standard Specifications for the Construction of Roads and Bridges, latest edition. It shall be the Contractor's responsibility to determine the exact requirements of the Georgia Department of Transportation. If there is a conflict between these Specifications and the Georgia Department of Transportation Specifications the latter shall take precedent.

2.02 Stainless Steel Casing Spacers

A. Spacers shall be bolt on style with a two piece shell made from T-304 stainless steel of a minimum 14 gauge thickness. The shell shall be lined with a ribbed PVC sheet of a .090-inch thickness that overlaps the edges. Runners, made from UHMW polymer, shall be attached to risers at appropriate positions to properly locate the carrier within the casing ant to ease installation. Risers shall be made from T-304 stainless steel of a minimum 14-gauge thickness and shall be attached to the shell by MIG welding. All welds shall be fully passiyated. All fasteners shall be made from t-304 stainless steel.

2.03 Coatings and Linings

A. Steel pipe used for water distribution and sewer shall be coated and lined in accordance with Division III, Section 12.

B. Steel pipe used as casing shall not require a coating or lining unless otherwise indicated.

Acceptable Manufacturers

Steel pipe shall be domestically manufactured.

1. As Approved.

3.01 Pipe Classification

A. Buried service three-quarter (¾) inches in diameter to one (1) inch in diameter shall be seamless, annealed copper tube conforming to the requirements of ASTM B-88, Type “K”.

B. Buried service greater than one (1) inch in diameter shall be soft temper copper tube conforming to the requirements of ASTM B-88, Type “K”.

3.02 Fittings

A. Fittings for annealed copper tube, Type “K”, shall be brass compression type.

B. Meter couplings and tail pieces shall be cast brass threaded type.

Acceptable Manufacturers

Copper components shall be domestically manufactured.

1. As Approved.

4.01 Casing for Copper Pipe

A. PVC pipe shall be used as a casing for copper water service lines that are to be installed under pavement (in subdivisions only).

B. PVC pipe used as a casing shall be a minimum of Schedule 40, Class 200.

C. PVC casing pipe shall have a minimum diameter of two (2) inches.

4.02 Sewer Pipe Classification

A. PVC pipe used as sewer shall be SDR 26 push-on joint type with O-rings in accordance with ASTM 3034.

B. Gaskets shall be plain rubber.

4.03 Sewer Pipe Fitting Classification

PVC fittings shall be in accordance with ASTM 3034.

Acceptable Manufacturers

PVC pipe shall be domestically manufactured.

1. As Approved.

5.01 Plug Valve

A. Plug valves shall be used on sanitary sewer force main and pump station applications or as indicated.
B. All materials shall be new. All plug valves shall be resilient seat with mechanical joint fittings if utilized for buried service and flanged fittings for open air installation. Valve bodies shall be cast iron, 30,000 psi tensile strength, ASTMA126 Grade B. Screwed in seats shall not be acceptable.
C. Valves 24-inch and smaller shall have a minimum of 80% - open port area. Valves larger than 24-inch shall have a minimum 80% open port area as measured by the percent cross sectional area of equivalent size (nominal same diameter) pipe.
D. Non metallic bearing shall not be acceptable.
E. Shaft seals shall be externally repackable.
F. Valves shall have a pressure rating equal to the pipe test pressure (200 psi).
G. Valves shall have gear actuators and 2 inch vertical operating nuts.

Acceptable Manufacturers

1. DeZurik.
2. Pratt
3. Val-matic
4. Approved Equal

5.02 Gate Valve

A. Gate valves shall conform to AWWA C500-86 for double-disc gate valves or AWWA C509-87 for resilient-seated gate valves.
B. Gate valves shall be hand operated, non-rising stem, with cast or ductile iron bodies, and adapted for joints as indicated in the approved design drawings, or as directed.
C. All gate valves shall open by turning the operating nut to the left (counter clockwise)
D. Valve stems shall be manganese bronze with the collar cast solid with the stem. The threads of stems and stem nuts shall be of the square or Acme type. The ultimate tensile strength shall not be less than 65,000 pounds per square inch and an elastic limit of not less than one-half of the ultimate tensile strength.

E. Gate valves shall be provided with "O" ring seals. Ring seal plate shall be fitted with two (2) "O" rings: the upper ring serving as a dirt seat, the lower ring as a pressure seal. Design shall permit replacement of "O" rings while the valve is under pressure in the fully opened position. "O" rings shall be Precision Rubber Products Corporation, Quality Compound No. 122-70, or approved equal.

Acceptable Manufacturers

1. Meuller
2. American Flow Control
3. U.S. Pipe
4. Approved Equal

5.03 Butterfly Valve

A. Butterfly valves will only be allowed on a case by case basis by FCDWS.

B. Provide butterfly valves meeting the requirements of AWWA C504-80, except as modified herein. Furnish valves of the short body laying length with operators sized on the basis of actual line pressure and velocity.

C. Provide butterfly valves having bodies of cast iron, alloy cast iron or ductile iron with integrally cast hubs for shaft bearing housing, Class 150B.

D. Furnish valves having Type 304 stainless steel valve shaft, keyed for operator connection and connected to the disc with Type 304 stainless steel pins secured in place. Orient shaft as indicated.

E. Furnish two- way thrust bearings, preset at the factory and permanently grease lubricated.

F. Provide resilient valve seat of natural rubber per ASTM Des. D735-R, or Buna N Type per ASTM Des. D735-SB, providing uninterrupted 360 degree seating, completely adjustable around circumference. Furnish mating seat of Type 304 or 316 stainless steel. Apply the resilient seat to the body, recessed in a groove, or to the disc, per AWWA C504, Sec. 9.5.

G. Furnish valve discs, seating at 90 degrees to the pipe axis, of ductile iron per ASTM Des. A536, Grade 65-45-12, cast iron per ASTM Des. A48, Class 40, or fabricated steel per ASTM Des. A36.

Acceptable Manufacturers

a. Meuller
b. Kennedy
c. Pratt
d. Approved Equal

5.04 Air/Vacuum Valve

A. Combination air vacuum/release valves with backwash kits shall be sized according to the manufacturer's recommendations, which shall be submitted as part of the pumping station design report.

B. Valves designated for use with water or sewage shall be used on the respective system.

C. Valve shall be housed in a "dog house" style manhole.

D. Operation of the valve shall be as follows:

1. Prior to the ingress of liquid into the valve chamber, as when the pipeline is being filled, valves shall vent through the large orifice when sewage/effluent approach velocities are relative to a transient pressure rise, on valve closure, of <2 x valve rated pressure.
2. At higher sewage/effluent velocities, which have a potential to induce transient pressure rises greater than 2 times valve rated pressure on valve closure the valve shall automatically discharge air/gas through the anti-shock orifice and reduce sewage/effluent approach velocity, so that on closure a maximum transient pressure rise of less than 2 times valve rated pressure is realized.
3. Valves shall not exhibit leaks or weeping of liquid past the large orifice seal at operating pressures of 7.3 psi to twice rated working pressure.
4. Valves shall respond to the presence of air/gas by discharging it through the small orifice at any pressures within a specified design range, 7.3 psi to 150 psi and shall remain leak tight in the absence of air.

5. Valves shall react immediately to pipeline drainage or liquid column separation by the full opening of the large orifice so as to allow unobstructed air intake at the lowest possible negative internal pipeline pressure.

E. Use detail No. 20.0 and 21.0 when applicable.

Acceptable Manufacturers

1. Vent-O-Mat
2. Approved Equal

5.05 Corporation Valve

A. Corporation valves shall be of the ball valve type and manufactured of bronze in conformance with ASTM B61, ASTM B62 and NSF 61.

B. Corporation valves shall withstand a working pressure of 300 psi, Mueller 300 Ball Corporation Valve (Mueller B-2500Y) or approved equal.

C. Corporation valves shall be tapered for installation in a double strap saddle and shall have compression fittings.

D. Corporation valves shall be ¾ inch or one (1) inch in size as required by the service.

E. Corporation valves shall be domestically manufactured.

Acceptable Manufacturers

1. Mueller Brass
2. Approved Equal

5.06 Curb Stop

A. Curb stops shall be of the ball valve type and manufactured of bronze in conformance with ASTM B61, ASTM B62 and NSF 61.

B. Curb stops shall withstand a working pressure of 300 psi, Mueller 300 Ball Angle Meter Valve (Mueller B-24258) or approved equal.

C. The internal ball shall be manufactured of low carbon steel coated with brass.

D. Internal O-rings and seats shall be of Buna-N.

E. Curb stops shall be compression fitting with meter swivel nut.

F. Curb stops shall be fitted with wing locks suitable to accept a keyed padlock.

G. Curb stops shall be ¾ inch, one (1) inch or two (2) inches in size as required by the service. For ¾" – 1", a 90 – degree angle curb stop is required, with a meter swivel nut.

Acceptable Manufacturers

Curb stops shall be domestically manufactured.

1. Mueller Brass
2. Approved Equal

5.07 Valve Box

A. Valve boxes shall be of the two-piece type and manufactured of cast iron.

B. Valve boxes shall have an internal diameter of 5.25 inches.

C. Valve boxes shall be fitted with a cast iron cover with the word "WATER" or "SEWER" integrally cast in the cover depending on the service.

Acceptable Manufacturers

1. Bingham-Taylor (Fig. # 4905 or #4908)
2. Approved Equal

6.01 Tapping Sleeve

A. Tapping sleeves shall be fabricated tapping sleeves of stainless steel. Steel shall be type 304 (18-8).

B. Gaskets shall be virgin nitrile (Buna-N, NBR).

C. Sleeve outlet shall be flanged or mechanical joint in accordance with ANSI/AWWA C110/A21.1.

Acceptable Manufacturers

1. Power Seal– Part No. 3490 (stainless steel) on cast iron and ductile iron mains.
2. Smith Blair – Part No. 663 or 665 (stainless steel) on cast iron and ductile iron mains.
3. Ford Meter Box– FTSS (stainless steel).
4. Approved Equal

6.02 Tapping Saddle

A. Tapping saddles shall be epoxy coated ductile iron with stainless steel straps. Ductile iron shall conform to ANSI/AWWA standards. Stainless Steel shall be type 304 (18-8).

