

DIVISION 2 - SITE WORK
SPECIFICATION 02080.1
WATER MAINS AND APPURTENANCES

PART 1 - GENERAL

02080.1 - 1.1 DESCRIPTION

- A. The following specification covers the design, installation, inspection, testing, and acceptance of potable water systems. Construction consists of furnishing all labor, equipment, tools, appliances and materials for performing all operations necessary for the construction and installation of water mains and service lines, including all piping, valves, valve boxes, fire hydrants, casings, service lines, appurtenances, complete and ready for operation, as indicated on the construction drawings and described herein.
- B. The Contractor shall furnish to the County a two (2) year warranty on the design, materials, fabrication, and workmanship of any and all pipe and fittings furnished. Warranty period shall commence upon written acceptance of the particular component or appurtenance by the County for ownership and operation.
- C. All pipeline and appurtenance material in contact with potable water must be NSF-61 Certified.
- D. All construction plans and record drawings shall comply with the requirements of Section 2 of the Hillsborough County Water Resource Services (HCWRS) Technical Manual.

02080.1 - 1.2 REFERENCE DOCUMENTS

- A. American Association of State Highway & Transportation Officials (AASHTO).
- B. American National Standards Institute (ANSI)
- C. American Society of Mechanical Engineers (ASME)
- D. American Society of Sanitary Engineers (ASSE)
- E. American Society for Testing Materials (ASTM).
- F. American Water Works Association (AWWA)
- G. Hillsborough County Cross-Connection Control and Backflow Prevention Ordinance and Manual, Ordinance Number 03-06.
- H. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
- I. National Fire Protection Association (NFPA)
- J. NSF International (NSF)

02080.1 - 1.3 SHOP DRAWINGS AND SUBMITTALS

- A. For County run projects, shop drawings and related manufacturer's product certification shall be made in accordance with the General and Special Conditions of the Contract for approval prior to purchase or fabrication of the material by the manufacturer. The following items that require shop drawings are brought to the Contractor's attention. This list may not include all items for which shop drawing submittals are required to meet the requirements of the project:
 - 1. Detail Drawings of all classes of pipe, joints, and fittings.
 - 2. Detail Drawings of restrained and flexible joints, including test reports to confirm thrust restraint capacities and restraining mechanism application.
 - 3. Pipeline laying schedule tabulated and referenced to construction line and grade controls

shown on plans, with station, offset and elevations. References shall be provided for pipe fittings, valves, service connections and other important features of the pipeline.

4. Detail Drawings of all Jack and Bore Pits.
 5. Service Connections.
 6. Valves and Valve Boxes.
 7. Fire Hydrants and/or Assemblies.
 8. All Appurtenant Items.
 9. Contractor's flushing and testing plans for all water system piping supplied.
- B. Certification and test reports for the materials, manufacturing, and testing of the types of pipe supplied shall be performed and furnished by the pipe manufacturer in accordance with the latest standards of the industry as referred to in part 1.2 herein.

02080.1 - 1.4 RELATED WORK

- A. All Specifications of Division 2.
- B. All Specifications of Division 3.

PART 2 – DESIGN

02080.1 - 2.1 LINE SIZING CRITERIA

The pipe sizing design criteria for water distribution systems shall as a minimum provide for at least 100% of the combined peak hour, maximum day demand rate, plus fire flow. The allowable minimum service pressure under said design condition shall not be less than 20 psi or 35 psi in a transmission line. Design flows and method of computation shall be submitted to PGMD for review by the WRS Infrastructure Planning Group at the time of the preliminary plat or site plan submittal, or at the time of the Master Plan submittal.

02080.1 - 2.2 MINIMUM LINE SIZE

The minimum pipe size for distribution mains shall be 4 inches, with the exception that the minimum size for distribution mains serving fire hydrants and fire hydrant branches shall be a minimum of six inches in diameter.

02080.1 - 2.3 LINE ROUTING

- A. The primary feed for the water distribution system for a residential or commercial subdivision shall be routed within County road right-of-way, unless otherwise approved. A secondary feed may be routed within a utility easement that is dedicated to the County, only if there is no road right-of-way available. Multiple points of connection may be required in order to minimize service outage in emergencies, repairs, etc., and to improve fire protection and water quality.
- B. The County may require a project's off-site infrastructure to be extended beyond the point(s) of connection in the ROW to the extent of the development's property. This facilitates future system interconnections and would be determined on a case-by-case basis. As a minimum, at the entrance to the project, the off-site main extension shall be extended within the right-of-way with a valve and one length of pipe with a cap.

02080.1 - 2.4 DEPTH OF COVER

- A. Cover, as measured from finished grade to top of the pipeline, shall be a minimum of 36 inches for pipe diameters up to and including 12 inches. Depth of cover for pipes 14 inches or greater in diameter shall be a minimum of 48 inches.
- B. When automatic air release valves are required, additional cover (enough to maintain the valve vault flush with the existing or proposed grade) shall be incorporated into the design.

02080.1 - 2.5 PROTECTION OF POTABLE WATER SYSTEMS

A. GENERAL

There shall be no physical connection between a public or private potable water supply and a wastewater line or appurtenance which would permit the passage of any sewage, untreated, or polluted water supply into the potable water supply.

B. HORIZONTAL SEPARATION

Water mains shall be laid to provide a minimum horizontal separation of 10 feet from any existing or proposed wastewater line (gravity or force main). A minimum separation of 3 feet shall be maintained between potable water mains and any existing or proposed reclaimed or storm waterlines. The distance shall be measured face to face. In cases where it is not practical to maintain the 10-foot separation, see Appendix D for details.

C. VERTICAL SEPARATION

Water mains crossing other pipelines shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the storm water, reclaimed water, or wastewater line. This shall be the case where the water main is either above or below the other pipelines. Water main crossings below the other pipelines should be avoided whenever possible. At crossings, one full length of water pipe shall be located so both joints will be as far from the other pipelines as possible. If the above vertical separation is not possible, see Appendix D.

02080.1 - 2.6 CROSS-CONNECTION CONTROL

- A. Backflow prevention devices shall be installed in all lines where the possibility exists for water from any other source to enter the public water supply system.
- B. All rules, regulations and procedures necessary to administer and enforce the provisions of cross-connection control are established in Hillsborough County's Cross-Connection Control and Backflow Prevention Ordinance and Manual, Ordinance Number 03-06, which is incorporated herein and made a part hereof.
- C. Backflow prevention assembly installations shall be in accordance with 02080.2, Exhibits W-1A – 1E, and W-2A and 2B.

02080.1 - 2.7 METERING ASSEMBLIES

- A. All fire lines serving commercial and industrial facilities shall be metered and be equipped with backflow prevention devices as shown in 02080.2, Exhibits Numbers W-1A - W-1D. Alternatively, a facility may be equipped with a Double Check Detector Valve Assembly, as shown in 02080.2, Exhibit W-2B, provided the following three criteria are met:
 - 1. The fire line feeds a single structure;
 - 2. There are no hydrants, stand pipes, hose bibs, etc. downstream of the assembly; and

3. There will be no more than 200 feet of pipe between the assembly and the structure it serves.
- B. A master meter assembly will be directly accessible by boom truck off the County ROW or by an interior road that is not blocked by a wall or gate. The access road shall be a minimum width of 12 feet. All access roads shall comply with the Hillsborough County Transportation Technical Manual, and FDOT requirements. The elevation of the concrete slab will be higher than the immediate surroundings area. Do not mulch around slab. Do not plant any landscape that will hinder access in the future to the meter assembly.
- C. The meter assembly shall be painted above ground with one coat of rust prohibitive primer and one coat Federal Safety blue (OSHA approved) high grade brushing enamel.

02080.1 - 2.8 SERVICE CONNECTIONS

- A. Water service connections shall be included as part of the distribution system and consist of: the service line, the corporation stop, the curb stop, and (for dual near-side connections) a dual service wye. The builder shall furnish and install water service connections as shown in 02080.2, Exhibit W-3 and specified herein.
- B. Dual service near-side connections are **not** allowed where reclaimed water service is not available.
- C. All near-side residential services shall be 1-inch polyethylene (PE) tubing for both single and dual services. See 02080.2, Exhibits W-3, W4A, 4B, 4C, and 4D.
- D. All far-side services shall be single 1-inch PE tubing with individual service connections. Dual far-side services shall be two individual 1-inch PE tubes. See 02080.2, Exhibits W-3, W-4A, and W-4E.
- E. Far-side service pipe (1 inch PE tubing) crossing under pavement shall be installed in a 2 inch PVC or HDPE sleeve at a minimum depth of 3 feet below pavement. A single 3" sleeve may be used to encase two 1" service lines. The sleeve shall extend to a minimum of 24 inches beyond edge of curb and gutter, where present.
- F. No trees or shrubs shall be planted within 5 feet of a service meter.

02080.1 - 2.9 METERS

- A. All meters and their associated lay lengths shall meet ANSI/AWWA C700 series.
- B. All meters shall be manufactured from copper alloy containing not less than 75% copper. Plastic and/or cast iron cases are not acceptable.
- C. Polymer clamping devices are not acceptable.
- D. All external bolts, nuts and washers shall be bronze
- E. Shear pin bolts shall not be used
- F. All meters shall be adaptable to a computerized central reading system (automated meter reading – AMR) of other manufacturer's meters.
- G. Manufacturer must provide independent testing confirmation with each meter that calibration was performed in accordance with AWWA standards.

