

## ARTICLE 29

### SANITARY SEWER FORCE MAINS

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This ARTICLE shall govern the design and construction of force mains including valves, fittings, and other appurtenances.

Pipe used in wastewater force main systems shall be either Polyvinyl Chloride (PVC). Ductile Iron Pipe (DIP) or HDPE/Directional Drill may be allowed if prior approval is obtained from the City.

The Contractor shall be responsible for all materials furnished and storage of the same until the date of substantial completion. At the Contractor's expense, all materials found to be defective or damaged in handling or storage shall be replaced. The Contractor shall, if requested by the City, furnish certificates, affidavits of compliance, test reports, or samples for check analysis for any of the materials specified herein. All pipe delivered to project site for installation is subject to random testing for compliance with the designated Specifications.

<b>Section</b>	<b>29.02</b>	<b><u>DESIGN CRITERIA</u></b>
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	<b>29.02.01</b>	<b><u>Design Period</u></b>
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Force main systems shall be designed for the estimated ultimate tributary population, as derived from the City's approved future land uses and/or historical flows. In the event the approved City of Ocoee Wastewater Master Plan, latest edition, identifies components of the force main under consideration, the largest capacity consideration shall be required.

	<b>29.02.02</b>	<b><u>Design Calculations</u></b>
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Owner's/Developer's Engineer shall submit signed, sealed and dated design calculations with the plans for all force main projects. Calculations shall show that force mains will have sufficient hydraulic capacity to transport all design flows. The Design Flow shall be the Peak Flow Rate.

### 29.02.03 Sanitary Sewer Collection System Hydraulic Modeling

The City of Ocoee maintains a sanitary sewer collection hydraulic model (Bentley SewerCAD) which is used for but not limited to determining system performances, pump runtimes and efficiencies, and offsite impacts. For developments that may substantially add to or impact the City sanitary sewer collection system, the Owner/Developer shall cause the incorporation of the development elements into the City's model and the simulation/analyzing of the model. Unacceptable operating conditions and/or offsite impacts created by the proposed development shall be remediated by the Owner/Developer.

This effort to be undertaken by Owner/Developer can be done by either the developer's engineer performing the model work with a City review or by electing to have the City undertake the work. The election for the City to perform the work shall require City approval. All costs incurred by the incorporation and outside reviews by the City shall be at the Owner/Developer's expense. All final products shall become the property of the City.

### 29.02.04 Velocity and Diameter

At design pumping rates, a cleansing velocity of at least 2 feet per second shall be maintain/Achieve. Maximum velocity at design pumping rates shall not exceed 5 feet per second. The minimum force main diameter shall be 4 inches with the exception of 2" sleeved applications in conjunction with the application of a minor lift station. Only 4", 6", 8", 10", 12", 16", 20", 24", 30", 36", 42", 48" and 54" diameter force mains shall be permitted.

### 29.02.05 Design Friction Losses

Friction losses through force mains shall be based on the Hazen-Williams formula. In the use of Hazen-Williams formula, the value for "C" shall be 100 for ductile iron pipe, 120 for PVC pipe and HDPE pipe. When initially installed, force mains may have a significantly higher "C" factor. The higher "C" factor shall be considered only in calculating maximum power requirements and duty cycle time of the motor.

### 29.02.06 Design Pressure and Restraint

The force main and fittings, including all restrained joint fittings and thrust blocking, shall be designed to withstand pump operating pressures and pressure surges, but not less than 150 psi. The required lengths of restrained joints shall be determined by the Engineer and shown in a tabular form as depicted on the "Restrained Pipe Table" in the Typical City Details attached as part of this Manual. Thrust blocks shall not be typical and shall only be used when the City Engineer deems it a hardship or good engineering standards deem it necessary because restraining assemblies are impractical or insufficient. If thrust blocks are used, the bearing area of thrust blocks shall be adequate to prevent any movement of the fitting. The sizes and dimensions of the thrust blocks shall be shown in a thrust block table.

29.02.07      Termination

Force mains shall not terminate directly into a gravity sewer line. Force mains shall enter the terminal facility, gravity sewer manhole, pumping station wet well or other, at a point equal to the operational water level of said receiving unit and not more than 1 foot above the flow line. Should an elevation drop be required to obtain the outlet connection, the prior down-slope of the force main shall not exceed 45°. Adequate air venting shall be provided at the profile break-point.