B. Double strap saddles with 2” gate valve shall be used when tapping for 1-1/2 inch or 2 inch service lines.

C. Tapping saddles shall seal with pipe by an O-ring gasket virgin nitrile (Buna-N, NBR).

D. Saddle outlet to pipe shall be flanged or tapped with pipe threads.

Acceptable Manufacturers

For pipe diameters 4 inches through 12 inches:

1. Smith Blair – 313
2. JCM Industries - 408

7.01 Residential and Light Commercial

A. Water meters shall be positive displacement type with oscillating piston or nutating disk having a magnetic drive conforming to AWWA C-700 and a sealed register conforming to AWWA C-707.

B. Meters shall be capable of operating up to a working pressure of 150 psi and have an operating flow range shown on the following table.

SIZE (in)	OPERATING FLOW RANGE (gpm)	LOW FLOW REGISTRATION
5/8	1 to 20	95% at 1/8 gpm
¾	2 to 30	95% at 1/4 gpm
1	3 to 50	95% at 3/8 gpm
1-1/2	5 to 100	95% at 3/4 gpm
2	8 to 160	95% at 1 gpm

C. Meter outer case shall be constructed of Water Works bronze (minimum 75% copper content) and shall be split case. External fasteners shall be corrosion resistant.

D. The size of the meter and a flow direction arrow shall be cast in raised figures on the outer casing. The manufacturer's serial number shall be permanently affixed to the outer case and shall be visible from the topside.

E. Meter shall have a separate measuring chamber that shall be easily removable from the outer case. The measuring chamber shall be held in-place without the use of fasteners. The measuring chamber shall be constructed of Water Works bronze (minimum 85% copper content) or a suitable synthetic polymer.

F. The sealed register shall be of the straight reading type and have a full test dial on the face. The register shall be fitted with an external or internal locking device so that the register can only be removed with specialized tools.

G. The register shall measure flow in gallons and shall be read by visual inspection and remote data relay. Remote data relay shall be accomplished using a Touchpad and/or a Meter Transceiver Unit that is sturdy and tamperproof and shall be located external to the meter. The Touchpad shall be compatible with the Touch Probe, Touch Gun or Smart Gun as manufactured by Solid State Interrogator or Visual Reader.

H. Meters shall have a corrosion resistant strainer that is easily removed without the meter itself being disconnected from the service line.

I. Meter connections to 5/8 inch and one (1) inch service lines shall be with a meter spud. Meter connections to 1-1/2 inch and two (2) inch service lines shall be with a two (2) bolt flange.

J. 5/8" – 1 " meter boxes shall be cast iron and have a cast iron cover that is made to house a "radio read" device. 1 ½ " - 2" meter shall be housed in Carson Industries, LLC Super Jumbo , specification grade 1324, meter boxes with plastic lids manufactured for use with radio read equipment. All meter covers shall be supplied with plugs installed in. Meter box covers shall be provided with plugs installed to keep out debris until the meter is set and the radio read antenna is installed

Acceptable Manufacturers

1. Schlumberger Neptune T-10
2. Approved Equal

7.02 Commercial and Industrial

A. Compound meters shall consist of a combination of an AWWA Class II turbine meter for measuring high rates of flow and a nutating disc type positive displacement meter for measuring low rates of flow enclosed in a single main case. An automatic valve shall direct flows through the disc meter at low flow rates and through the turbine meter at high flow rates. At high flow rates, the automatic valve shall also serve to restrict the flow through the disc meter to minimize wear.

B. Meters shall comply with the operating characteristics below:

SIZE (in)	OPERATING FLOW RANGE (gpm)	LOW FLOW REGISTRATION
2	½ - 160	1/8 gpm
3	½ - 350	1/8 gpm
4	1 – 700	½ gpm
6	1-1/2 – 1400	¾ gpm
8"x6"	1-1/2 – 2000	¾ gpm

C. The size of the meters shall be determined by the nominal size (in inches) of the opening in the inlet and outlet flanges. Overall lengths of the meters shall be as follows.

Meter Size	Laying Length
2”	15-1/4”
3”	17”
4”	20”
6”	24”
8” x 6”	55-3//8”

D. The main case and cover shall be of water works bronze containing not less than 75% copper. The size, model, and flow arrows shall be cast in raised characters on the main case or cover. The cover shall contain a stainless steel calibration vane for the purpose of calibrating the turbine measuring element while the meter is in-line and under pressure. A test plug shall be located in the main case or the cover for the purpose of field-testing the meter.

E. Casing bolts shall be made of Type 316 stainless steel.

F. Main cases shall have meter threads. 2” meters shall have IPT and be used with meter nipple and 3” through 6” sizes shall be round flanged per table 4, AWWA C702. Separate magnetic-drive registers shall record the flow of the turbine and disc meters and their total will be the registration of the compound meter. The registers shall be permanently roll-sealed, straight reading indicating in gallons. Registers shall include a center-sweep test hand, a low flow indicator, and a glass lens. The registers shall be serviceable without interruption of the meter’s operation.

H. Register boxes and covers shall be of bronze composition. The name of the manufacturer and the meter serial number shall be clearly indentifiable and located on the register box covers.

I. Registers shall be affixed to the cover by means of a plastic tamperproof seal pin that must be destroyed in order to remove the register.

J. The meter serial number shall be imprinted on the meter flange or cover as well as the register box covers.

K. The measuring chamber shall be a self-contained unit, attached to the cover for easy removal. The turbine spindles shall be tungsten carbide or 316 stainless

steel with tungsten carbide inserts and shall rotate in removable graphite bushings. Thrust bearings shall be tungsten carbide. The nutating disc chamber shall be a self-contained unit mounted on the cover and easily removable from the cover. It shall conform to AWWA Standard C-700 for the following sizes: 2'-3" – 5/8" disc; 4" – ¾" disc; 6" – 1" disc.

L. The intermediate gear train shall be directly coupled from the turbine spindle and magnetically coupled to the register through the meter cover. The gear train shall be enclosed in the turbine rotor outlet and shall be capillary sealed. All moving parts of the gear train shall be made of a self-lubricating polymer or stainless steel for operation in water.

M. The automatic valve shall be of the spring-loaded, poppet type. All valve parts shall be made of waterworks bronze, stainless steel, or a suitable polymer with a replaceable semi-hard EPDM rubber seat. Only the cover must be removed to gain access to the valve for inspection or service.

N. A strainer shall be provided for the disc meter. It shall be easily removable and have an effective straining area of at least double the disc meter inlet.

O. Registration accuracy over the normal operating range shall be 98.5% to 101.5%. Registration at the crossover shall not be less than 95%. Registration at the low flow rate shall not be less that 95%.

P. The register shall measure flow in gallons and shall be read by visual inspection and remote data relay. Remote data relay shall be accomplished using a Touchpad and/or a Meter Transceiver Unit that is sturdy and tamperproof and shall be located external to the meter. The Touchpad shall be compatible with the Touch Probe, Touch Gun or Smart Gun as manufactured by Solid State Interrogator or Visual Reader.

Q. Water meters and back-flow preventers larger than 2" will be furnished and installed by the Developer and set in vaults located at the edge of the street right-of-way. Meters larger that 2" must have a by-pass with valves located inside the vault, and shall have a plate strainer at the meter inlet. The by-pass pipe shall be no less than ½ the diameter of the meter and shall be installed parallel to the master meter assembly.

R. For meter applications requiring a fire service meter, the meter shall be a Neptune Protectus III Fire Service Meter or approved equal.

Acceptable Manufacturers

Domestic Service

1. Schlumberger Neptune Tru/Flo Compound
2. Approved Equal

Fire Service

1. Neptune Protectus III Fire Service Meter
2. Approved Equal

7.03 Water Meter Vaults (Commercial and Industrial)

A. Vaults shall be constructed of pre-cast concrete or cast-in-place concrete.

B. Vaults shall be designed to withstand a minimum H-10 Live Load. Additional design strength may be required.

C. Vaults shall be adequately sized to contain all piping, valves, bypass, fittings, meter and strainer associated with the meter installation.

D. A minimum distance of 12” shall be maintained between any piping and the vault floor and the wall running parallel to the piping.

E. Meter vaults shall have a gravel bottom, minimum 12” of #57 stone on top of geo-textile fabric. The bed of No. 57 stone shall extend to the edges of the excavation.

F. Where vaults are constructed of pre-cast or cast-in-place concrete, the walls shall be a minimum of six (6) inched thick and steel reinforced.

G. Vaults shall be covered with a removable pre-cast concrete cover. The cover shall be a minimum of six (6) inches thick and steel reinforced. Cover shall be sealed to top of walls using neoprene gasket material.

H. Where two (2) pre-cast vaults are situated together to form one (1) larger vault, each of the two (2) vaults shall have their separate cover.

I. An aluminum access hatch, shall be installed per Section 7.04.

J. Bottom side of the meter assembly shall have a minimum twelve (12) inch clearance from the top of the gravel bottom.

K. Meter assembly shall be supported at a minimum of two (2) points by galvanized pipe saddles. Backflow assembly shall be supported at a minimum of one (1) point by galvanized pipe saddles. Pipe saddles shall be capable of carrying the weight of the assembly. Pipe saddle height shall be adjustable via screw jack. Pipe saddle shall have a minimum four (4) inch square base, one-quarter (1/4) inch thick.

L. Pipe penetrations (annulus between concrete and outside face of pipe) shall be sealed with expanding foam or bricked and grouted.

M. Vault cover shall not extend more than three (3) inches above finished grade.

Acceptable Manufacturers

1. As Approved.

7.04 Vault Access Hatches

A. Vault access shall be via aluminum double hatch having a minimum clear opening, per F.C. Detail No. 7.0 and 8.0.

B. Access shall be rated to withstand a minimum H-10 Live Load. Design strength of access hatch may be increased.

C. Access hatch shall have a manual locking arm device to prevent hatch lids from closing.

D. Access hatch shall be capable of being secured using a keyed lock, or by a T-handle latch.

Acceptable Manufacturers

1. As Approved.

8.01 Fire Hydrant

A. Fire hydrants shall be three-way, post type, dry top traffic model with compression main valve opening against and closing in the direction of normal water flow, complying with AWWA C502 for 200 psi working pressure and NFPA, 1993 or latest edition.

B. Drain – The drain mechanism shall be designed to operate automatically with the operation of the main valve and shall allow a momentary flushing of the drain ports. A minimum of two internal and two external bronze lined drain ports shall be required in the main valve assembly to drain the hydrant barrel.