02080.1 - 2.10 FIRE HYDRANT SPACING, LOCATION, AND FLOW

A. MANUFACTURING AND INDUSTRIAL AREAS

Fire hydrants shall be placed every 300 feet along the right-of-way with a maximum of 150 feet to the last lot. The minimum required fire flow shall be 1000 gpm, provided by either: 1) each hydrant individually, or 2) multiple hydrants flowing simultaneously. The required fire flow shall be determined by the County Fire Marshall's Office as part of the preliminary plan review process. Hydraulic capacity of the system may be able to provide fire flow above the 1000 gpm minimum, but any required fire flow not provided by the system must be provided onsite.

B. COMMERCIAL AND APARTMENT AREAS

Fire hydrants shall be placed every 500 feet along the right-of-way with a maximum of 250 feet to the last lot. The minimum required fire flow shall be 1000 gpm, provided by either: 1) each hydrant individually, or 2) multiple hydrants flowing simultaneously. The required fire flow shall be determined by the County Fire Marshall's Office as part of the preliminary plan review process. Hydraulic capacity of the system may be able to provide fire flow above the 1000 gpm minimum, but any required fire flow not provided by the system must be provided onsite.

C. RESIDENTIAL AREAS

Fire hydrants shall be placed a maximum of 500 feet apart along the right-of-way with a maximum of 500 feet to the last lot. The minimum flow from each hydrant shall be 750 gpm.

D. OTHER AREAS

Fire hydrants shall be placed a maximum of 1000 feet apart, along the right-of-way of rural roads or other areas as approved by the County on a case-by-case basis.

E. LOCATION CRITERIA

1. Hydrants shall be located within one foot of the side lot lines, between adjacent properties.
2. Hydrants shall be a minimum of 24 inches from edge of right of way in areas without sidewalks and a minimum of 6 feet with sidewalks.
3. The pumper discharge will face the nearest roadway unless plans approved by the Site Plan and Subdivision Review Section, show details of locations other than the above. Refer to 02080.2, Exhibits W-5A, 5B, and 5C for further clarification.
4. No object(s) may be placed/constructed near a fire hydrant that would obscure the hydrant from full view or would in any other manner hinder the Fire Department from gaining immediate access to a fire hydrant.
5. Hydrants shall be a minimum of 4 feet from back of valley gutter (Miami curb) and 2 feet from back of upright curb in urban sections. For cul-de-sacs the fire hydrant shall be positioned at the entrance to the cul-de-sac. If the cul-de-sac exceeds 500 feet (as measured from the intersection) another hydrant shall be installed within the cul-de-sac. See 02080.2, Exhibit W-6B.
6. For rural sections, FDOT Index 700 Clear Zone Criteria shall be met. Hydrants shall be a minimum of 10 feet from edge of pavement.
7. Hydrants in paved areas shall be protected by bollards of 4 inch (min) steel pipe three feet above and below grade filled with concrete and set in a cubic yard of concrete, placed as required. Bollards shall be painted OSHA Safety yellow.
8. The location of new fire hydrants shall be identified with a blue reflective pavement marker installed on the roadway. The reflective marker shall be located perpendicular to the hydrant, in the center of the lane closest to the hydrant.

9. Fire hydrants shall be installed as shown in 02080.2, Exhibits W-5A, W-5B, and W-5C.

02080.1 - 2.11 VALVE LOCATION

- A. Valves and roadway boxes shall be provided for all branch connections (3 valves on a tee, 4 valves on a cross), fire hydrant stubs or other locations, as required to facilitate operation of the distribution system. All valves shall be installed within one pipe length from the connection.
- B. Valves shall be placed so that the maximum allowable length of water main required to be shutdown for repair work shall not be more than 500 feet in commercial, industrial or multi-family residential districts and 1,000 feet in other areas.
- C. The end of all water main extensions or water mains ending at a project phase shall have a valve and valve box installed with a blow-off assembly.
- D. AIR RELEASE VALVES
 1. Air release valves shall be located at high elevation points on the pipeline.
 2. Areas prone to high water table or flooding shall require automatic air release valves to be installed above ground.
 3. Air release valves shall not be placed in driveways.
 4. Construction plans and record drawings shall include air release valve stationing on both the plan and profile views.
- E. Valves shall be readily accessible, and located in an area not subject to flooding. Valves shall not be located below the "top of bank" within a stormwater "ditch".

02080.1 - 2.12 PIPE, FITTINGS, AND APPURTENANCES

- A. Distribution mains outside of residential subdivisions, or within the ROW of collector or arterial roads, and all transmission mains (sizes 16" and larger) shall be constructed of ductile iron pipe (DIP). Pipe larger than 24 inches in diameter shall be approved on a case-by-case basis.
- B. Distribution systems, constructed within a subdivision, with pipe size 12 inches and less shall be either polyvinyl chloride (PVC) or DIP; pipes larger than 12 inches shall be DIP.
- C. RESTRAINED JOINTS
 1. Restrained joints shall be installed wherever water main pipe alignment changes direction.
 2. The length of pipe to be restrained shall be noted on the drawings.
 3. Shop drawings from the manufacturer shall be submitted to and approved by the Engineer prior to actual construction. Refer to part 1.3.
- D. Thrust blocks are not allowed in the HCWRS distribution system.
- E. Road crossings of collector and arterial roads shall be cased. The casing shall extend a minimum of 2' beyond the back of curb.

02080.1 - 2.13 SUBAQUEOUS SERVICE PIPE AND AERIAL CROSSING PIPE

All subaqueous service pipe and aerial crossing pipe shall be DIP.

02080.1 - 2.14 BLOW-OFF ASSEMBLY

- A. A blow-off assembly shall be installed on all dead-end mains and at the end of cul-de-sac distribution mains. See 02080.2, Exhibits W-6A and 6B for details.

- B. Construction plan and record drawings shall include blow-off assembly stationing on both the plan and profile views.
- C. Blow-offs shall not terminate in driveways, sidewalks, or any paved surface.

PART 3 - PRODUCTS

02080.1 - 3.1 PIPE MATERIAL

- A. The following table lists the allowable pipe materials for various sizes of potable water main pipe:

WATER MAIN PIPE		
Diameter	Material	General Specification
Less than 2"	PE PVC	ASTM D1248, SDR9 ASTM D1785, Class 1120 or 1220, Sch 80, 200 psi (min)
2" and 3"	PE PVC	ASTM D1248, SDR9 (casing pipe) ASTM D2241, Class 1120 or 1220, SDR 21, 200 psi (min)
4" to 12"	PVC	ANSI/AWWA C900, Class 150, DR 18 ANSI/AWWA C909, Class 200
4" to 24"	DIP	ANSI/AWWA C151/A 21.51, CL 50
24" and greater	DIP	ANSI/AWWA C151/A 21.51, CL 50

- B. Alternative piping materials will be considered by Hillsborough County if proper testing documentation, performed by recognized piping industry authorities, is submitted for review to the Water Resource Services Product Review Committee prior to commencement of design. Refer to Section 1 of the Water Resource Services Technical Manual for submittal procedures. Tests on alternative piping materials should be at least as rigorous as testing conducted by ASTM, AWWA and ANSI. A letter of variance must be issued by Water Resource Services prior to commencement of installation of any alternative material.
- C. All pipe, fittings and appurtenances shall be supplied in accordance with the approved material list in Appendix B.

02080.1 - 3.2 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile iron pipe shall conform to the requirements of ANSI/AWWA C151/A21.51, "Ductile-Iron Pipe, Centrifugally Cast, For Water", minimum Class 50, unless otherwise specified herein, or on the drawings.

- B. Joints for ductile iron pipe shall be mechanical or push-on joints, unless otherwise specified herein.
- C. Pipe shall have an exterior bituminous coating in accordance with ANSI/AWWA C151/A21.51. Pipe interior shall have a cement mortar lining with an asphaltic seal coat conforming to ANSI/AWWA C104/A21.4, "Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water".
- D. The weight and class designation shall be painted in white on the exterior surface of every pipe. Manufacturer's code or serial number shall be provided on the bell of each pipe joint.
- E. DIP shall be marked with blue stripes/tape in accordance with F.A.C. 62-555.320 (21), (b),(3). Adhesive tape shall be 2" wide vinyl, and at least 4.5 mil thick.
- F. FITTINGS
 1. All ductile fittings shall be mechanical joint with a minimum pressure rating of 250 psi, and shall conform to the requirements of ANSI/AWWA C110/A21.10, "Ductile-Iron and Gray-Iron Fittings for Water", or C153/A21.53, "Ductile-Iron Compact Fittings For Water Service".
 2. All fittings shall be coated and lined as specified in item C. above for ductile iron pipe.
 3. All DIP fittings shall bear the approval seal of the National Sanitation Foundation (NSF) for potable water pipe.
- G. MECHANICAL JOINTS
 1. Mechanical joints consisting of bell, socket, gland, gasket, bolt and nuts shall conform to ANSI/AWWA C111/A21.11, "Rubber-Gasket Joints For Ductile-Iron Pressure Pipe and Fittings".
 2. Bolts shall be high strength low alloy steel. T-head type having hexagonal nuts.
 3. Bolts and nuts shall be machined true and nuts shall be tapped at right angles to a smooth bearing surface.
- H. Push-on Joints: Single seal gasket push-on type joints shall conform to the requirements of ANSI/AWWA C111/A21.11 and Appendix B.
- I. SUBAQUEOUS SERVICE PIPE
 1. Pipe shall comply with ANSI/AWWA C151/A21.51, Class 55 and rated for 350 psi (min) working pressure.
 2. All service pipe shall be coated and lined as specified in item C. above.
 3. Pipe joints shall be "ball and socket" type, capable of 15° free deflection in each joint without separation, leakage, or reduction in the pipe waterway. Each joint shall be self restrained without the use of bolts or similar external locking devices. Locking retainer glands shall be ductile iron or high strength alloy steel.
 4. Gaskets shall be designed to fit into the gasket seat. It shall not be displaced from its seat when the joint is assembled and in any stage of deflection, under pressure or vacuum
 5. Pipe shall be furnished with the necessary gaskets, lubricant, and retainer locking accessories.
- J. AERIAL CROSSING PIPE, HANGERS, AND ACCESSORIES
 1. Pipe designated for aerial crossings and/or attachment to bridge or drainage structures shall comply with the requirements of ANSI/AWWA C151/A21.51, Class 54.
 2. Pipe length shall correspond to "Long Span Pipe".
 3. Pipe joints shall consist of mechanical joint-flange (MJ-FLG) or flanged-plain end (FLG-PE), and flanged-restrained (FLG-RJ). The flange joint shall be equipped with an O-ring gasket.
 4. Flanged joints to be coated per ANSI/AWWA C115/A21.15, "Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges". Exposed threads are to be coated with