29.02.08      Air Release and Vacuum Relief Valves

Where the force main profile is such that air pockets or entrapment could occur, resulting in flow blockage, provisions for air release shall be provided. Automatic air release assemblies shall be installed, where venting is required, on all major force mains and at critical points on lesser mains. At profile break points on major force mains, such as tops of hills, etc., where free flow will occur during operation or after pumping stops, combined air release and vacuum valve assemblies shall be provided. Air and vacuum valves and/or air release valves shall be as capacity requires and, if in an open area, they shall be suitably housed in a properly vented, underground chamber (vault/manhole). All such valves shall be clearly delineated on the force main profile in the detail sheets. The Owner's/Developer's Engineer shall submit calculations to the City justifying the valve sizing.

29.02.09      Aerial Crossings

A)      Structural Support

Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent overturning and settlement.

B)      Expansion Protection

Expansion joints shall be provided between the aerial and buried sections of the pipe.

C)      Flood Clearance

For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe shall be placed no lower than 1 foot above the 100 year flood elevation.

D)      Pipe Material and Joints

Flanged joints shall be used. Pipe and flange material shall be a lined ductile iron, minimum class 53. All aboveground pipe shall be painted as specified in ARTICLE 29 of this Manual for aboveground wastewater force mains. Use of epoxy coated steel pipe may be allowed on a case-by-case basis.

E) Valves

Underground valves shall be provided at both ends of the crossing so that the section can be isolated for testing or repair. The valves shall be easily accessible and not subject to flooding. An air release/vacuum relief valve shall be installed at the high point of the crossing.

F) Guards

Appropriate guards shall be installed at both ends of the crossing to prevent pipe access to the public.

G) Permits and Requirements of Other Agencies

It shall be the responsibility of the Owner/Developer to obtain all applicable regulatory permits. When the Aerial Crossing is accomplished by attachment to a bridge or drainage structure, the Owner/Developer shall meet all requirements of the Agencies who own or have jurisdiction over such structures.

29.02.10 Underwater Crossings

A) Pipe Material and Cover

Underwater Crossings shall be directional drilled with HDPE pipe. Fusible PVC may be used with Specific Approval. The Owner/Developer shall provide, for City approval, a signed, sealed and dated design report. Report shall include but not be limited to a geotechnical report with installation recommendations. Both design and geotechnical reports must be signed, dated and sealed by a Florida licensed Professional Engineer.

B) Valves

Valves shall be provided at both ends of the water crossings so that the section can be isolated for testing or repair. The valves shall be easily accessible and not subject to flooding. Both valves shall be provided in a manhole or a valve vault.

C) Permits

It shall be the responsibility of the Owner/Developer to obtain all applicable regulatory permits, including dredge and fill permits and/or sovereign lands.

29.02.11 Additional Requirements

While designing force main systems, consideration shall be given to possible future connecting pumping stations. If applicable, this requirement shall be reviewed with the City prior to finalization of the design.

**Section 29.03 MATERIALS**

**29.03.01 PVC Pipe**

All PVC pipe of nominal diameter 4” through 12 inches shall be manufactured in accordance with AWWA standard C-900. The PVC pipe shall have a minimum working pressure rating of 150 psi and shall have a dimension ratio (DR) of 25. Pipe shall be the same OD as ductile iron pipe. PVC pipe shall be AWWA Standard C-900, DR 18.

**29.03.02 PVC Joints**

PVC pipe shall have integral bell push-on type joints conforming to ASTM D-3139.

**29.03.03 Fittings for PVC Pipe**

Fittings used with PVC pipe shall conform to Section 27.03.05.

**29.03.04 Ductile Iron Pipe**

All ductile iron pipe of nominal diameter 4 through 54 inches shall conform to ANSI/AWWA A-21.51/C-151. A minimum of Pressure Class 350 pipe shall be supplied for all sizes of pipe unless a higher class pipe is specifically called out or required by the City.

**29.03.05 Fittings**

All fittings shall be mechanical joint ductile iron or gray iron conforming to ANSI/AWWA A-21.10/C-110, 250 psi minimum pressure rating, or ductile iron compact fittings 4 through 12 inches in accordance with ANSI/AWWA A-21.53/C-153.

**29.03.06 Joints for DIP**

Joints for ductile iron pipe and fittings shall be push-on or mechanical joints conforming to ANSI/AWWA A-21.11/C-111, unless otherwise specifically called out or required by the City. Where called for on the Drawings, restrained or flanged joints shall be provided. Flanged joints shall conform to ANSI Standard B-16.1-125 lb restrained joints shall conform to ARTICLE 26 of this Manual.