C. Hydrants shall be furnished having factory burying depths of 4'-6" or 5'-0". Deeper burying depths shall be accomplished using extension kits provided by same manufacturer. If hydrant requires more than a 3' extension, a deeper bury hydrant should be used. Break-away device shall be situated +/- 3 inches from finished grade.

D. Hydrant standpipe, fittings and upper barrel shall be ductile iron. Parts designed to break away may be cast iron.

E. Hydrant bolts below ground level shall be stainless steel.

F. Hydrant lead to main line connection shall have a 6" mechanical joint connection, complete with accessories.

G. The means of attaching the barrel to the standpipe shall permit 360º rotation of the barrel.

H. Traffic Design – the hydrant barrel sections shall be connected at the ground line in a manner that will prevent damage to the hydrant when struck by a vehicle. The main valve rod sections shall be connected at the ground line by a frangible coupling. The standpipe and ground line safety construction shall be such that the hydrant nozzles can be rotated to any desired position without disassembling or removing the top operating components and top section of the hydrant standpipe.

I. Main Valve – The main valve shall be made of synthetic rubber and formed to fit the valve seat accurately.

J. Main Valve Seat – The main valve seat shall be of bronze and its assembly into the hydrant shall involve bronze to bronze thread engagement. Two “C” ring seals shall be provided as a positive, pressure seal between the bronze seat ring and the shoe. The valve assembly pressure seals shall be obtained without the employment to torque compressed gaskets. The hydrants shall be designed to allow the removal of all operating parts through the hydrant barrel by means of a single, light weight disassembly wrench without excavating.

K. Internal working parts shall be removable without disturbing the barrel.

L. The operating nut situated atop the hydrant shall be hexagonal and constructed of ductile iron or cast iron and open in a counter clockwise direction. The threads shall be enclosed in an operating chamber separated from the hydrant barrel by a rubber O-ring stem seal lubricated by a grease or oil reservoir. Nozzle caps shall have the same cross-section as the operating nut and shall come with heavy duty, non-kinking chains. Chains shall be securely affixed to the hydrant upper barrel and permit free turning of caps.

M. Size – Internal main valve diameter shall be a minimum of 5-1/4”.

N. Hydrant shall be equipped with two 2-1/2 inch threaded (7.5 threads per inch) hose connections and one 4-1/2 inch threaded (4 threads per inch) hose connection. Hose and pump connections shall be threaded and pinned to seal the connection to the barrel. Threads shall comply with National Standard Threads. Each connection shall be equipped with a cap and chain.

O. Extensions – Barrel extension sections shall be available in 6” increments complete with rod, extension coupling and the necessary flanges, gaskets and bolts so that extending the hydrants can be accomplished without excavating. If hydrant requires more than a 3’ extension, a deeper bury hydrant should be used.

P. Nozzles – No lead will be allowed in nozzle installation.

Q. Testing: – All fire hydrants shall be factory tested in strict accordance with AWWA-C502-80at the supplier’s expense. Certification of Compliance will be furnished to the Engineer upon his request.

R. Painting, Coating, and Lubricating: All iron parts of the hydrant inside and outside shall be thoroughly cleaned and thereafter, unless otherwise stipulated, all surfaces except the exterior portion above the ground line shall be coated or painted with, or dipped in an asphalt or bituminous base paint or coating. If these parts are painted, they shall be covered with two (2) coats, the first being allowed to dry thoroughly before the second coat is applied. The outside of the hydrant valve above the finished ground line shall be thoroughly cleaned and thereafter painted in the shop with two coats of Koppers Primer 621 or approved equal. After installation, each hydrant shall be painted with two (2) field coats of Glamortex Enamel as manufactured by the Inertol Company or approved equal, color to be SILVER. Al bronze threaded and contact moving parts shall, during shop assembly by lubricated and protected by a coating or rust proof compound to prevent damage in shipment and storage.

S. Dry Top Bonnet - Each hydrant shall be constructed with a moisture-proof lubricant chamber which encloses the operating threads and which provides automatic lubrication of the threads and bearing surfaces each time the hydrant is operated. This assembly shall be comprised of a top “O” ring serving as a dirt and moisture barrier and lower “O” ring which will serve as a pressure seal.

Acceptable Manufacturers – Product

Approved manufacturers must produce only ductile iron fire hydrants.

1. AVK Series 27
2. Approved Equal

9.01 Manholes

A. Pre-cast manhole barrel, base and cone sections shall be of the dimensions indicated on the Drawings or required and shall meet the latest requirements of ASTM C-478. Barrels shall be 48-inch, machine made, tongue and groove indicated. Joints shall be jointed by an approved preformed plastic gasket meeting the requirements of federal specifications SS-S-00210, "Sealing Compound, Preformed Plastic For Pipe Joints," Type 1, rope form (Kent Seal or approved equal).

B. Add grout inside joints.

C. All riser joints shall be sealed on the outside with a 6” to 9” EPDM rubber seal wrap (Infi-Shield Gator Wrap, Seal Wrap, or approved equal).

D. Grade ring and cover shall be sealed on the outside with a molded EPDM rubber seal (Infi-Shield Uni-Band or approved equal).

E. Riser sections to be sealed with single offset gasket per ASTM C-443.

F. Manhole bases shall have inside diameters based on the size and type of pipe being connected to the manhole as shown in the drawings or as approved by the Engineer. Where 5'-0" diameter and larger bases are used, a flat top reducer section shall be used to transition to a 4'-0" diameter riser section. See detail drawings.

G. Manhole wall thickness shall be in accordance with the following schedule:

Manhole	Wall thickness (in)
4’ diameter	5"
5’ diameter	6"
6’ diameter	7"
7’ diameter	8"
8’ diameter	9"

H. Concrete bases shall be of the size and minimum thickness, as indicated on the Drawings. Bases shall be pre-cast, cast-in-place bases if approved by the

Engineer shall be Class A concrete conforming to the requirements of the item titled CONCRETE. Bases shall be placed and leveled on a twelve (12) inch bed of crushed stone.

I. Suitable provision shall be made to assure a watertight connection of the sewer to the manhole. Holes in pre-cast bases to receive sewer pipes shall be provided with flexible manhole boots of high quality synthetic rubber, equal to Kor-N-Seal flexible connectors manufactured by NPC Systems, Inc or pre-approved equal. The outer end of the boot shall fit around the outside of the pipe and shall be secured to the pipe by means of a stainless steel strap clamp. The synthetic rubber shall be suitable for use in sewage service.

J. Holes in pre-cast bases to receive sewer pipes shall be pre-cast at the factory at the required locations and heights or cored if approved by FCDWS. Knocking out of holes in the field will not be permitted.

Minimum Manhole Inside Diameter

Pipe Size Deflection Min M.H. Diameter

Pipe Size	Deflection (degrees)	Min. MH Diameter
8" Through 12"	0˚ - 90˚	4'-0"
15"	0˚ - 60˚	4'-0"
15"	60˚ - 90˚	4'-0"
18"	0˚ - 60˚	4'-0"
18"	60˚ - 90˚	5'-0"
20"	0˚ - 60˚	5'-0"
20"	60˚ - 90˚	5'-0"
24"	0˚ - 60˚	5'-0"
24"	60˚ - 90˚	6'-0"
27"	0˚ - 60˚	5'-0"
27"	60˚ - 90˚	6'-0"
30"	0˚ - 60˚	5'-0"
30"	60˚ - 90˚	6'-0"
≥36"		per FCDWS

K Transition bases shall be accepted as equal to the bases specified above and for manholes with pipes greater than 30”.

L. Manhole barrels shall be constructed of pre-cast reinforced concrete unless otherwise indicated on the Drawings.

M. Manhole cones and slab tops shall be constructed of pre-cast concrete. Pre-cast Grade Rings shall be used to adjust ring and cover to finish grade. No more than 10 vertical inches of grade rings will be allowed per manhole. Grade Rings shall conform to ASTM C478 and shall be no less than 4" in height.

O. Brick shall not be used to adjust ring and cover to grade. *Pre-cast concrete riser rings with a flexible rubber seal are required to adjust rings and covers to grade. A cast in place riser collar using methods and equipment as specified by the Whirlygig Company is considered as an acceptable alternative.*

P. Inverts and tables may be constructed of rowlock brick if pre-cast inverts are not specified on the Drawings, and shall have the same radius as the outflow pipe. Invert walls shall be constructed to a height corresponding to the spring line of the influent and effluent pipes with smooth rounded walls. Inverts shall be appropriately channeled for all stub connections to the manhole.

Q. The flow channel though manholes should be made to conform in shape and slope to that of the sewers. Minimum drop though manhole shall be 0.2 feet, or as specified on the Drawings to prevent solids deposition. Tables are to be gently sloped and troweled smooth from manhole wall to invert wall height and constructed of aggregate-mix cement with smooth, veneer finish.

R. Manhole drops shall be provided at all locations where difference in invert elevations of the sewer pipes is two (2) feet or greater, or at such other locations as may be directed or indicated. All drop connections shall be constructed using ductile iron pipe.

S. All aluminum in contact with concrete shall have been painted with coal tar pitch paint.

T. Manhole steps shall be equal to M. A. Industries #PS-1. The manhole step shall be designed to be cast in place. The legs shall be at least 10" on center and overall width of the step shall be 12". Manhole Steps shall meet ASTM C-478, ASTM D-4104, ASTM A-615, and AASHTO No. M-199-811

U. A cast iron frame and cover shall be furnished for each manhole as follows:

1. Type A - For street and areas not subject to flooding. Provide heavy duty U.S. Foundry & Mfg. Corp. Model USF 229 & CU Cover, East Jordan Iron Works V1357, or approved equal. Areas not subject to flooding include those manholes whose cover resides at or above the 100-year flood plain shown on the drawings.

2. Type B - For areas subject to flooding. Provide East Jordan Iron Works V2358 watertight, U.S. Foundry & Mfg. Corp. Model 152-BV-BWT or approved equal. Areas subject to flooding include those manholes whose cover resides below the 100-year flood plain shown on the drawings.

3. Type C - For areas requiring venting. Provide, where shown on drawings, Neenah Foundry Co., Catalog R, 9th Edition, No. R-1659 or approved equal.