asphalt and/or paint.

5. HANGERS AND ACCESSORIES

- a. Anchor bolts shall be Grade 316 stainless steel, installed in accordance with the construction drawings.
- b. Roller stands: Roller stands and roller axles shall be Grade 316 stainless steel.
- c. Insulated pipe rollers: Pipe support rollers shall be constructed of dielectric synthetic resin.
- d. Link seal and sleeve seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.
- e. Hangers: Hangers shall be made in accordance with MSS SP-58, and ANSI/ASME pressure piping code B31.1.

K RESTRAINED JOINTS

1. Restrained joints shall be of the types fabricated by the various pipe manufacturers and not the type that requires field welding or grooves cut into the pipe barrel for restraint.
2. The restraining joints for mechanical joint fittings and valves shall conform to the requirements of ANSI/AWWA C111/A21.11 and Appendix B. See 02080.2, Exhibit W-7A.
3. When field lock gaskets are installed the bell of the pipe shall be marked in red. Wrap the bell with adhesive red marking tape.

- L. Encasement: All ductile iron pipe and fittings shall be encased in polyethylene in accordance with ANSI/AWWA C105/A21.5, "Polyethylene Encasement for Ductile-Iron Pipe Systems" when required by soils conditions. Polyethylene shall be 8 mils thick.

02080.1 - 3.3 POLYVINYL CHLORIDE PIPE AND FITTINGS

- A. All PVC pipe and fittings shall bear the approval seal of the National Sanitation Foundation (NSF) that will remain legible during normal handling, storage, and installation. PIPE COLOR SHALL BE BLUE FOR POTABLE WATER MAINS.
- B. PVC pressure pipe (4 inches through 12 inches in diameter) shall conform to the requirements of ANSI/AWWA C900, "Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in. for Water Distribution". It shall have the same O.D. as ductile iron pipe and be compatible for use with ductile iron fittings. The pipe shall conform to these standards:
 1. For pipe 4 inches - pipe dimension ratio (DR) of 18, working pressure of 200 psi, and laying length of 20 feet. (when installed by directional drill, 4" pipe shall be DR 14, see specification 02072)
 2. For pipe 6" and greater - pipe dimension ratio (DR) of 18, working pressure of 150 psi, and laying length of 20 feet.
 3. Restrained pipe installed under roadway pavement in sizes 4" through 12" shall be Class 200, DR-14. Pipe shall be furnished in standard laying lengths of 20 ft.+1 inch.
- C. All PVC shall be formulated for sunlight exposure and shall pass the impact strength test as described by ASTM D2444, latest revision, using Tup A with impact level of 94 ft.-lbs.
- D. FITTINGS
 1. Fittings for PVC pipe 3 inches and smaller shall be Schedule 80 PVC with solvent welded or threaded joints, and conform to the requirements of ASTM D2467, and D2464, respectively.
 2. Fittings for PVC pipe (4 inches through 12 inches) shall be ductile iron mechanical joint

and comply with the requirements of part 3.2.F, above.

E. JOINTS

1. All PVC pipe, 4 inches and greater, shall have provisions for expansion and contraction provided in the joints.
 2. All joints, for pipe size 4 inches and greater, shall be designed for push-on makeup connection. A push-on joint may be an elastomeric gasket bell end coupling manufactured as an integral part of the pipe barrel consisting of an integral wall-thickened section with an expanded bell with a ring groove to retain an elastomeric sealing ring of uniform cross-section as approved in Appendix B for PVC pipe.
 3. For pipe 3" and less, joints are to be solvent welded.
- F. Restrained Joints: See 02080.2, Exhibit W-7A and W-7B for restrained joint details. See Appendix B for acceptable products.

02080.1 - 3.4 GASKETS

Pipe and fitting gaskets, conforming to ANSI/AWWA C111/A21.11, shall be made of viton (fluorocarbon elastomer), EPDM (ethylene propylene diene monomer) or SBR (styrene-butadiene rubber).

02080.1 - 3.5 POLYEHTYLENE (PE) EXTRUSION

- A. Extrusion compound shall comply with the applicable requirements for the Type III, Grade P34, Class C, PE 3408 very high molecular weight polyethylene plastic material, as specified in ASTM D1248, and a cell classification of 345434C or 355434C as specified in ASTM D3350.
- B. Tubing shall be 200 psi, type CTS (copper tubing size), or as otherwise approved
- C. Standard Dimension Ratio (SDR):
 1. The standard dimension ratio (SDR) for Copper Tubing Size (CTS) shall be 9. The average outside diameter, minimum wall thickness and respective tolerances for any cross section shall be specified in ASTM D2737.
 2. The standard dimension ratio (SDR) shall be seven (7) for IPS pipe sizes. The average inside diameter, minimum wall thickness, and respective tolerances for any cross-section shall be as specified in ASTM D2239.
- D. Environmental stress cracking resistance testing shall be performed in accordance with ASTM D1693, Condition C, and shall have no failures during 5000 hours test period.
- E. Pipe Identification: Polyethylene potable water service pipe or tubing shall be blue or identified with a blue stripe with the words "Potable Water" at 8-inch intervals. See a list of approved materials in Appendix B.

02080.1 - 3.6 CORPORATION STOPS

- A. The corporation stops shall be manufactured from cast bronze with machined fitting surfaces in accordance with ANSI/AWWA C-800, "Underground Service Line Valves and Fittings", for sizes 1 inch up to and including 2 inches.
- B. The inlet connection shall be male, iron pipe thread inlets. The outlet connection shall be a Pack Joint or compression joint outlet for copper or plastic tubing (CTS). See Appendix B for approved material / products.

02080.1 - 3.7 CURB STOPS

- A. The curb stops shall be ball valve, round way, with check, with lock wing cast on stop body and operating tee cap to provide for locking the stop in closed position.
- B. Curb stops for use with copper or plastic services shall have an inlet connection with a compression joint and an outlet connection with meter swivel nut. See Appendix B for approved products. Curb stop for 2-inch service line shall have an inlet compression joint connection and the outlet shall be female iron pipe thread.

02080.1 - 3.8 DUAL SERVICE WYES

Dual service branches shall be solid brass and have CTS compression type connections with internal and external locking device. Dual service branches for a 1-inch service shall comply with Appendix B.

02080.1 - 3.9 METER BOXES

- A. Meter boxes shall be black in color and of one-piece construction. Boxes shall not exceed 25 pounds in weight.
- B. Boxes and lids must pass an AASHTO H-20 (16,000 pound wheel load) style test, and the boxes shall be able to withstand a 200 pound side load.
- C. Boxes shall have pre-cut pipe entry areas and shall be designed to be securely stackable.
- D. Boxes shall be able to take a standard lid size:
 - 1. Single Service: 11-1/8 inches x 18 inches ($\pm 1/8$ inch).
 - 2. Dual Service: 14-5/8 inches x 16-5/8 inches ($\pm 1/8$ inch).
- E. Box depth shall be 12 inches, from the face of the lid to the bottom of the box. See 02080.2, Exhibit W-8.
- F. Lids shall comply with 02080.2 Exhibit W-8.
- G. Dimensional deviations must be approved by the HC-PRC.
- H. See Appendix B for a listing of approved products.

02080.1 - 3.10 VALVES

- A. All valves shall be the manufacturer's standard design for the service intended and shall bear the maker's name and pressure rating cast on the body, also the valve type, size, flow direction arrow, if applicable.
- B. Valves shall open left (counter clockwise) with an arrow cast in the metal of operating hand wheels or nuts indicating the direction of opening.
- C. CHECK VALVES
 - 1. Check valves shall conform to ANSI/AWWA C508, "Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS", and shall be iron body bronze mounted, swing-check valves, 4-inches through 24-inches NPS, for normal horizontal installation in water service and shall be equipped with a grade 303 stainless steel hinge pin not less than 3/4" in diameter, and removable inspection covers.
 - a. The check valve shall be rated for 175 psig for valves with diameters of 4-inches through 12-inches, and 150 psig minimum working pressure for valves 16-inches through 24-inches in diameter.
 - b. Check valves shall permit full flow area equal to that of the connecting pipe.