#### 29.03.07 Coatings and Linings for DIP

Where ductile iron pipe and fittings are to be below ground or installed in a casing pipe the coating shall be a minimum 1.0 mil thickness in accordance with ANSI/AWWA A-21.51/C-151. Where ductile iron pipe and fittings are to be installed above ground, the pipe, fittings and valves shall be thoroughly cleaned and given one field coat (minimum 1.5 mils dry thickness) of rust inhibitor primer. Intermediate and finished field coats of Alkyd shall also be applied by the Contractor (minimum 1.5 mils dry thickness each coat). Primer and field coats shall be compatible and shall be applied in accordance with the manufacturer's recommendations. (See approved Manufacturer's List attached as part of this Manual.) Final field coat color shall be green for raw wastewater.

All ductile iron pipe and fittings shall have interior protective lining of Protecto 401 shall be provided with a minimum dry thickness of 40 mils or equivalent applied by the pipe manufacturer.

#### 29.03.08 Polyethylene Encasement

The pipe shall be polyethylene encased (8 mil) where shown in the Typical City Details or required by the City in accordance with ANSI/AWWA A-21.51/C-105.

#### 29.03.09 Directional Drill/HDPE

HDPE pipe shall be used for directional drill application. See ARTICLE 33 for requirements.

### **Section 29.04 VALVES**

Sufficient valves shall be provided on force main systems to facilitate effective isolation of the pipe system for repairs and maintenance. On straight runs of force mains, valve spacing shall not exceed 1,000 feet. Additional valves shall be provided where force mains intersect to facilitate isolation of pipe segments.

#### 29.04.01 Plug Valves

Plug valves shall have a semi-steel body, non-lubricated, eccentric type, 100% port opening with resilient faced plugs capable of drip-tight, bi-directional, shut-off at the full rated pressure. Exposed valves shall have flanged connections. Buried valves shall have mechanical joint connections. Gear actuators for valves 8 inches or larger shall be provided.

#### 29.04.02 Check Valves

Check valves shall have an iron body, bronze-mounted, stainless steel hinge pin, outside spring operated, swing non-slam type, equipped with removable inspection covers. Units shall be rated for 150 psi minimum working pressure and permit full flow area equal to that of the connecting pipe.

29.04.03 Air Release Valves

Air release valves shall have a polimer or stainless steel body, minimum 150 psi working pressure, equipped with a vacuum ball to prevent air return and a properly sized blow off valve. All pipe, hardware, and isolation ball valves shall be per Standard Manufacturer's List Detail.

29.04.04 Tapping Sleeves and Valves

Tapping Sleeves shall be a joint type with flanged outlet per ANSI B-16.1, Class 125. Valves shall be gate valves specially designed for wet tapping and compatible with the connecting sleeve.

29.04.05 Valve Boxes

Valve boxes shall be adjustable, cast iron and suitably sized to the valve with a minimum diameter of 5 inches. The cover shall have the word "SEWER" legibly cast into the face. Boxes shall be suitable for H-20 loading.

**Section 29.05 INSTALLATION**

29.05.01 General

Excavation and backfill including sheeting and bracing, dewatering, bedding and foundation, and furnishing and disposal of materials shall be as required in ARTICLE 6 Table 6-1 of this Manual.

29.05.02 Pipe Laying

All pipe shall be laid "in-the-dry" along straight lines and grades between fittings, manholes, or other defined points, unless definite alignment deflections or grade changes are necessary. The standard minimum cover for sewage force main systems shall be 3 feet from the top of the pipe to finished grade. Where waterways, canals, ditches, or other cuts are crossed, either jack and bore, or directional drill shall be required. Additionally, approved utility crossing signs shall be placed on the pipe alignment at each side of the canal, etc. All materials shall be maintained and all coatings shall be protected from damage and kept clean. The interior of the pipe shall be maintained clean and free of dirt and debris. When work is not in progress, plug all open ends. Underground piping shall not be driven to grade by striking it with an unyielding object. Bell holes in the bedding shall be provided to allow uniform load bearing along the pipe barrel.

29.05.03 Push-on Joints

The pipe bell and spigot shall be thoroughly cleaned immediately prior to inserting the gasket and jointing. The gasket shall be properly faced and positioned. Lubrication shall be in accordance with the manufacturer's recommendations. Pipe shall be protected against damage from jointing equipment by using timber headers, etc.

#### 29.05.04      Mechanical Joints

The socket and plain end shall be wiped clean. The plain end, socket, and gasket shall be washed with a soap solution immediately prior to jointing. The joint shall be kept straight during assembly with the gasket pressed firm and even into the recess. Bolts shall be tightened such that the gland remains reasonably parallel to the flange by alternating from bolt to bolt in cycles. The required bolt size (pipes 4 inches to 24 inches in diameter) shall be ¾ inches, torqued to 75-90 ft-lbs.