4. Type D – For elevated manholes, particularly on sanitary sewer trunk and outfall lines, the manholes should be installed with a ring and cover casting that allows the cover to rotate on a shaft recessed into the cast iron ring. The cover shall be of a water-tight and bolt down configuration equal to U.S. Foundry & Mfg. Corp. Model USF 275 Ring & RO Cover or East Jordan Iron Works “Revolution” ring and cover. Both cover and frame shall be Class 35 B and meet the latest requirements of ASTM A48

   NOTE: The following shall be cast into all sanitary sewer manhole covers:

   “Sewer”

5. Type A frames and covers shall be properly set in place in full bed of mortar and adjusted so as to make the top of the frame conform to the finished surfaces when located in street and public highways. In other locations, they shall be so adjusted as to conform to such elevations as are indicated on the Drawings or as required.

6. Type B, Type C and Type D frames and covers shall be cast into the pre-cast manhole cones or slab tops at the place of manufacture of the manholes, unless drawings indicate that an adjustment to exact elevation is required. In that case Type B ,Type C and Type D frames and covers will be set as described for Type A frames and covers.

9.02 Service Clean-out Ring and Cover

A. Ring and covers shall be gray cast iron or ductile iron
B. ASTM Standards A48 Class 30B (gray cast iron)
C. ASTM Standards A536 Grade 65-45-12 (ductile iron)
D. Shall be designed, constructed and capable of withstanding a minimum of H-20 type loading if installed in a paved area subject to vehicular traffic
E. Shall be cleaned according to good foundry practice, chipped and ground as needed to remove fins and rough places on castings
F. Bearing surfaces shall be machined to ensure a proper fit and prevent rattling and fit flush without forcing
G. All castings shall be true and free of holes
H. Cover shall be labeled with an “S” to indicate sanitary service
I. Clean out boxes in traffic areas shall be U.S. Foundry & Mfg. Corp. USF-7621 or Neenah Model R-1976
J. Clean out boxes not subject to vehicular traffic shall be the “Rome” type as manufactured by Russell Foundry and Mfg. Co. and shall be of cast iron, oval shape and have minimum inside dimensions of 19 inches by 10 inches and shall be at least 11 ½ inches deep. The combined weight of the box and lid shall be not less than 60 lbs.

10.01 Concrete Design

A. Work Included

1. There shall be two classes of concrete, Class A for formed, reinforced, cast-in-place structures, or Class B for non-reinforced concrete thrust blocks, concrete cradles, concrete encasement, concrete fill and similar uses. All concrete shall be a minimum of 3000 PSI.

B. Cement

1. All cement shall be dry, free from lumps and shall conform to the current Standard Specifications for Portland Cement ASTM Designation C150, Type II for General Construction.

C. Fine Aggregate

1. The fine aggregate or sand used in the concrete masonry shall be clean, siliceous sand.

2. Fine aggregate shall be well graded and shall conform to the following requirements:

Passing	Percentage by Weight
3/8 inch sieve	100
No. 4 sieve	at least 90
No. 16 sieve	not less than 45 nor more than 70
No. 50 sieve	not less than 15 nor more than 30
No. 100 sieve	not less than 3 nor more than 8

E. Coarse Aggregate

1. Coarse aggregate shall be composed of hard, strong, durable, broken stone or crushed gravel, subject to the Engineer's approval. Course aggregate shall be well graded and shall conform to the following requirements:

Passing	Percentage by Weight
1-1/2 inch sieve	not less than 95
3/4 inch sieve	not less than 35 nor more than 70
3/8	inch sieve not less than 10 nor more than 30
1/4 inch sieve	not more than 5

2. In thin sections, such as roof and floor slabs, or where otherwise directed by the Engineer, the maximum size of coarse aggregate to be used in making concrete shall be three-quarter inch.

E. Water

1. The water used in mixing concrete shall be potable and shall be accurately measured for each batch. The quantity to be added shall vary as hereinafter provided with the dryness of the materials and with the condition of the weather.

2. The amounts of water used in concrete, inclusive of that contained by the aggregate shall not exceed five and three-quarter gallons per sack of cement.

F. Reinforcement

1. Steel reinforcement shall be designed, detailed, fabricated and placed in conformance with all applicable requirements of ACI 315, ACI 318, and the CRSI Manual of Standard Practice.

2. No concrete shall be placed until all steel reinforcement to be covered has been inspected in place and approved by the Engineer.

G. Proportions

1. Provide concrete which, on test in standard cylinders, shall show a compressive strength of not less than 3000 PSI in twenty-eight days for Class A and Class B concrete.

2. Slump shall range from three to five inches.

3. In no case shall there be less than six bags of cement per cubic yard for Class A or Class B concrete.

4. The Contractor shall make slump tests as required to determine the workability of the concrete and the proper proportions of aggregates to be used.

5. The Contractor shall provide a standard cone of metal for making slump tests and a supply of suitable non-absorbent cardboard containers for making standard six inch by twelve inch cylinders for testing the compressive strength of the concrete.

6. No admixtures will be permitted unless specifically approved by the County Engineer.

H. Forms

1. The Contractor shall furnish all labor and materials for all forms required for the construction of the work.

2. Either metal or wood forms may be used.

3. All forms shall be true to the required shape, clean, of sufficient strength, and well braced so that they will maintain their proper position during the placing and vibrating of the concrete.

I. Mixing

1. Concrete shall be obtained by mixing at the site or plant-mixed concrete may be used, subject to the conditions contained hereinafter.

2. The mixing of concrete, except when hand mixing is authorized by the Engineer, shall be done in an approved type of rotary batch mixer which will insure a uniform distribution. No mixer shall be used which requires less than a bag of cement per batch of concrete mixed therein. The entire contents of the drum shall be discharged before recharging. In no case shall concrete be discharged which has not been mixed for a period of at least two (2) minutes at a peripheral drum speed of not less than two hundred (200) feet per minute after all materials, including water, are in the mixer.

3. When necessary to mix small batches of concrete by hand, the ingredients shall be mixed until they are homogeneous in appearance and color.

4. Concrete shall be mixed in such quantities and at such times that any batch can be placed in the work within thirty (30) minutes after the time of mixing. No concrete shall be placed in the work after its initial set has occurred, and no retempered concrete shall be allowed to be used under any conditions.

5. Plant-mixed concrete shall conform to the following conditions.

   a. The truck used in transporting concrete shall have its drum rotating continuously at agitating speed from the time it is charged until it is discharged. Plant-mixed concrete shall be on the job site and placed within a period of thirty (30) minutes after being loaded, and in any case, prior to the period of initial set.

   b. The placing of concrete shall be a continuous operation throughout any pour.

J. Placing

1. Before placing concrete, forms shall be thoroughly cleaned and wetted and the space inside the forms shall be thoroughly cleaned of all chips, shavings

or other debris. Concrete shall be deposited so as to maintain a nearly level surface and avoid flowing along the forms. It shall be continuously and sufficiently vibrated to expel air.

2. All formed concrete and all slab on grade concrete shall be vibrated. Minimum 6 mil polyethylene sheeting shall be utilized under any concrete slab poured on earth or gravel.

K. Bonding and Joints

1. Joints, either vertical or horizontal, shall be made only where and as permitted by the Engineer.

L. Surface Finish

1. All surfaces which are exposed prior to the filling of the structures with water or sewage and all exposed surfaces immediately following the removal of the forms, by first moistening and then vigorously rubbing with carborundum brick and water so as to produce a smooth surface. Where necessary, rubbing shall be done with grout composed of one part cement and two parts fine sand. Unless otherwise specified, all surfaces not built against forms shall be screeded to an even finish.

2. Particular care shall be taken in order to secure smooth, dense and hard surfaces of flow conduits.

3. Floor and similar surfaces shall be pitched to drain as directed. No plastering of any concrete surfaces shall be done unless expressly permitted.

M. Curing

1. All exposed surfaces of finished shall be kept constantly wet in an approved manner for a minimum period of ten days.

N. Pipes, Metal Work, and Openings

1. The Contractor shall build into the concrete the steel reinforcement, pipes, sleeves, anchor bolts, steps, castings and other inserts. Great care shall be taken to tamp under and around them so that there will not be a passage for water.

O. Placing in Water Prohibited

1. Unless permission is granted in writing by the County Engineer, concrete shall not be laid in water nor shall water be allowed to rise on or flow over freshly placed concrete until the concrete has set for at least twenty-four hours.

P. Freezing and Inclement Weather

1. Concrete shall not be mixed at any time during freezing, inclement weather, or at night, without explicit permission, and then only at the Contractor's risk. If permitted to build concrete structures in freezing weather, the Contractor shall provide and use proper facilities for covering and keeping warm the newly laid concrete.

Q. Defective Work

1. Any concrete masonry found to be defective from any cause whatever, at any time before the Final Acceptance of the work, shall be removed and either replaced or repaired at the expense of the contractor.

11.01 Brick

A. All brick used shall, unless otherwise shown or specified, be of such quality as to meet ASTM Designation C62-62 Grade SW for hard grade, common, building brick or clay or shale 2-1/4 x 3-3/4 x 8 inches in size.

B. Should brick be brought upon the site of the work of which only a portion is of acceptable quality, the Contractor shall once remove the same and shall not offer them again for inspection.

11.02 Mortar and Grout Materials

A. The brick shall be laid in mortar consisting of one (1) part by volume of Portland Cement and two (2) parts of volume of clean, coarse, screened sand, thoroughly mixed dry, with sufficient water afterwards added slowly to give proper consistency. Twenty (20) pounds of lime per sack of cement may be added.

B. Portland Cement shall meet ASTM C150, Type I, natural color, domestic manufacturer. Use only one brand of cement throughout project.

C. Masonry Cement shall meet ASTM C91-89, non-staining, 22% maximum air content by volume.

D. Hydrated Lime shall meet ASTM C207-79 (1988), Type S.

E. Aggregates for mortar shall meet ASTM C144-87 and ASTM C404-87, size 2 natural and shall be clean, hard and washed sand.

F. Aggregates for cement grout shall meet ASTM C404-87, fine aggregate, size 1.

G. Water reducing and plasticizing admixtures are acceptable.

H. Admixtures containing calcium chloride shall not be used unless approved by FCDSW Engineer.

I. Water shall be clean, potable and free from deleterious amounts of alkalis, acids and organic matter.

J. Non-shrink Grout: Submit products for approval by FCDWS Engineer.

11.03 Mortar and Grout Proportions

Proportion materials by volume in accordance with ASTM C270-88a or as follows.