- c. Check valves shall be non-slam type.
 - d. Check valves 4-inch and larger in diameter shall be equipped with outside lever and adjustable weight operator.
 - e. Valve ends shall be flanged for above ground installation.
2. Check valves smaller than 4-inches in diameter shall be bronze body, bronze mounted, horizontal swing, y-pattern, threaded ends, 125 psig WOG.

D. GATE VALVES

1. Gate valves shall be of the resilient seat type meeting the requirements of ANSI/AWWA C509, "Resilient-Seated Gate Valves for Water Supply Service", and coated per ANSI/AWWA C550, "Protective Interior Coatings for Valves and Hydrants". Valves 2-inch in size shall comply with the "intent" of ANSI/AWWA C509 and C550.
2. Gate Valves shall open by turning the operating unit (operating nut or hand wheel) to the left, or counterclockwise, when viewed from the top. The operating nut, or hand wheel, shall have an arrow cast in the metal indicating the direction of opening.
3. All gate valves shall be iron body, bronze trimmed, solid wedge, resilient-seated, and shall be equipped with O-Ring type stuffing boxes.
 - a. All gate valve stem nuts shall be bronze.
 - b. All gate valve "gates" shall be fully encapsulated with the resilient seat material that shall be fully bonded to the gate
 - c. All gate valve resilient wedge, O-Rings, and gaskets in contact with the potable water, reclaimed water, or wastewater shall be E.P.D.M. (Ethylene Propylene Diene Monomer) material.
4. All gate valve bolting materials, excluding joint accessories, shall be a minimum of Grade 304 stainless steel, shall be readily accessible for valve maintenance, shall have square or hexagonal heads and shall be in conformance with the requirements of Section 4.4.4 of ANSI/AWWA C509.
5. All gate valves shall be coated with a fusion bonded epoxy coating applied to both the exterior and the interior surfaces prior to assembly of the valves.
6. All gate valves, when fully opened, shall have an unobstructed waterway diameter equal to or larger than the full nominal diameter of the valve.
7. Underground ("buried") gate valves
 - a. These valves shall have non-rising stems and shall be furnished with 2-inch square AWWA operating nuts.
 - b. Valves shall have mechanical joint ends and shall be furnished complete with joint accessories.
8. Exposed or above-ground gate valves shall be outside screw and yoke (OS&Y) flanged joint type with an operating hand wheel. The face-to-face dimensions and drilling shall conform to ANSI B16.10 for Class 125 flanged joint end gate valves.
9. All gate valves shall have the manufacturer's distinctive marking or name, the year the valve casting was made, the size of the valve, and the working water pressure rating.
10. The minimum design working water pressure shall be:
 - a. 200 psig for 3-inch through 12-inch sizes.
 - b. 150 psig for 16-inch through 36-inch sizes.
11. All gate valves, prior to shipment from the manufacturing facility, shall be tested by subjecting it to a minimum hydraulic pressure equal to twice the specified working pressure.
12. All gate valves shall be warranted by the manufacturer for a minimum of 10-years.

E. TAPPING VALVES, TAPPING SLEEVES, & SERVICE SADDLES

1. Tapping sleeves, tapping crosses, and tapping valves used to make “wet” taps into existing mains shall be provided and installed at locations shown on the Construction drawings.
2. TAPPING VALVES
 - a. Tapping valves shall be mechanical joint outlet, non-rising stem, resilient seat gate valves meeting the applicable requirements of ANSI/AWWA C509 and C550.
 - b. Tapping valves shall be specifically designed for pressure tapping with sufficient seat opening to allow full diameter taps to be made.
 - c. Tapping valves shall be manufactured with an integral tapping flange having a raised lip design in accordance with MSS SP60.
3. TAPPING SLEEVES AND CROSSES
 - a. Tapping sleeves and crosses for size-on-size connections shall be mechanical joint split cast iron units and rated for 150 psi working pressure in accordance with ANSI/AWWA C110/A21.10.
 - b. For less than size-on-size connections, tapping sleeves shall be fabricated steel units with a fusion-bonded epoxy coating and shall be pressure rated as above.
 - c. The Contractor shall determine the outside diameter of the existing main before ordering the sleeve.
 - d. Tapping sleeves shall have an outlet flange per ANSI B16.1, Class 125 standard.
4. SERVICE SADDLES
 - a. Service saddles shall have a ductile iron body, be equipped with double tie straps, and be suitable for either wet or dry installation.
 - b. The sealing gasket shall be the O-ring type suitable for the applicable service. Outlet flange shall be ANSI B16.1, Class 125 standard.
 - c. Tie straps and bolts shall be a corrosion resistant alloy steel.
- F. AIR RELEASE VALVE ASSEMBLY
 1. Air release valves shall be installed as indicated in Construction drawings. The locations indicated are approximate. Actual locations shall be determined in the field during construction.
 2. Air release valves shall be of the type that will release air from the line when pressurized and keep air from entering the line when not pressurized.
 3. The air release valves shall be installed in traffic bearing pre-cast concrete vaults with concrete bottoms. See 02080.2, Exhibit W-9A for standard automatic detail, W-9B for offset automatic detail, and W-9C for manual detail.
 4. The air release valve shall have a 2-inch inlet, corporation stop (full port ball valve), saddle, brass or stainless steel pipe and fittings, and locking curb stop.
 5. Valves, fittings, and piping shall be rated for a minimum working pressure of 150 psi, and meet the requirements of ANSI/AWWA C512, “Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service”.
- G. VALVE BOX
 1. Valve boxes for all valves installed below ground shall be cast iron.
 2. They shall be adjustable (mechanical type – threaded to make adjustments) to fit the depth of earth cover over the valve and shall be designed so as to prevent the transmission of surface loads directly to the valve or piping.
 3. Valve boxes shall have a minimum interior diameter of 5 inches.
 4. Valve box extension shall be installed to reserve a minimum of 50% of the adjustment for a future extension.
 5. The cover of the valve box shall be marked “Water”. The valves shall be identified with a

bronze disc embedded in concrete. See 02080.2, Exhibits W-10A and 10B.

02080.1 - 3.11 FIRE HYDRANTS

- A. Fire hydrants shall be of the dry barrel, compression type closing with the line pressure; shall comply with ANSI/AWWA Standard C502 "Standard for Dry-Barrel Fire Hydrants"; shall be Underwriters Laboratory (UL) listed and Factory Mutual (FM) approved; and shall comply with additional requirements as set forth herein.
- B. Fire hydrants shall open left with an arrow clearly cast on the top showing the direction of opening.
- C. Hydrants shall have a 1½ -inch pentagon operating nut with an anti-friction washer and bushing above the thrust collar to reduce operating torque. The operating nut, main stem, coupling and main valve assembly shall be capable of withstanding input torque of 200 ft.-lbs. in opening or closing directions.
- D. The hydrant shall have a factory-filled lubricant reservoir surrounding the working parts in the bonnet, and these parts shall be replaceable without removal of the bonnet section.
 - 1. The reservoir shall have double "O"-ring stem seals, a thrust nut "O" -ring seal, and a weather shield designed to protect the operating nut seal.
 - 2. Grease lubricated hydrants shall use food grade "NEVERSEIZE"-lubricant
- E. Fire hydrants shall have two 2½ -inch hose nozzles and one 4½ -inch pumper nozzle with National Standard Hose Threads.
 - 1. Hose nozzles shall have a minimum 18-inch clearance from their center line to the bury line which will be cast (or otherwise permanently designated) on the lower barrel and shall be threaded, "O"-ring sealed, and locked into place with a stainless steel locking device.
 - 2. Hose nozzle caps shall have durable neoprene nozzle cap gaskets. Nozzle caps shall be cast with a 1½ -inch pentagon nut for cap removal.
- F. Fire hydrants shall have a traffic feature consisting of a breakable safety flange and steel or cast-iron stem coupling located below the break line of the hydrant and which allows 360 degree positioning. The safety stem coupling shall have corrosion resistant coating with grade 304 stainless steel stem pins and cotter pins. All other stem pins or bolts shall also be Grade 304 stainless steel.
- G. Fire hydrant main valves shall be a minimum ¾-inch thickness and 95 durometer neoprene. The main valve shall be fully supported by bronze or epoxy coated upper and lower valve plates. Lower stem threads shall be gasket sealed from water intrusion in both the open and closed position for corrosion protection. The bronze seat ring shall be a minimum 5-inch inside diameter and shall thread into a bronze ring. The drain valves and outlets shall not be drilled, creating a positively plugged drain system. All wetted, bronze, hydrant parts shall not exceed 16% zinc alloy, Grades D or E, in accordance with ANSI/AWWA C502, Section 2.2.5.2, Table I. The main valve assembly shall be replaced by disassembling at the hydrant bonnet flange.
- H. Fire hydrants shall have a minimum bury depth of 3 feet 6 inches to the bottom of the shoe, and the barrel sections shall have a fully assembled 6-inch mechanical joint shoe inlet. The preferred bolt configuration in the underground flanging of the shoe and the lower barrel shall be ¾-inch electro-galvanized steel with six full bolts. However, if there are less than six bolts or the bolts are smaller than ¾-inch, then the bolts shall be stainless steel.
- I. Fire hydrant shall have a 150 psi working pressure and 400 psi test pressure. Hydrants shall have a maximum 2.4 psi head loss when tested in accordance with ANSI/AWWA C502,

Section 5.2.1.