A. Mortar: One (1) part Masonry cement to ½ part Portland cement to aggregate proportioned at not less than 2-1/4 nor more than three (3) times the volume of cementious material used.

B. Grout: One (1) part Portland cement and ¼ to ½ parts hydrated lime to aggregate, proportioned at not less than three (3) times the combined volume cement and lime used.

11.04 Concrete Masonry Units

A. Concrete masonry units shall be in accordance with ASTM C90-85, light weight, Grade N, Type 1.

B. Concrete masonry units shall have a nominal face dimension of 8”x 8”x16” or 8”x12”x16”.

C. Concrete masonry units shall have a minimum compressive strength of 2,500 psi, based on net area.

D. Concrete masonry units damaged in any manner shall not be used.

11.05 Joint Reinforcement

Horizontal joints between concrete masonry units shall be reinforced as follows.

A. Use cold drawn wire meeting ASTM A82-88.

B. Longitudinal rods shall be nine (9) gauge galvanized deformed wires with nine (9) gauge galvanized cross wires welded to form triangular style pattern.

C. Width of reinforcement shall be two (2) inches less than the total wall thickness.

D. Provide reinforcement in ten (10) foot lengths with prefabricated corners and tees at intersecting walls of same design and finish.

Acceptable Manufacturers

1. As Approved.

11.06 Brick Laying

A. The brick shall be laid regularly and truly to line with joints not exceeding one-quarter (1/4) inch in thickness on the face and with joints completely filled with mortar as each brick is pushed into place and no subsequent filling of said joints will be allowed. No bats or imperfect bricks will be permitted to be used.

B. The exposed faces of the brick masonry shall have all mortar projecting beyond the surface of the brick scraped off and the brickwork shall be thoroughly cleaned, and the joints pointed immediately after placing.

C. No broken or cut brick will be allowed to be used except where necessary as closures, and where cutting of bricks is necessary. Then such faces as are exposed in the same must be accurately trimmed to the contour of the face of the work in which the bricks are laid.

D. All brick work shall be bonded as may be directed and adjoining courses shall break joint one-half a brick as nearly as practicable. The brick work shall be executed straight and vertical or regularly curved or battered as shown or specified. Whenever brick masonry is left for the night or is left unfinished for any reason, the masonry shall be racked off or toothed as directed and mortar removed from the exposed surfaces of the bricks. When new work is joined to work previously laid, the old brick work must first be thoroughly scraped free from adhering mortar or earth, and thoroughly washed with water.

12.01 Materials Requiring Coatings

A. Materials for buried surface shall be coated as indicated in their respective section.

B. The following materials shall have exterior coatings manufacturer applied or field applied.

1. Piping and appurtenances
2. Supports
3. Pumps
4. Valves
5. Equipment and appurtenances

12.02 Coating Schedule

A. Non-Submerged Ferrous Metal
Minimum Surface Preparation: SSPC – SP6
Generic System Type: Aliphatic Polyurethane

Coat No.	Induron		Tnemec	
	DFT	Product	DFT	Product
1	3.0	P-14	2.0	#69
2	3.0	Armorgaurd	2.0	#69
3	2.0	5500	2.0	#74

B. Submerged Ferrous Metal
Minimum Surface Preparation: SSPC – SP10
Generic System Type: Polyamide Epoxy

Coat No.	Induron		Tnemec	
	DFT	Product	DFT	Product
1	5.0	PE-54	5.0	#20 P-Pox
2	5.0	PE-54	5.0	#20 P-Pox

C. Non-Submerged Non-Ferrous and Galvanized Metal
Minimum Surface Preparation: SSPC – SP6 (non-ferrous); SP1 (galvanized)
Generic System Type: Aliphatic Polyurethane

Coat No.	Induron		Tnemec	
	DFT	Product	DFT	Product
1	0.5	VW Prime	5.0	#69
2	2.0	5500	2.0	#74

D. Submerged Non-Ferrous and Galvanized Metal
Minimum Surface Preparation: SSPC – SP10 (non-ferrous); galvanized per coating manufacturer. Generic System Type: Polyamide Epoxy

Coat No.	Induron		Tnemec	
	DFT	Product	DFT	Product
1	0.5	VW Prime	5.0	#69-1211
2	5.0	PE-54	5.0	#69

Acceptable Manufacturers

1. Induron.
2. Tnemec.
3. As Approved.

SECTION 13: MISCELLANEOUS MATERIALS

Materials not covered in Division III, Material Requirements, shall be in accordance with the approved plans.

1.01 Contractor License

A. A licensed Utility Contractor shall install any underground utility or component thereof.

B. Prior to commencing construction activities on a FCDWS approved project, the FCDWS Engineer/Inspector shall receive a copy of the Utility Contractor's License.

1.02 Utility Notification

A. The Official Code of Georgia, Title 25, Chapter 9 requires that utilities be located in the proposed work area prior to commencing any clearing, grading or excavation activity.

B. The Utilities Protection Center can be reached at (770) 623-4344 or 1-800-282-7411.

C. The Utilities Protection Center shall be notified at least three (3) business days prior to commencing work.

1.03 Work Commencement

A. Clearing and grubbing activities shall not commence on any project until Forsyth County Engineering has issued a Land Disturbance Permit.

B. Work on a water distribution system and/or sanitary sewer system shall not begin until the FCDWS approves the development plans, and permit is issued by Forsyth County Engineering.

C. Contractor shall schedule & attend a pre-construction meeting with FCDWS Inspector prior to beginning work.

D. The FCDWS Engineer shall receive a 24-hour notice prior to commencing construction activities on a water distribution system and/or sanitary sewer system.

E. A set of plans stamped approved by the FCDWS shall be present on the job site during all phases of construction of the water distribution system and/or the sanitary sewer system.

F. The installation of water distribution piping should not begin until curb and gutter has been installed, and lot lines and numbers are painted on the curb.

1.04 Miscellaneous Standards

Construction standards not covered in Division IV, Construction Standards, shall be in accordance with the approved plans.

2.01 General

A. Work covered by this section shall include all labor, equipment and accessories required to distribute material.

B. All materials installed as part of an extension to the existing water distribution system and sanitary sewer system shall be new

2.02 Delivery

Equipment and facilities shall be furnished for unloading and distributing pipe, equipment and materials.

2.03 Handling

A. Pipe shall be handled by use of forklift or excavator using choker straps or cable. Forks, chains or other devices shall not be inserted into pipe.

B. Any pipe, equipment or material dropped or dumped during handling procedures shall be subject to rejection by the FCDWS without further justification.

2.04 Storage

A. Pipe should not be strung more than 500 feet beyond the point where pipe is being laid.

B. Drainage ditches shall not be obstructed by stored materials.

C. Necessary arrangements shall be made to store pipe, fittings, valves and accessories that cannot be distributed along the route.

D. Pipe that is either stored or strung out shall be kept clean, so no dirt or mud is allowed to get inside pipe.

2.05 Maintenance and Protection

A. The contractor shall be responsible for maintenance and protection of all pipe, equipment and material.

A. All equipment shall be boxed, crated or otherwise completely enclosed and protected during transportation, handling and storage.

C. Equipment shall be stored above ground level and adequately supported on wood blocking or other approved support material.

D. All equipment shall be protected from exposure to elements and shall be kept dry at all times.

E. Pumps, motors, valves, control panels, instrumentation, electrical equipment and other equipment having anti-friction or sleeve bearings shall be stored in a weather-tight enclosure which is maintained at a minimum air temperature of 60°F.

F. Any pipe, equipment or material damaged by impact, vibration, abrasion, discoloration or other damage shall be repaired in accordance to manufacturer instructions or replaced at the discretion of the FCDWS.

3.01 Clearing and Grubbing

A. Prior to commencing clearing activities, areas designated by the plans to be cleared shall be demarcated using survey ribbon, stakes or other suitable means.

B. In areas to be cleared, all trees, stumps, buried logs, brush, grass and other unsatisfactory materials shall be removed.

C. Trees to remain in or near work area shall be protected from clearing activities.

D. All damaged trees over three (3) inches in diameter shall be repaired by an experienced nursery expert.

E. Tap roots and other projections exceeding 1-inch in diameter shall be grubbed out to a depth of at least 18 inches.

F. All holes remaining after grubbing activities shall be filled with suitable material and properly compacted in layers to density required for in-place backfill.

G. All materials cleared and grubbed shall be disposed of off-site in accordance with applicable local, state and federal regulations.

H. Burning of any material or debris shall not be permitted on County property without written authorization from FCDWS.

I. Prior to and upon completion of clearing and grubbing activities, install erosion control and sedimentation measures as identified on the Erosion Control and Sedimentation Plan prepared by the Design Engineer.

J. Prior to commencing any other job site activity, installed erosion control and sedimentation measures shall be inspected and approved by Forsyth County Department of Engineering, or their designated representatives.

3.02 Topsoil Stockpiling

A. Remove topsoil to full depth encountered in areas to be graded and stockpile soil and install erosion control devices as indicated on drawings.

B. Soil shall be placed such that the integrity of an excavation or proposed excavation is not jeopardized.

C. Soil shall not be stockpiled against tree trunks.

D. Stockpile shall be shaped to drain.

3.03 Removing Pavement

A. Removal of pavement shall be performed so as not to endanger roadway activity. Work shall be coordinated and be in compliance with the appropriate road and highway agencies.

B. Pavement shall be marked squarely and neatly to size of excavation.

C. Pavement shall be scored and broke along the marked lines using a rotary saw and jackhammer.

D. Upon removal, pavement shall be loaded and disposed of off-site.

E. Adjacent pavement damaged during construction shall be removed as described above.

F. Driveways and sidewalks shall be removed to their full width from the edge of curb or road pavement to the nearest construction/control joint.

G. Curbs shall be removed for the entire length from control joint to control joint.

4.01 Soil Excavation

A. Excavation shall include those measures necessary to establish grades indicated on drawings for utilities, structures and appurtenances.

B. Excavated soil shall be placed in a location such that the integrity of the excavation is not jeopardized.

C. Excavation walls shall be sloped or stepped in accordance with recognized industry standards.

D. The Contractor shall assume the responsibility for design and construction of excavation shoring and bracing capable of supporting excavations and construction loads.

E. The excavation shall provide space for foundation work and inspection.

F. Excavations shall be covered in accordance with applicable regulations and/or barricaded and roped-off with identifying tape during work progress.

4.02 Rock Excavation

A. Excavation shall include those measures necessary to establish grades indicated on drawings for utilities, structures and appurtenances.

B. Rock shall be excavated to a minimum depth of six (6) inches below grades indicated on drawings.

C. The Contractor shall be responsible for determining methods required for removal of rock or hard materials.

D. Perform blasting only after receiving written approval from the applicable regulatory agencies.

E. A licensed explosive contractor shall perform blasting operations.

F. Blasting operations shall be conducted in accordance with all local, state and federal regulations.

G. Excavated rock shall not be used as backfill in the pipe trench.

4.03 Pipe Trench Excavation

A. Pipe trenching shall comply with excavation and rock excavation specifications.

B. Trench should be excavated to natural undisturbed soil.

C. Where unsuitable material is encountered, over excavate through unsuitable material and backfill to required grade with No. 57 stone. The FCDWS Inspector shall determine depth of over excavation. No. 57 stone shall conform to the GDOT Standard Specifications for the Construction of Roads and Bridges, latest edition.

D. Where encountered, remove rock to a minimum of six (6) inches below required bottom of trench elevation and backfill to required grade with No. 57 stone.

E. Bottom of trenches shall be prepared so that the entire length of the pipe barrel is supported.

F. Maintain trenches dry at all times using pumps, well points or other dewatering means.

G. Limit trenching to not greater than 300 feet ahead of completely backfilled work.

H. In populated areas, cover or barricade open trenches until completely backfilled.

I. Open trenches shall be made safe at all times.

5.01 Pipe Bedding

A. PVC sewer shall be bedded according to manufacturers specifications and ASTM D 2321, latest revision

B. PVC sewer shall be laid atop a minimum of four (4) inches of No. 57 stone. No. 57 stone shall be extended to the top of pipe. Stone shall be shovel sliced from beneath the pipe up to one-half (½) the pipe diameter. (Use detail No. 31.0 and 32.0). No. 57 stone shall conform to the GDOT Standard Specifications for the Construction of Roads and Bridges, latest edition.

C. DIP shall be laid with type III, IV, or V bedding, depending on pipe diameter, class, and laying conditions. (Use detail No. 33.0 and 34.0)Valves shall be laid atop a minimum of twelve (12) inches of No. 57 stone. No. 57 stone shall be extended up to one-half (1/2) the valve diameter. Stone shall extend twelve (12) inches in all directions of valve. Stone shall be shovel sliced.

D. Standard Laying Conditions

   a. Type 1 - Flat bottom, undisturbed soil with loose backfill
   b. Type II - Flat bottom, undisturbed soil backfill is lightly consolidated to centerline of pipe
   c. Type III – Pipe is bedded in 4 inch loose, native soil excavated from the pipe trench, free of foreign materials and rocks. Backfill is lightly consolidated to the top of the pipe
   d. Type IV – Pipe bedded in sand, gravel or crushed stone in accordance with ASTM D 2321 and ASTM D 2487, latest revisions. Bedding shall be to a depth of one eighth (1/8) pipe diameter or 4 inch minimum. Backfill material shall be compacted to the top of the pipe approximately eighty (80) per cent standard proctor, AASHTO T-99
   e. Type V – Pipe bedded to its centerline in compacted granular material as defined per the Unified Soil Classification System ASTM D 2487

E. Fire hydrants shall be set atop a minimum of twelve (12) inches of No. 57 stone. Stone shall extend up six (6) inches above drain holes. Stone shall extend eighteen (18) inches to the sides of the hydrant. (Use detail No. 9.0, 10.0, and 11.0)

5.02 Pipe, Fitting, Valve and Fire Hydrant Installation

A. Prior to placement, the interior of pipes, fittings and valves shall be cleaned free of dirt and debris.

B. Pipe, fittings, valves and accessories shall not be laid or jointed in water.

C. Pipe, fittings, valves and accessories shall be lowered into their respective positions using an excavator with choker straps or cables. Pipe barrel shall be supported for its entire length.

D. Gravity flow pipe shall be laid to the consistent grade change as indicated on drawings and aligned straight using pipe laser or transit.

E. Pressure flow pipe shall be aligned to follow route. Pipe alignment shall not be deflected greater than 75% of the manufacturer's recommended maximum deflection.

F. Install compression type gaskets in accordance with manufacturer's instructions to ensure proper joint sealing.

G. Pipe shall be jointed in accordance with manufacturer's instructions. The mating ends (bell and spigot) shall be thoroughly cleaned and soaped before jointing. The mating ends shall be aligned and shoved together using a steady force.

H. Connections of fittings, valves and fire hydrants shall be with bolts and nuts as supplied with the component. Upon tightening, a minimum of two (2) bolt threads shall be exposed to ensure proper thread engagement.

I. Retaining gland of mechanical joint shall be evenly spaced from the fitting or valve for its entire circumference upon installation.

J. After jointing pipe, repair any damage to pipe's protective coating in accordance with manufacturer's instructions or replace pipe.

K. Prior to jointing consecutive pipe, backfill previously jointed pipe with sufficient material to prevent movement.

L. Place a plug in the open end of uncompleted laid piping at the end of each day.

5.03 Thrust Blocking

A. Thrust blocking shall be installed at all bends, tees, valves, fire hydrants and points where thrust may develop in pressurized piping.

B. Thrust blocking shall consist of cast-in-place concrete, tie rods, combinations thereof or other method approved by the FCDWS Engineer.

C. Cast-in-place concrete blocking shall be formed to the required dimensions and installed against undisturbed earth. Blocking size may be increased based on soil bearing capacity. Forms may be earthen berm, or wood as directed by FCDWS Engineer/Inspector.

D. Concrete shall have a minimum 3,000 psi compressive strength at 28 days, and shall be plant mix.

E. Bolts and nuts shall be protected from concrete coverage.

F. Use detail No. 16.0, 17.0, 18.0, and 19.0 when applicable.

5.04 Manhole Installation

A. Manholes shall be set atop a twelve (12) inch bed of No. 57 stone that extends a minimum of twelve (12) inches beyond all exterior sides.

B. The bedding of No. 57 stone may be replaced with a six (6) inch layer of steel reinforced cast-in-place concrete.

C. The bed shall be prepared so that the manhole is set level.

D. Manhole sections shall be handled with lifting straps or hooked cables using a minimum of two (2) of the manufactured manhole lifting holes.

E. Manhole sections shall be positioned such that influent and effluent piping enter the center of their respective opening not pinching the rubber boot seal. Pipe shall not rest on invert of opening.

F. Stainless steel boot clamps shall be tightened in accordance with the manufacturer's instructions.

G. Annulus between pipe and rubber boot shall be grouted with non-shrink grout prior to commencing backfill operations.

H. An invert shall be built in each manhole to transition flow from the influent pipe to the effluent pipe, if pre-cast inverts are not used.

I. The built invert shall be shaped as a “U” channel and match the inverts of the influent and effluent pipes.

J. Inverts shall be pre-cast, or be built of rowlock brick and mortar.

K. Prior to jointing consecutive sections, tongue-and-grooved ends shall be cleaned free of dirt and debris.

L. Tongue-and-grooved ends shall be fitted with preformed gasket sealing compound.

M. Manhole joints and grade adjustment rings shall be sealed with an 8” EDPM rubber seal wrap for joints and a flexible EDPM rubber seal for grade adjustment rings to prevent leakage of water into the manhole.

N. Manhole sections shall be stacked level and plumb at all times.

O. Manhole sections shall be stacked such that interior steps are vertically aligned.

P. Manhole lifting holes shall be sealed using non-shrink grout throughout the entire depth of hole.

Q. Upon bringing manhole to finished grade with pre-cast grade rings, set ring and cover with non-shrink grout.

R. Manholes shall be kept free of dirt and debris.

S. Use detail No. 41.0, 42.0, 43.0, and 44.0 when applicable.

5.05 Lateral Installation

A. Laterals shall have a minimum diameter of 6”, be of the same material as mainline, and be set as shown on plans.

B. Lateral shall extend to R/W or easement line, where a 6” clean out shall be installed, stubbed out 5’ above grade and capped.

C. After a residence or facility connects to sewer lateral, the clean out shall be set to grade and set in a cast-iron meter box.

D. Use detail No. 38.0, 39.0, and 40.0 when applicable.

5.06 Meter Box and Vault Installation

A. Meter boxes shall be installed as follows.

1. Meter box shall be set atop 6” of No. 57 stone. Backfill around box shall be compacted using a hand tamp.

2. Top of meter box shall be set flush with curb, or finished grade. Meter box shall not be set in a depression.

3. Stone within meter box shall be to the bottom of the meter assembly and free of debris.

B. Meter vaults shall be installed as follows.

1. Meter vault shall be bedded atop undisturbed or compacted soil. Backfill around vault shall be compacted in accordance with Division IV, Section 6.

2. Vaults shall be set atop a minimum twelve (12) inch layer of No. 57 stone that extends a minimum of twelve (12) inches beyond the outside face of all walls.

3. The bedding of No. 57 stone may be replaced with a six (6) inch layer of steel reinforced cast-in-place concrete. A vault drain must also be installed.

4. The stone filled sump beneath vault drain shall be fully encased in a geo-fabric membrane.

5. The bed shall be prepared so that vault is set level.

6. Annulus between pipe and wall openings shall be bricked and grouted with non-shrink grout or brick and mortar prior to commencing backfill operations.

7. Prior to installing vault cover, tongue-and-grooved ends shall be cleaned free of dirt and debris.

8. Tongue-and-grooved ends shall be fitted with preformed gasket sealing compound.

9. Vault lid lifting holes shall be sealed using non-shrink grout throughout the entire depth of hole.

10. Vault shall be kept free of dirt and debris.

11. Top of vault lid shall be set no more than three (3) inches above finished grade. Vault shall not be set in a depression.

12. Use detail No. 6.0, and 7.0 when applicable.

5.07 Borings and Casings

A. The Contractor shall provide to the FCDWS for approval, a detailed plan for the methods proposed for the construction of the casing. These plans shall include the methods proposed for groundwater control and face protection.