- J. Fire hydrant shall be painted above ground with one coat of rust prohibitive primer and one coat Federal Safety yellow (OSHA approved) approved high grade brushing enamel. All continuously wetted ferrous metal surfaces in the hydrant shoe, including the lower valve plate, shall be epoxy coated and all other surfaces shall be coated with asphalt varnish as noted in ANSI/AWWA C502, Section 4.2. All hydrants shall be designated "Hillsborough County Specifications" on the low barrel. Fire hydrants shall be AWWA Traffic Models meeting the above stipulations and as approved in Appendix B.
- K. All fire hydrants shall be flow tested and the bonnet color coded in accordance with NFPA 291. All flow test results shall be submitted to WRS personnel during final walk-through inspection.

02080.1 - 3.12 BACKFLOW PREVENTION ASSEMBLIES

A. REDUCED PRESSURE BACKFLOW PREVENTION ASSEMBLY

- 1. The reduced pressure backflow prevention device shall contain within its structure a minimum of two independently acting, approved check valves, together with an automatically operating pressure differential relief valve located between the two check valves.
 - a. The first check valve reduces the supply pressure to a predetermined amount, so that during normal flow and at cessation of normal flow, the pressure between the checks shall be less than the supply pressure.
 - b. In case of leakage of either check valve the differential relief valve, by discharging to the atmosphere, shall operate to maintain the pressure between the checks less than the supply pressure.
 - c. The unit shall include tightly closing shut-off valves located at each end of the device, and each device shall be fitted with the properly located resilient-seated test cocks.
 - i. Shut-off valves 2-inches and smaller shall be ball type.
 - ii. Shut-off valves larger than 2-inches shall be gate type.
- 2. All moving parts shall be corrosion resistant. The device shall meet the requirements of ANSI/ASSE 1013 and ANSI/AWWA C511, "Reduced-Pressure Principle Backflow Prevention Assembly".
- 3. In all cases, the device shall have the capability of in-line repair for ease of maintenance.

B. DOUBLE CHECK VALVE ASSEMBLY

- 1. The double check valve assembly backflow preventer shall be a device containing within its structure two spring-loaded independently operating poppet-type valves mounted in a common body.
 - a. Two gate valves and four test cocks and shall be designed for installation in a normal horizontal flow attitude.
 - b. The test cock arrangement will be such that each check valve can be tested without removal of the assembly from the line.
- 2. The check valves shall be designed to open under normal flow conditions at a pressure differential not less than 1 psi at each check valve and close when the down stream pressure is greater than the supply pressure.
- 3. All moving parts shall be corrosion resistant. The device shall meet the requirements of ANSI/AWWA C510, "Double Check Valve Backflow Prevention Assembly" and ANSI/ASSE 1015.

4. In all cases, the device shall have the capability of in-line repair for ease of maintenance.

PART 4 - CONSTRUCTION

02080.1 - 4.1 WORK AT HIGHWAY OR RAILROAD CROSSINGS

Construction work for any County/FDOT highway or railroad crossing to be performed shall not commence until all Right-of-Way permits for the pipeline occupancy have been obtained.

02080.1 - 4.2 PRECONSTRUCTION PIPE INSPECTION/CERTIFICATION

- A. The Contractor shall obtain from the pipe manufacturer a certificate of inspection to the effect that the pipe and fittings supplied for the project have been inspected at the plant and that they meet the requirements of these specifications.
 1. For County Contracted projects, the Contractor shall submit these certificates to the Project Manager prior to installation of the pipe materials.
 2. For developer projects, the Contractor shall submit these certificates to the WRS Inspection Group prior to the installation of the pipe materials.
- B. Joints or fittings that do not conform to these specifications will be rejected and must be removed immediately by the Contractor.
- C. The entire product of any plant may be rejected when, in the opinion of the County, the methods of manufacture fail to secure uniform results, or where the materials used are such as to produce inferior pipe or fittings.
- D. For County contracted projects all pipe and fittings shall be subjected to visual inspection at time of delivery and before they are lowered into the trench to be laid.

02080.1 - 4.3 INSTALLATION

- A. The provisions set forth herein shall be applicable to all underground potable piping installations.
- B. It shall be the Contractor's and/or developer's responsibility to verify all existing conditions and to locate all structures and utilities along the proposed utility alignment in order to avoid conflicts. Where conflicts exist, work shall be coordinated with the facility owner and performed so as to cause minimum interference with the service rendered by the facility disturbed.
- C. Facilities or structures damaged shall be repaired and/or replaced immediately at the contractor's and/or developer's expense, in conformance with current standard industry practices, according to the direction of the owner of such facility, and approved by the County.
- D. See 02080.2, Exhibit W-11 for Jack and Bore details and Exhibit W-12 for Ditch Crossing details.
- E. Directional Drill/Jack and Bore: Where open cut is not practical, directional drilling per specification 02072, or jack and bore per specification 02070, shall be used.
 1. All directional drill and jack and bore locations shall be indicated on the Construction drawings, and approval from WRS is required prior to starting construction.
 2. Horizontal directional drilling shall use Certalock PVC per Appendix B, or for service casing, HDPE. As an alternate, ductile iron or fusible PVC may be used with prior WRS approval.
- F. No pipe shall be laid when the trench conditions or the weather is unsuitable for such work.

- G. Polyvinyl chloride pipe may be damaged by prolonged exposure to direct sunlight. The Contractor shall take necessary precautions during storage and installation to avoid this damage. Pipe shall be stored under cover and sufficient backfill shall be placed to shield it from the sun as the pipe is installed.
- H. Electronically detectable tape shall be installed in trenches above all PVC water piping approximately 18 inches above pipe. The tape shall be continuous between valves and secured to each valve. The tape shall be at least 4.5 mils thick, 2-inch minimum width and made with an aluminum material sandwiched between 2 layers of polyethylene. It shall have imprinted in permanent black ink with 1-inch letters "CAUTION WATER MAIN BURIED BELOW" on blue background. See Appendix B for approved products.
- I. All PVC pipe shall be installed with 2 insulated 10 gauge copper locating wires (use 6 gauge wire when directional drill installation has been approved) attached at 10:00 and 2:00.
 - 1. Wires shall be attached using minimum 2" wide duct tape. Tape shall be at every joint and 4 to 5 feet spacing.
 - 2. Locating wires shall terminate 4 or more inches above the concrete valve pad and shall be folded back inside a 3" PVC access pipe (see 02080.2 Exhibit W-13A).
 - 3. Wires shall be installed on terminal water lines leading to fire hydrants. Access to tracer wires at the hydrant valve, shall be provided when the hydrant is more than 10 feet from the water main.
 - 4. In the case where a valve's location falls within paved road, wires shall be continuous to the next valve outside pavement.
- J. Excavation, trenching and backfilling shall be in accordance with the requirements of the applicable portions of these specifications. In addition, all underground facility installations shall comply with the requirements of section 5.4 of the Utility Accommodation Guide.

02080.1 - 4.4 TRENCH EXCAVATION

- A. All excavations shall be open cut, with banks of trenches kept as nearly vertical as possible and wide enough to allow approximately 8 inches clearance on each side of the pipe.
- B. The trench floor shall provide a uniform bearing for each full length of pipe section. Excavate bell holes after trench has been graded.
- C. Perform all excavations of whatever substance encountered to the depths shown or indicated on plans.
- D. In the event unsuitable or unstable soil is encountered, remove it and replace with sand, gravel, #57 limestone (or combination thereof) or other material as approved by the Project Manager or Engineer.
- E. Dewatering: Remove all water from excavations and maintain the excavations free of water while construction therein is in progress. Provide dewatering equipment as necessary to conform to this requirement. Dewatering procedure must meet all regulatory requirements.
- F. Protection of Trees: Trenching shall not take place within the root zone of trees with a trunk diameter of 6-inches or larger. The root zone shall be defined as the greater of 1) the drip line of the tree or 2) a circular zone extending outward from the base of the tree a distance equivalent to ½ -foot for every inch of trunk diameter as measured 4½ feet above natural grade (see 02080.2 Exhibit W-14). Exotic nuisance species, such as Brazilian Pepper and Melaleuca, are exempt from this protection.

02080.1 - 4.5 HANDLING AND CUTTING PIPE

- A. Every care shall be taken in handling and laying pipe and fittings to avoid damaging the pipe, scratching or marring machined surfaces, and abrasion of the pipe coating.
- B. Any fitting showing a crack, and any fitting or pipe which has received a severe blow that may have caused an incipient fracture (even though no such fracture can be seen) shall be marked as rejected and removed at once from the work.
- C. In any pipe showing a distinct crack and in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portion, if so approved by WRS, may be cut off before the pipe is laid. The cut shall be made in the sound barrel at a point of at least 12 inches from the visible limits of the crack. All cutting shall be done with a machine adapted to the purpose. All cut ends shall be examined for possible cracks caused by cutting.
- D. Cutting Pipe: The Contractor shall cut pipe by means of an approved mechanical cutter. The cut shall be perpendicular to the longitudinal axis of the pipe and rough ends or spurs will be satisfactorily removed prior to installation and seating.