B. In general, jack and bore operations shall conform to the requirements of the Georgia Department of Transportation as presented in their Standard Specifications for the Construction of Roads and Bridges, latest edition. If a conflict between these specifications and the Georgia Department of Transportation specifications exists, the Department of Transportation specifications shall govern.

C. Install the steel casing pipe by the dry boring method. Bore the hole and install the casing through the soil simultaneously by a cutting head on a continuous auger mounted inside the casing pipe. Fully weld lengths of casing pipe to the preceding section in accordance with AWS recommended procedures.

D. After construction of the casing is complete, and has been approved by FCDWS, install the pipeline in accordance with the detailed Drawings and/or the Specifications.

E. Check the alignment and grade of the casing and prepare a plan for approval to set the carrier pipe at proper alignment, grade, and elevation. The carrier pipe shall be supported by stainless steel casing spacers to limit radial movement to a maximum of 1-inch within the casing. Provide a minimum of two spacers for each section nominal length of pipe. One spacer shall be placed not more than two feet from each end of the casing. Subsequent spacers shall be placed at a maximum spacing of 10 feet within the casing.

F. Seal the ends of the casing with 4-inch brick walls, plastered with Portland cement mortar and waterproofed with asphaltic roofing cement or Link-Seal Model PL or approved equal.

G. Provide all necessary bracing, bulkheads, and shields to ensure complete safety to all traffic at all times during the work. Perform the work in such a manner as to not permanently damage the roadbed or interfere with normal traffic over it.

H. Begin the bore operation in a pit, sheeted and shored as necessary, and proceed from one end. Observe all applicable requirements of Georgia Department of Transportation regulations. Conduct the operations in such a manner that all work will be performed below the level of the roadbed. Coordinate and schedule all of the work with the Georgia Department of Transportation if on a State highway.

I. Complete all boring work at one particular location before boring work is started at another location.

J. If, in the opinion of the FCDWS or Georgia Department of Transportation, the casing installation work is being conducted in an unsafe manner or in a manner detrimental to the over-passing roadway or to the safety of the traveling public, all operations of boring shall cease until the necessary corrections have been made. In the event that distress occurs to the roadway due to the boring, the Contractor shall be required to submit a plan to repair the roadway. The plan must be acceptable to Department of Transportation and/or Forsyth County. After approval, the road repairs shall be made by the Contractor.

K. Casing damage during installation shall be repaired. Should damaged casing prevent the installation of the pipe, then that boring and casing shall be abandoned.

L. Use detail No. 26.0 and 27.0 when applicable.

5.08 Pipe and Valve Identification

A. Install aluminum detection tape or other detectable wire, during backfill operations, above nonferrous pipe or any pressure pipe having more than six (6) feet of cover. Detection tape or wire shall be installed approximately two (2)

feet below finished grade. Sanitary sewer force mains shall be marked by tape; other lines as directed by FCDWS Engineer.

B. Service lines and valves shall be locatable via marked curbing or other FCDWS approved method. Adjacent street curb to service line and valves shall be marked via saw-cut as follows. Curb markings shall be a minimum of four (4) inches in height.

1. "W" for water service location.
2. "V" for water valve location.
3. "X" for sewer service location.

C. Concrete valve markers are required at each valve, set to a minimum 18" above grade, per Forsyth County Detail No. 13.0.

6.01 Backfill

A. Excavations shall be backfilled using suitable material recommended in ASTM D 2321 Table 2, Recommendations for Installation and Use of Soils and Aggregates for Foundation, Embedment, and Backfill with soil groups classified by the Unified Soil Classification System outlined in ASTM D 2487

B. The suitability of backfill materials shall be as defined in ASTM D 2321 Table 1 Classes of Embedment and Backfill Materials

C. Place no backfill until any poured concrete has developed design compressive strength.

D. Place backfill against below grade walls in uniform level lifts to prevent wedging action.

E. Backfill shall not be placed on surfaces that are saturated, frozen or containing frost or ice.

F. Place backfill in excavations as follows.

1. Backfill in loose lifts not exceeding 6 inches when compacting using manual tamping devices (jumping jack).

2. Backfill in loose lifts not exceeding 12 inches when compacting using vibrating/ramming devices (sheep-foot vibratory roller).

G. Any settlement shall be filled and compacted to conform to adjacent surfaces.

H. All material remaining after completion of backfilling operations and unsuitable excavated material must be properly disposed of in a manner acceptable to Forsyth County and in a manner that will not adversely impact the development***.***

6.02 Compaction

A. Backfill shall be compacted using manual tamping devices or vibrating/ramming devices.

B. Use manual tamping devices as follows.

1. When area is inaccessible to vibrating devices and within 5 feet of below grade walls (includes manholes).

2. From bottom of pipe trench to twelve (12) inches above the top of pipe.

C. Compaction requirements are as follows.

1. Backfill, beneath and within 10 feet of the building line of any structure, proposed structure or other area determined by the FCDWS, shall be compacted for the entire depth to a minimum of 98% of the maximum dry density as determined by a Standard Proctor Analysis at ± 3% of optimum moisture content.

2. Backfill, beneath any road, walk, proposed improvement or area determined by the FCDWS shall be compacted for the entire depth to a minimum of 100% of the maximum dry density as determined by a Standard Proctor Analysis at ± 3% of optimum moisture content.

3. Backfill in road right-of-way and not described above shall be compacted the entire depth to a minimum of 95% of the maximum dry density as determined by a Standard Proctor Analysis at ± 3% of optimum moisture content.

6.03 Compaction Testing

A. Soil samples from the proposed construction area shall be analyzed for maximum dry density in accordance with ASTM 698 – Method C.

B. The extent of testing required shall be dependent upon soil conditions, Contractor's methods of construction and regulatory requirements.

C. Minimum compaction testing shall be as follows.

1. Backfill in excavations shall be tested at 2-foot lift intervals per 1,000 square feet of fill or as deemed necessary by the FCDWS Engineer/Inspector.

2. Backfill in trench excavations shall be tested at 2-foot intervals per 400 linear feet of fill or as deemed necessary by the FCDWS Engineer/Inspector.

7.01 Grading

A. Grade areas to lines and elevations indicated on drawings or to surrounding surface grades.

B. Graded areas shall be within 0.10 foot of required sub grade elevation and shall not permit the ponding of water.

C. In areas to receive grassing, redistribute stockpiled topsoil over graded areas to a minimum depth of four (4) inches. Provide additional topsoil to achieve required depth.

D. Where finish grade meets or abuts curbs, walks or pavement, uphill grades shall be slightly higher than curb or pavement to permit drainage.

E. All material remaining after completion of backfilling operations and unsuitable excavated material must be properly disposed of in a manner acceptable to Forsyth County and in a manner that will not adversely impact the development.

F. Stabilize site in accordance with the approved soil erosion and sedimentation control plan.

7.02 Replacing Pavement

A. Existing pavement shall be replaced in accordance to the standards required by Forsyth County Engineering and/or the Georgia Department of Transportation.

B. Construction shall be performed so as not to endanger roadway activity. Work shall be coordinated and be in compliance with the appropriate road and highway agencies.

C. Pavement shall be reinstalled immediately after completing backfill operations and compaction requirements.

D. Driveways and sidewalks shall be replaced to their full width from the edge of curb or road pavement to the nearest construction/control joint.

E. Curbs shall be replaced for the entire length from control joint to control joint.

F. Removed pavement shall be disposed offsite.

F. Use Detail No. 35.0, 36.0 and 37.0 when applicable.

8.01 General

A. The following tests shall be performed at the expense of the Developer/Utility Contractor.

B. Water distribution systems and/or sanitary sewer systems failing the required tests shall be repaired at the expense of the Developer/Utility Contractor.

8.02 Mandrel Testing

A. PVC Sanitary sewers shall be tested for deformation using a mandrel in accordance with ASTM D 3034.

B. Pipe shall be tested at the end of the 1-year maintenance period.

C. Pipe shall be free of dirt and debris.

D. Cords shall be attached to each end of the mandrel. One cord shall be passed through the section of pipe being tested. One cord shall be used to retrieve the mandrel should the pipe not allow passage.

E. The mandrel shall be sized such that its outside dimension is 5% less than the actual inside diameter of the pipe.

F. Test shall be considered acceptable when mandrel passes freely through pipe.

8.03 Televising

A. Sanitary sewers shall be televised to ensure integrity.

B. Pipe shall be free of dirt and debris. Pipe shall be jetted, flushed, and vacuumed prior to test.

C. Televising cable attached to a video monitor shall be directed through pipe to view for the following deficiencies.

1. Cracks in pipe and liner material.
2. Rolled gaskets.
3. Leaking joints.
4. Deviations from line and grade.
5. Other deficiencies.

D. Contractor shall repair all deficiencies noted by FCDWS. Method must be approved by FCDWS Engineer.

E. Test shall be considered acceptable when the televised pipe does not reveal the deficiencies indicated in Item C.

F. Test shall be recorded on F.C. T.V. Test form Appendix G.

8.04 Hydrostatic

A. Water distribution piping and force mains shall be subjected to a hydro static pressure and leakage test in accordance with AWWA Standard C600, latest edition.

B. Pipe shall be flushed free of dirt and debris.

C. A corporation stop or fire hydrant shall be installed at the high point of elevation in the pipe line system to release air, or a meter service can be used if in the right location.

D. Water and force main pipe shall be filled with potable water to a pressure of 200 psi as measured from the lowest elevation of testing and pipe pressure allowed to stabilize. Hydrostatic pressure testing will not be done unless the temperature is at least 36 degrees (F) and rising

E. Pressure test shall be considered acceptable when test pressure has not varied by more than +/- 5 psi for a minimum period of two (2) hours.

F. After satisfactory completion of the pressure test, all pressure piping shall be leak tested. During test period, pressure shall be maintained within 5 psi of test pressure.

G. Leakage test shall be considered acceptable when leakage is less than or equal to the allowable leakage as calculated in

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

L = allowable leakage, gal/hr

S = length of pipe, ft

D = diameter of pipe, in
P = test pressure, psi

8.05 Air Pressure

A. All gravity sewer pipes, including service laterals, shall be subjected to a low air pressure test in accordance with Uni-bell UNI-B-6-98.