02080.1 - 4.6 PIPE LAYING

- A. Pipe shall be constructed of the materials specified and as shown on the drawings.
- B. Cradle: Upon satisfactory excavation of the pipe trench, recesses for the pipe bells and joints (or couplings) shall be excavated by hand digging. When the pipe is laid in the prepared trench, true to line and grade, the pipe barrel shall receive continuous, uniform support and no pressure will be exerted on the pipe joints from the trench bottom.
- C. Cleanliness: The interior of the pipes shall be thoroughly cleaned of all foreign matter before being gently lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. During suspension of work for any reason at any time, a suitable stopper shall be placed in the end of the pipe last laid to prevent mud or other foreign material from entering the pipe.
- D. GRADIENT
 - 1. Lines shall be laid straight, and depth of cover shall be maintained uniform with respect to finish grade, whether final grading is completed or proposed at time of pipe installation. When a grade or slope is shown on the Construction Drawings, means shall be used by the Contractor to assure conformance to required grade.
 - 2. Any pipe which has its grade or joint disturbed after lying shall be taken up and re-laid.
- E. Pipe Joint Deflection: Whenever it is desirable to deflect pipe, the amount of deflection for ductile iron pipe shall not exceed 75% of the maximum limits as shown in AWWA C600. Deflection of PVC pipe shall not exceed 75% of the manufacturer's recommendations.
- F. Rejects: Any pipe and fittings defective due to interior or exterior damage shall be immediately removed and replaced with sound pipe or fitting at the Contractor's expense.
- G. PVC: All PVC water mains shall have a suitable electronic locator tape in accordance with part 4.3.G, herein. The tape shall be continuous between valves and secured to each valve.
- H. Subaqueous Crossings: Piping for subaqueous crossings for water mains shall be placed in position with the use of non-metallic canvas slings. Metal chains are not permitted to be used to lower piping into the subaqueous trench.

02080.1 - 4.7 INSTALLING JOINTS

- A. The joints of all pipelines shall be made tight. The particular joint used shall comply with the requirements of part 3.2 and 3.3. For County contracted projects, the particular joint used shall be reviewed and approved by the Engineer prior to installation.

- B. Pipe joints shall be bolted or otherwise restrained, where shown on the Construction drawings, or where in the opinion of the Design Engineer, settlement or vibration is likely to occur.
- C. Mechanical Joints: All types of mechanical joint pipes shall be laid and jointed in full conformance with manufacturer's recommendations. Torque wrenches set as specified in ANSI/AWWA C111/A21.11, shall be used; or spanner type wrenches not longer than specified therein may be used with the permission of the County.
- D. Push-On Joints: Push-on joints shall be made in strict compliance with the manufacturer's recommendations. Lubricant shall be an inert, non-toxic, water soluble compound.
- E. Joint Compounds: Sulfur based joint compounds shall not be used.
- F. Ball and socket joints shall be installed in strict accordance with the manufacturer's instructions.
- G. Restrained Joints shall be provided at all changes in direction, and size changes, of all mains. All pipe and fitting joints shall be restrained as shown on the Construction Drawings, and in accordance with manufacturer's recommendations.

02080.1 - 4.8 INSTALLING APPURTENANCES

A. VALVES AND VALVE BOXES

- 1. Valves: Valves shall be carefully inspected, opened wide and then tightly closed and the various nuts and bolts shall be tested for tightness, on site, prior to installation.
 - a. Special care shall be taken to prevent any foreign matter from becoming lodged in the valve seat.
 - b. Any valve that does not operate correctly shall be immediately removed and replaced by the Contractor.
- 2. Valve Boxes: Valve boxes shall be carefully centered over the operating nuts of the valves so as to permit a valve key to be fitted easily to the operating nut.
 - a. Valve boxes shall be set to conform to the level of the finished surface and held in position by a ring of concrete placed under the support flange as shown on the Construction Drawings.
 - b. The valve box shall not transmit surface loads to the pipe or valve.
 - c. Care shall be taken to prevent earth and other material from entering the valve box.
 - d. Any valve box which is out of alignment or whose top does not conform to the finished ground surface shall be dug out and reset.
 - e. Before final acceptance of the work, all valve boxes shall be adjusted to finished grade and valve box extensions shall be installed to reserve a minimum of 50% (1/2) of the adjustment for the future extension.
 - g. The operating nut should not exceed 36 inches below finished grade. However, if conditions require that the operating nut exceeds 36 inches, then an extension, mechanically attached to the valve, shall be added, and the top of the extension shall not exceed 12 inches below finished grade. See 02080.2, Exhibit W-13B.
 - f. The valve boxes shall be provided with covers marked "WATER" and shall be so constructed as to prevent tipping or rattling. The valves shall be identified with a bronze disc embedded in concrete. See 02080.2, Exhibits W-10A and 10B.

B. AIR RELEASE VALVE ASSEMBLIES

- 1. Air release valves, as specified in part 3.9 shall be installed at locations as indicated on the Construction Drawings.
- 2. The locations indicated are approximate. The actual placement of the air release valves shall be determined in the field and shall be located at the high points as established during installation of the water main and as approved by the Project Manager

3. The Contractor shall submit for approval a profile of the water main in the vicinity of all high points indicated on the Construction Plan set. The profile shall extend a minimum of 200 linear feet to each side of the expected high point(s) of the water main. Elevations shall be submitted of the high point(s) and the top of the pipe at 50 foot intervals within the 400 linear foot area described above.
- C. BLOW-OFF VALVE ASSEMBLIES
1. The Contractor shall furnish and install blow-off valve assemblies as shown on the Construction Drawings.
 2. The locations shown are approximate. The actual placement of the blow-off valve shall be determined in the field and shall be located at the low point of the pipeline as established during installation of the water main and as approved by the Project Manager.
- D. SLEEVES
1. Sleeves shall be constructed in accordance with the details shown on the Construction drawings.
 2. Sleeves shall be constructed when:
 - a. Indicated on the drawing
 - b. The Project Manager orders the line encased.
 - c. Vertical and horizontal clearances, complying with part 2.5 herein, cannot be maintained between pipelines

02080.1 - 4.9 WATER SERVICE CONNECTIONS

The Contractor shall furnish and install water service connections as shown on the Construction Drawings and/or as directed by the County as dictated by actual field conditions. Water service connections shall include service lines, corporation stops, curb stops, and meter boxes as defined in Part 2 and Part 3, herein.

02080.1 - 4.10 POLYETHYLENE TUBE ENCASEMENT

- A. Locations for polyethylene tube encasement shall be as indicated on the Construction Drawings. Installation of polyethylene tube encasement for pipe and fittings shall be in accordance with Method A of ANSI/AWWA C105/A21.5 and as specified herein.
- B. Raise a length of pipe at the side of the trench to a height of about 3 feet above ground level by means of hoisting equipment and a pipe sling or tongs.
- C. Using a precut length of polyethylene tubing, 2 feet longer than length of pipe to be covered, slide plastic tubing over spigot end of the pipe up to the pipe sling or tongs. Bunch the excess of the plastic tubing near the sling or tongs.
- D. Lower the pipe into the trench, joining the lowered length of pipe with that already in place. Shallow bell holes at the pipe joints must be made to facilitate overlapping of the polyethylene at the pipe joints.
- E. Raise bell end of the pipe mechanically or by hand, clear of trench bottom. Slide plastic tube along balance of pipe length to the pipe bell. Leave surplus bunched at the bell for subsequent covering of the joint. Approximately 1 foot of surplus should be provided at each end of pipe.
- F. To cover the joined pipe joint pull the plastic tubing from the preceding length of pipe over the bell end of the pipe, fold around the spigot end of new pipe section and wrap with three circumferential turns of 1-1/2 inch wide polyethylene tape to seal and hold the film in place.
- G. Pull the bunched polyethylene tubing on the new pipe barrel near spigot end over the first

polyethylene wrap until it covers the joint, neatly folded behind the bell, seal and hold in place by three circumferential turns of 1-1/2-inch wide polyethylene adhesive tape.

- H. The polyethylene film covering the pipe will be loose. Excess material should be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe and held in place by means of pieces of the plastic tape at approximately 3 to 5 foot intervals.
- I. Repair any rips, punctures or other damage to the polyethylene with tape or by cutting open a short length of tube, wrapping it around the pipe and securing with tape.
- J. Fittings such as pipe bends shall also be covered by use of the plastic tubing and plastic adhesive tape in much the same manner as the pipe.
- K. Irregular-shaped appurtenances shall be covered by splitting a suitable length of the polyethylene tubing and using the resulting flat sheet with plastic tape to effect the covering of such items.