B. Pipe shall be free of dirt and debris.

C. During testing, personnel shall not be permitted in manholes connected to pipe being testing.

D. The internal air pressure of the pipe shall be raised to four (4.0) psi greater than the average back pressure of groundwater around the sewer (add 0.43 psi to test pressure for each vertical foot that the groundwater is above the top of pipe). Test pressure shall not exceed 9.0 psi.

E. The test shall begin when the stabilized pressure is at a minimum of 4 psi greater than the average back pressure of groundwater around the sewer.

F. If the time shown in the following table for the designated pipe size and length elapses before the air pressure drops 1.0 psi; the section undergoing test shall be considered acceptable

G. If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be considered acceptable and the test complete.

AIR TEST - BASED ON FORMULAS FROM UNI-N-6-98

SPECIFICATION TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP FROM 3 1/2 TO 2 1/2 PSIG WHEN TESTING ONE PIPE DIAMETER ONLY

	PIPE DIAMETER IN INCHES													
Length	4	6	8	10	12	15	18	21	24	27	30	33	36	42
25	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:40	25:30	28:20	31:10	34:00	39:40
50	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:40	25:30	28:20	31:10	34:00	39:40
75	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:40	25:30	28:20	32:19	38:28	52:21
100	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:48	28:51	35:37	43:06	51:17	69:48
125	3:47	5:40	7:33	9:27	11:20	14:10	17:00	21:49	28:30	36:04	44:31	53:52	64:06	87:15
150	3:47	5:40	7:33	9:27	11:20	14:10	19:14	26:11	34:11	43:16	53:25	64:38	76:56	104:42
175	3:47	5:40	7:33	9:27	11:20	15:35	22:26	30:32	39:53	50:29	62:20	75:25	89:45	122:10
200	3:47	5:40	7:33	9:27	11:24	17:48	25:39	34:54	45:35	57:42	71:14	86:11	102:34	139:37
							:							
225	3:47	5:40	7:33	9:27	12:49	20:02	28:51	39:16	51:17	64:55	80:08	96:58	115:24	157:04
250	3:47	5:40	7:33	9:54	14:15	22:16	32:03	43:38	56:59	72:07	89:02	107:44	128:13	174:31
275	3:47	5:40	7:33	10:53	15:40	24:29	35:16	47:59	62:41	79:20	97:56	118:31	141:02	191:58
300	3:47	5:40	7:36	11:52	18:00	26:43	38:28	52:21	68:23	86:33	106:51	129:17	153:51	209:25
350	3:47	5:40	8:52	13:51	19:57	31:10	44:52	61:05	79:47	100:58	124:39	150:50	179:30	244:19
400	3:47	5:42	10:08	15:50	22:48	35:37	51:17	69:48	91:10	115:24	142:28	172:23	205:09	279:13
450	3:47	6:25	11:24	17:48	25:39	40:04	57:42	78:32	102:34	129:42	160:16	193:55	230:47	314:07

Table based on allowable air loss of .0015 cu ft / min per square foot of internal pipe surface and a maximum air loss per test section of 1 cu ft / min

8.06 Vacuum Testing for Manholes

A. Vacuum testing of manholes for water tightness may be required to demonstrate the integrity of the installed materials and the construction procedure

B. Testing shall be in accordance with ASTM C 1244

C. If the manhole fails the initial test, the contractor shall make all necessary repairs, then retest until a satisfactory test is obtained

9.01 General

A. All newly installed water distribution piping and piping affected during construction shall be disinfected in accordance with AWWA C651.

B. The FCDWS shall be involved in disinfecting the following piping.

1. Water mains.
2. Service connections up to and including water meters and back flow prevention devices.

C. The Contractor shall supply an appropriate chlorine solution and complete disinfection procedures.

D. Water for disinfection shall be provided by the FCDWS at no expense to the contractor.

E. Excessive use of water during disinfection procedures, as determined by the FCDWS, may be reason for charges to be levied against the contractor.

F. Collection and testing of water samples shall be performed by the FCDWS at the expense of the developer. The fee for the test will be collected when the final plat and as-builts are presented to FCDWS for approval.

G. No water piping system shall be placed in service until written approval is received from the FCDWS Engineer/Inspector.

H. The contractor shall be responsible for preventing soil erosion associated with disinfecting procedures.

9.02 Initial Flushing

A. Prior to disinfection, the contractor shall flush piping system with sufficient water to create a minimum velocity in the pipe of 2.5 ft/s.

B. All piping and components associated with service connections shall be thoroughly flushed with fresh potable water prior to installation.

9.03 Chlorination

A. The Contractor shall introduce a chlorine solution having a concentration of 50 to 100 milligrams per liter (mg/l) into the piping system.

B. Upon introducing chlorine solution, all valves associated with piping system shall be fully operated to ensure complete disinfection.

C. Piping system shall have a minimum 25 mg/l chlorine residual after a 24-hour retention period.

D. Disinfection of piping system shall be repeated until the minimum chlorine residual is obtained.

E. All piping and components associated with service connections shall be thoroughly flushed with a chlorine solution.

F. Laboratory analyses shall be performed and certified by the FCDWS.

9.04 Final Flushing

A. After chlorination is complete, the contractor shall flush the piping system until the chlorine residual in water of the piping system is at a maximum concentration of one (1) mg/l.

B. After chlorination is complete, all piping and components associated with service connections shall be thoroughly flushed with fresh potable water.

C. Due to the proximity of creeks, streams, ponds, or other bodies of water, the Contractor may be directed to dechlorinate any water flushed from the main to prevent damage to aquatic organisms, plants, fish, etc.

10.01 Formwork

A. Formwork shall comply with ACI 347R-94.

B. Contractor shall be responsible for design and construction of concrete formwork capable of supporting construction loads. Forms shall be as follows.

1. Pre-engineered steel.
2. Pre-engineered reinforced fiberglass.
3. Wood.
4. Earth.

C. Construct formwork to lines and elevations as shown on drawings.

D. Construct forms to be removed without hammering or prying against concrete.

E. Plug holes in existing forms to prevent leakage of cement.

F. Clean forms of dirt and debris prior to each use.

G. Form ties shall be as follows.

a. Break-back type with 5/8-inch removable sleeve or 1-inch cone type.

b. For retaining walls and walls below liquid level, provide ties with positive water stop projection at center of wall.

H. Prior to placement of reinforcing steel, apply form release agent to formwork. Release agent shall be evenly applied and compatible with type form being used.

I. Construct bulkheads with shear keys at separation of pours.

J. Shear key width shall be 1/3 of the wall or slab thickness.

K. Removal of formwork shall take place only after concrete has developed sufficient strength to support itself and resist damage during removal.

L. Forms used below grade shall be removed prior to backfill.

10.02 Steel Reinforcement

A. Shop fabricate reinforcement to shape and dimensions as indicated on drawings.

B. Use no bars or wire mesh with kinks or bends not shown on the drawings.

C. Secure reinforcement in forms in accordance with the drawings, ACI 315, ACI 318 and CRSI “Recommended Practice for Placing Reinforcing Bars”.

D. Steel reinforcement shall set atop concrete bricks and/or be spaced using steel highchairs. When highchairs are used as a form spacer, the highchair feet shall be plastic dipped.

E. Concrete coverage over reinforcing shall be as follows.

1. Concrete cast against earth ..... 3 inches.
2. Formed concrete exposed to earth or weather..... 2 inches.
3. Slabs and walls exposed to wet conditions ..... 2 inches.
4 Interior slabs and walls..... ¾ inch.

F. Splice reinforcement a minimum of 48 times (x) bar diameter. Mechanical splices shall be prohibited.

H. Steel reinforcement, at the time cement is placed, shall be free of dirt, rust and debris. Reinforcement with flaking rust shall not be used.

I. Conduits and pipes shall have same concrete coverage as reinforcing steel.

J. Tie wire shall be used to secure reinforcing.

K. Joints in wire mesh shall be lapped one wire spacing plus 2 inches. Wire mesh shall have one (1) inch of concrete cover at forms.

10.03 Placement

A. Place concrete in accordance with ACI 301-89, Chapter 8.

B. Place no concrete until all embedded items and reinforcement have been placed in accordance with the plans.

C. A FCDWS Inspector shall approve formwork layout and placement of steel reinforcement prior to placing concrete. Provide 24-hour notice prior to placing concrete.

D. Concrete shall not be placed on loose, saturated or frozen soil.

E. Concrete shall not be placed in water unless approved by the FCDWS Engineer.

F. Concrete shall be placed only when ambient temperature is at 40º F and rising or place concrete in accordance with ACI 306-R88.

G. During hot weather (>80°F), place concrete in accordance with ACI 305-R89.

H. Saw control joints as soon as concrete can be traveled by foot without leaving impressions. Saw joint depth shall be ¼ of the slab depth.

I. Consolidate all placed concrete with vibrator of suitable vibrations per minute.

J. Do not pull or push concrete with vibrator.

K. Do not drop concrete more than four (4) vertical feet.

10.04 Finishing

A. Screed floor slabs or tops of walls by use of straight edge or screed board.

B. Concrete shall be finished as follows.

1. Interior slab to receive setting bed ..... float finish.
2. Interior slab exposed ..... trowel finish.
3. Exterior slab exposed ..... broom finish.
4. Exterior wall/column exposed ..... rubbed finish.
5. Unexposed concrete ..... form finish.

10.05 Curing

A. Prevent freshly placed concrete from premature drying and protect from excessive hot or cold temperatures.

B. Maintain freshly placed concrete, without drying, at a relatively constant temperature.

C. Begin curing after placement and finishing of concrete as soon as free water has disappeared from concrete surface.

D. Curing methods shall be by the continuous application of water or by applying a liquid membrane forming curing-sealing compound to the fresh concrete surface.

1. Curing by the continuous application of water shall occur for a period of not less than 72 hours.

2. After application of liquid membrane forming curing-sealing compound, maintain continuity of coating and recoat areas damaged during curing period. Curing period shall be not less than 72 hours.

E. Do not apply liquid curing sealing compound to concrete that is to be finished with a coating material such as paint, flooring material, etc.

11.01 General

A. Priming, painting and special coating of all surfaces shall include but are not limited to the following.

1. Piping and appurtenances.
2. Supports.
3. Pumps.
4. Valves.
5. Equipment and appurtenances.
6. Concrete and masonry.
7. Structural and miscellaneous metals.

B. Priming, painting and special coating of all surfaces shall be in accordance with the coating manufacturer's recommendations.