02080.1 - 4.11 BACKFILL/COMPACTION

- A. Backfilling and compaction shall be conducted in a manner as to preclude subsequent settlement and provide adequate support for the surface treatment, pavement, pipelines, or structures to be placed thereon.
- B. Backfill material shall be common fill material free from organic matter, muck or marl, and rock exceeding 2-1/2 inches in diameter, and shall not contain broken concrete, masonry, rubble or other similar materials.
- C. Method of Compaction: The Contractor shall adopt compaction methods which will produce the degree of compaction specified herein without damage to the new or existing facilities. The degree of compaction specified below shall be considered the minimum allowable.
- D. Backfilling Procedures: The backfilling procedures outlined below shall be for water mains and related structures. The backfilling shall be done in three stages as follows:
 - 1. In the first stage, the Contractor shall provide adequate compacted fill beneath the haunches of the pipe, using mechanical tampers suitable for this purpose. This compaction applies to the material placed beneath the haunches of the pipe and above any bedding material. Fill compacted by mechanical compactors shall be placed in 6-inch layers and thoroughly tamped over the entire surface.
 - 2. In the second stage, the Contractor shall obtain a well-compacted bed and fill along the sides of the pipe and to a point of at least one foot above the top of the pipe. The width of backfill and compaction to be done under this second stage shall be the width of the portion of the trench having vertical sides; or, when no portion of the trench has vertical sides, it shall be to a width at least equal to twice the outside diameter of the pipe. Material to be placed in 6-inch layers (loose thickness).
 - 3. In the third stage, the remainder of the trench shall be backfilled with suitable material in layers not to exceed 12-inch loose thickness and compacted.
- E. Compaction Density: The trench backfill density for all stages shall be as provided below:
 - 1. From right-of-way line to right-of-way line, including all structures and railroad crossings: Compaction shall be 98 % of the maximum density as determined by AASHTO T-180 (ASTM D1557 - Modified Proctor) with a minus 2% tolerance.
 - 2. For outside of the right-of-way (but within maintenance easements): Compaction shall be 95% of the maximum density as determined by AASHTO T-180 (ASTM D1557 - Modified Proctor) with a minus 2% tolerance.
- F. COMPACTION TEST REQUIREMENTS
 - 1. Compaction test results shall be submitted for all work in existing or proposed right-of-

- ways and easements.
2. Results of compaction tests must meet minimum requirements prior to proceeding with the next stage of the work.
 3. For developer projects, one complete set of all test reports shall be submitted with the as-built package to the Site Plan and Subdivision Review Section upon project completion.
 4. For County run projects, one complete set of all test reports shall be submitted with the as-built package to the Project Manager upon project completion.
 5. The Contractor shall employ an independent testing laboratory, acceptable to the County and pay for all required tests.
 6. The laboratory shall submit one copy of the certified test reports, after testing in each phase, to the Construction Services Section in the Planning and Growth Management Department, or the County Project Manager (as applicable), for approval.
 7. In the second stage of backfilling, density tests shall be made every one (1) foot vertically, staggered every 500 feet (minimum) horizontally. There shall be a minimum of one test between structures.

02080.1 - 4.12 TEMPORARY WATER SERVICE FOR CONSTRUCTION

- A. The provisions set forth herein shall be applicable to all construction projects. The developer/Contractor shall be responsible to submit a temporary water plan (Plan). The Plan shall describe how water will be provided and metered for construction needs and, if applicable, fire demand. It shall include the maximum peak hour flow which will be required prior to acceptance for occupancy.
 1. For County Projects, the Plan shall be submitted to the Project Manager along with the required construction plans.
 2. For Developer projects, the Plan shall be submitted to the Planning and Growth Management Department along with the required construction plans.
- B. Water service for construction shall be supplied using a temporary construction meter assembly as described in item C. below. Private sources, such as wells, may also be acceptable to the County.
- C. 6" Temporary Meters: When flow demand necessitates the use of a 6" meter, the following criteria shall apply.
 1. The temporary construction service meter shall be placed along the right-of-way on the primary feed for the water distribution system of any proposed development. The meter shall be a maximum of 250 feet from the first lot. See 02080.2, Exhibit W-1E for meter assembly and Exhibit W-1F for meter placement details.
 2. Hydrostatic and Leakage Testing: The primary feed line from the point of connection including the meter assembly will be tested as described in part 4.14.
 3. Disinfection: The primary feed line from the point of connection up and including the meter assembly shall be disinfected and receive the required approvals and clearances prior to placing the meter assembly in service. Disinfection shall be in accordance with part 4.15.
 4. Pipe and Fittings:
 - a. Above ground pipe shall be flanged ductile iron. The pipe barrel shall conform to the requirements of ANSI/AWWA C151/A21.51, Class 54, with cement lined interior.
 - b. All above ground ductile fittings shall be flanged joint with a minimum pressure rating of 250 psi, and shall conform to the requirements of ANSI/AWWA C110/A21.10 or C153/A21.53.

- c. Underground pipe shall comply with the requirements of part 3.2 or 3.3.
5. REQUIREMENTS: For County projects, the Contractor shall be responsible for the proper installation of the temporary construction meter assembly. For developer projects, the Developer shall be responsible for the proper installation of the temporary construction meter assembly. Water Resource Services will be responsible for the operation, maintenance and testing of the backflow prevention and compound meter device.
6. COMPOUND METER ASSEMBLY: Compound meter assembly will be provided by the County Water Resource Services, Field Maintenance Group. The Developer shall provide (3) three County working days notice prior to picking-up the compound meter for transporting to the site. If a County meter is not available, the Contractor must provide his own meter of an approved model.
- D. Removal of Temporary Meter Assembly: After the entire development water distribution system has been installed, pressure tested, disinfected, and accepted by the Department of Health, the Contractor shall remove the meter assembly as directed by the County Water Resource Services and return the meter assembly back to the County Water Resource Services.

02080.1 - 4.13 FLUSHING AND CLEANING

- A. All mains shall be cleaned and flushed to remove all sand and other foreign matter.
 1. The Contractor shall be responsible for developing a flushing plan to be submitted to the County Engineer for approval with the shop drawings. The flushing plan must be submitted with the "temporary water plan" listed in part 4.12.A.
 2. The Contractor shall dispose of all water used for flushing without causing a nuisance or property damage.
 3. Any permits required for the disposal of flushing water shall be the responsibility of the CONTRACTOR.
- B. Flushing water used by the Contractor shall be taken from an approved metered source. Flushing water shall be at Contractor's expense.
- C. Pipeline shall be cleaned with a "pig", of an appropriate material for the pipeline to be cleaned, so as not to damage the interior lining of the pipeline. Contractor shall be responsible to install and remove appropriate connections to accomplish the required pipeline "pigging".
- D. Temporary plugs or caps shall be installed on new mains until the pressure and leakage tests are completed. Upon satisfactory completion of the tests the caps or plugs shall be removed and the connections made to the existing water mains.

02080.1 - 4.14 HYDROSTATIC AND LEAKAGE TEST

- A. Water mains shall be tested between valved sections. The total length of pipe for any single test shall not exceed 2,000 feet. Testing shall be done immediately after installation and backfilling has been completed.
- B. The piping shall be tested in sections, thereby, testing each valve for secure closure.
- C. The mains shall be tested in accordance with, the latest revision of AWWA (for Ductile Iron) and C605 (for PVC) under an average hydrostatic pressure of not less than 150 psi, using a 300 psi gauge, for a minimum of 2 hours. Pressure shall be maintained until all sections under testing have been checked for evidence of leakage.
- D. While the system is being filled with water, air shall be carefully and completely exhausted. If permanent air vents are not located at all high points, the Contractor shall install corporation

stops or fittings and valves at such points so the air can be expelled as the pipe system is slowly filled.

- E. The test pressure shall not vary by more than ± 5 psi for the duration of the test. The rate of loss shall not exceed that specified in sections M or N as listed below. Visible leaks shall be corrected regardless of total leakage shown by test.
- F. All pumps, gauges and measuring devices shall be furnished, installed and operated by the Contractor; and all such equipment, devices and their installation shall be approved by the County Inspector.
- G. All water for testing and flushing shall be potable water provided by the Contractor, no cost to the County, from a source approved by the County. Flow velocity during line filling should not exceed 2 feet per second (fps).
- H. The quantity of water used for testing, which shall be compared to the allowable quantity, shall be measured by pumping from a calibrated container, again approved by the County Inspector.
- I. All restrained sections of the buried main shall be completely backfilled before such sections are tested.
- J. All pressure and leakage testing shall be done in the presence of the County Inspector and the Engineer of Record or his designated representative.
- K. When leakage occurs in excess of the specified amount, the defective pipe, pipe joints or other appurtenances shall be located and repaired at the expense of the Contractor. If the defective portions cannot be located, the Contractor, at his own expense, shall remove and reconstruct as much of the original work as necessary to obtain a water main within the allowable leakage limits upon retesting.
- L. If the Contractor elects to perform hydrostatic testing against valves in an existing distribution system, he does so at his own risk and will bear the cost of any damage to the existing valve, piping system, private or public property, or the new pipeline under test.
- M. **ALLOWABLE LIMITS FOR LEAKAGE IN DUCTILE IRON PIPE**
 1. The hydrostatic pressure test shall be performed as herein above specified and no installation, or section thereof, will be acceptable until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = \frac{SD(P)^{1/2}}{148,000}$$

in which:

- L = Allowable leakage, in gallons per hour
- S = Length of pipe in feet being tested
- D = Nominal diameter of pipe, in inches
- P = Average test pressure during the test, in psi

2. Water shall be supplied to the main during the test period as required to maintain the test pressure as specified.
 3. The quantity used, which shall be compared to the above allowable quantity, shall be measured by pumping from a calibrated container. A 5/8-inch meter installed on the discharge side of the pump may be used to measure the leakage for large mains when approved by the County Inspector. All hydrostatic leakage tests shall be recorded on the form(s) attached in part 5.0.
- N. **ALLOWABLE LIMITS FOR LEAKAGE IN PVC PIPE**
 1. The hydrostatic pressure test shall be performed as hereinabove specified and no insta-

llation, or section thereof, will be acceptable until the leakage is less than the number of gallons per hour as determined by the formula:

$$(1) \quad Q = \frac{LD(P)^{1/2}}{148,000} \quad \text{OR} \quad (2) \quad Q = \frac{ND(P)^{1/2}}{7,400}$$

in which:

- Q = Allowable leakage, in gallons per hour
- N = Number of joints in the tested line (pipe & fittings)
- L = Length of pipe section being tested, in feet
- D = Nominal diameter of pipe in inches.
- P = Average test pressure during the test, in psi

NOTE: Equation (2) is for integral bell pipe in 20 ft. lengths.

2. Water shall be supplied to the main during the test period as required to maintain the test pressure as specified. The quantity used, which shall be compared to the above allowable quantity, shall be measured by pumping from a calibrated container. A 5/8-inch meter installed on the discharge side of the pump may be used to measure the leakage for large mains when approved by the County Inspector. All hydrostatic leakage tests shall be recorded on the form(s) attached in part 5.0.

02080.1 - 4.15 DISINFECTING WATER SYSTEMS

- A. After completion of pressure testing as described in Part 4.14 above, the Contractor shall disinfect all pipe and fittings installed in the system and receive the required approvals and clearances prior to placing the system in service.
- B. The disinfection shall be accomplished in accordance with the latest applicable provisions of ANSI/AWWA C651, "Disinfecting Water Mains", all appropriate approval agencies and the County Water Resource Services "Procedures for Water Main Cleaning, Disinfection, and Bacteriological Testing." The Contractor may obtain a current copy of these "Procedures" from Water Resource Services. Forty-eight (48) hours advance notice shall be provided to the County Department of Health and the Water Resource Services Governmental Laboratory prior to disinfection procedures start.
- C. Care shall be taken to provide disinfection of the entire system. After disinfection, the line shall be thoroughly flushed until water samples show a chlorine content equal to or less than the existing system.
- D. Temporary plugs or caps shall be installed on disinfected mains until the connections are made to the existing water mains.

02080.1 - 4.16 CONNECTION TO EXISTING WATER MAINS

- A. Connections to existing potable water pipelines shall be made as shown on the Construction Drawings. Coordination between the County and the Contractor shall be required in order to accomplish this task. The Contractor shall supply connection, procedure, and customer notification schedules to the County, for approval, two (2) weeks prior to the proposed connection date.
- B. All connections to existing water mains shall be made under the direct supervision of Hillsborough County Water Resource Services.
- C. The Contractor shall submit a request to the Service Availability Team, Customer Service

Section, of the Hillsborough County Water Resource Services to schedule a tap and pay the appropriate tapping fee. The request shall be made a minimum of 48 hours prior to proposed tie-in to the water main.

- D. The Contractor shall furnish, install and pressure test the tapping sleeves and valves to existing water mains:
 - 1. For all taps up through 12 inches, County Water Resource Services personnel will furnish the necessary tapping machine and tools and will perform the tap.
 - 2. For taps larger than 12 inches, the Contractor shall furnish the tapping machine and tools and shall perform the tap under Water Resource Services supervision. All taps shall be witnessed by the County Inspector.
 - 3. A hydraulic driven tapping machine is indicated for tapping concrete pipe mains. Either hydraulic or pneumatic driven tapping machines may be indicated for mains other than concrete.
- E. Taps smaller than 6 inches (for single connections or distribution systems) to transmission mains 16 inches or larger are not allowed.
 - 1. In areas where there is no reasonable alternative for providing service, the County may approve a 6-inch minimum size connection which reduces down to a 4-inch pipeline configured for a future parallel distribution system for additional services.
 - 2. The connection shall include a tapping saddle, an isolation valve at the point of connection, a minimum 4-inch tee to allow for expansions, and isolation valves on each extension.
- F. Prior to the tap:
 - 1. The Contractor shall assemble all materials, tools, equipment, labor and supervision necessary to make the connection.
 - 2. The Contractor shall excavate a dry and safe working area pit of sufficient size to enable the County Water Resource Services personnel to perform the necessary work.
 - 3. The Contractor shall pressure test the tapping sleeve and valve installation under the supervision of County Water Resource Services personnel. The test pressure shall be 150 psi, or 10 psig above the pressure in the water main being tapped (whichever is greater). This shall be held for 10 minutes at zero (0) pressure loss.
- G. Water mains shall be tapped in such a manner as to avoid disturbance or disruption to the operation of the main in service and to protect the potable water supply from contamination.
- H. Valves on existing mains shall be operated only by Water Resource Services personnel or under their direct supervision.
- I. The Contractor shall be responsible for properly backfilling the work area pit after the work is completed.
- J. When service must be interrupted to existing customers during construction of a tap or addition of appurtenances:
 - 1. The Contractor shall provide 3 days notice to the Hillsborough County Water Resource Services.
 - 2. The Contractor or developer shall be required to notify existing customers as directed by Water Resource Services.
 - 3. The Contractor shall be ready to proceed with as much material preassembled as possible at the site to minimize the length of service interruption. Such connections may be made at night to minimize effects. No customer shall be without service for more than six (6) hours.
 - 4. Water Resource Services will postpone a service cut-off if the Contractor is not ready to proceed on schedule.

PART 5 – PRESSURE TESTING FORMS
PRESSURE TEST REPORT

PROJECT: _____

ENGINEER OF RECORD: _____

CONTRACTOR: _____

SERVICE REQUEST NO: _____ DATE: _____ INSPECTOR: _____

_____ WATER PRESSURE TEST

_____ FORCE MAIN PRESSURE

CALCULATIONS BASED ON AWWA. STD. C600, SECTION 5

$$L = \frac{S D (P)^{1/2}}{148,000}$$

WHERE: L = ALLOWABLE LEAKAGE IN GALS. PER HOUR
S = LENGTH OF PIPE TESTED, IN FEET
D = NOMINAL DIAMETER OF PIPE IN INCHES
P = AVERAGE TEST PRESSURE (PSIG)

CALCULATIONS:

$$L = \frac{[] [] ()^{1/2}}{148,000} = \text{GALS./HR. ALLOWED}$$

$$L = \frac{[] [] ()^{1/2}}{148,000} = \text{GALS./HR. ALLOWED}$$

$$L = \frac{[] [] ()^{1/2}}{148,000} = \text{GALS./HR. ALLOWED}$$

**ALLOWABLE LEAKAGE TEST REPORT
FOR
DUCTILE IRON PIPE**

PROJECT NAME: _____ PROJ. NO.: _____

ENGINEER OF RECORD NAME: _____

COMPANY : _____

CONTRACTOR REPRESENTATIVE NAME: _____

COMPANY NAME: _____

SERVICE REQUEST NO.: _____ DATE: _____

INSPECTOR: _____

_____ WATER PRESSURE TEST _____ FORCEMAIN PRESSURE TEST

CALCULATIONS BASED ON AWWA C600

$$L = \frac{S D (P)^{1/2}}{148,000}$$

WHERE: L = ALLOWABLE LEAKAGE IN GALS. PER HOUR.
 S = LENGTH OF PIPE TESTED, IN FEET
 D = NOMINAL DIAMETER OF PIPE IN INCHES
 P = AVERAGE TEST PRESSURE (PSIG)

CALCULATIONS:

$$L = \frac{[\quad] [\quad] (\quad)^{1/2}}{148,000} = \quad \text{GALS./HR. ALLOWED}$$

$$\text{GALS.HR. X 2 HR.} = \quad \text{GALS. ALLOWED LOST}$$

FIELD MEASUREMENTS:

START TEST @ _____ PRESSURE = _____ # READING = _____

FINISH TEST @ _____ PRESSURE = _____ # READING = _____

LOSS = _____ # GALLONS = _____

PEOPLE PRESENT:

TEST RESULTS AND COMMENTS:

**ALLOWABLE LEAKAGE TEST REPORT
FOR
POLYVINYL CHLORIDE PIPE**

PROJECT NAME: _____ PROJ. NO.: _____

ENGINEER OF RECORD NAME: _____

COMPANY : _____

CONTRACTOR REPRESENTATIVE NAME: _____

COMPANY NAME: _____

SERVICE REQUEST NO.: _____ DATE: _____

INSPECTOR: _____

_____ WATER PRESSURE TEST _____ FORCEMAIN PRESSURE TEST

CALCULATION (1) BASED ON AWWA C605
CALCULATION (2) BASED ON UNI-BELL EQUATION 99 FOR GASKETED PIPE IN 20 FT LENGTHS.

$$(1) \quad Q = \frac{L D (P)^{1/2}}{148,000} \qquad (2) \quad Q = \frac{N D (P)^{1/2}}{7,400}$$

WHERE: Q = ALLOWABLE LEAKAGE IN GALS. PER HOUR.
 L = LENGTH OF PIPE BEING TESTED, IN FEET
 N = NUMBER OF JOINTS IN THE TESTED LINE (PIPE AND FITTINGS)
 D = NOMINAL DIAMETER OF PIPE IN INCHES
 P = AVERAGE TEST PRESSURE (PSIG)

CALCULATIONS:

$$Q = \frac{[\quad] [\quad] (\quad)^{1/2}}{148,000} = \text{_____ GALS./HR. ALLOWED}$$

$$\text{GALS.HR. X 2 HR.} = \text{_____ GALS. ALLOWED LOST}$$

FIELD MEASUREMENTS:

START TEST @ _____ PRESSURE = _____ # READING = _____

FINISH TEST @ _____ PRESSURE = _____ # READING = _____

LOSS = _____ # GALLON = _____

PEOPLE PRESENT:

TEST RESULTS AND COMMENTS:

END OF SPECIFICATION