#### 29.05.05      Flange Joints

Make all flanged joints tight, without applying undue strain upon the joint or other appurtenances. Joints shall be fitted such that contact surfaces bear uniformly on the gasket with relatively uniform bolt stresses.

#### 29.05.06      Connections at Structures

Where pipes are to extend into or through structures, Link Seal-Type penetration seals shall be provided at the wall face. Openings in existing structures shall be made with a circular core boring machine.

#### 29.05.07      Pipe Cutting

Cutting of pipes for the insertion of valves, fittings, or closure pieces shall be done in a neat, workmanlike manner without damaging pipe coatings or linings. The pipe shall be cut with an abrasive pipe saw, rotary wheel cutter, guillotine pipe saw, or milling wheel saw. Cut ends and rough edges shall be ground smooth and, for push-on joint connections, the cut end shall be beveled. Where castings or linings have been damaged, apply two coats of a Coal Tar/Bitumastic Coating. Where protective linings are provided within the interior of the pipe, repair of the lining shall be completed in accordance with the lining manufacturer's recommendations. All coatings and lining materials shall be in accordance with the Approved Manufacturer's List.

#### 29.05.08      Pipe Restraint

All plugs, caps, tees, and bends, unless otherwise specified, shall be restrained by the use of approved restraint glands, and/or restrained joints. Components of dissimilar metal shall be protected against corrosion by hand application of a bituminous coating. Backfilling over pipe restraints shall not proceed until inspected by the City Engineer or his Designee. Thrust blocks shall not be typical and shall only be used when the City Engineer deems it a hardship or good engineering standards deem it necessary because restraining assemblies are impractical or insufficient. If thrust blocks are used, the bearing area of thrust blocks shall be adequate to prevent any movement of the fitting. The sizes and dimensions of the thrust blocks shall be shown in a thrust block table.



#### 29.05.09 Polyethylene Encasement

Extra protection shall be provided for underground cast or ductile iron pipe and fittings within areas of severe corrosive conditions. This shall be accomplished by the installation of polyethylene encasement through the area of concern. The soil-test evaluation to determine the necessity for extra protection in suspect areas shall be as set forth in ANSI Standard A-21.5.

#### 29.05.10 Aboveground Pipe Support

Support exposed systems, as necessary, to hold the piping and appurtenances in a firm substantial manner to the required lines and grades with no undue piping stresses transmitted to the equipment. All above ground pipe, outside of buildings, shall be supported by concrete supports.

#### 29.05.11 Connections

Tapping shall be by tapping sleeve and valve installed with a tapping device designed for the pipe material.

#### 29.05.12 Valve Installation

Valves shall be installed on all subsidiary force mains at the point of connection to the major main, in order to isolate said pipeline for maintenance. Where force mains are to be extended, valves shall be placed at the future connection points so as to preclude line shut-down at the time of extension. All valves shall be opened wide and then tightly closed. Nuts and bolts shall be inspected for tightness. Special care shall be taken to prevent joint materials, stones, and other substances from becoming lodged in the valve seat. Any valve that does not operate correctly shall be replaced.

Unless otherwise noted, set valve stems vertically above the center-line of the pipe. Where extension stems are required within valve boxes, insert stems shall be provided.

#### 29.05.13 Valve Boxes

All valve boxes shall be centered over the operating nut of underground valves to permit a valve wrench to be easily fitted to the nut. Top of boxes shall be set to final grade. The valve box shall not transmit surface loads directly to either the pipe or valve. Excessive care shall be used to prevent earth and other materials from entering the boxes. Any valve box that becomes out of alignment or is not to grade shall be dug out and adjusted. A concrete collar shall be provided as specified in the Typical City Details attached as part of this Manual.

29.05.14      Air and Vacuum Valves

Where the force main profile is such that air pockets or entrapment could occur, resulting in flow blockage, provisions for air release shall be provided. Automatic air release assemblies shall be installed, where venting is required, on all major force mains and at critical points on lesser mains. At profile break points on major force mains, such as tops of hills, etc., where free flow will occur during operation or after pumping stops, combined air release and vacuum valve assemblies shall be provided. Air and vacuum valves and/or air release valves shall be as capacity requires and, if in an open area, they shall be suitably housed in a properly vented, underground chamber (manhole).

29.05.15      Terminal Discharge

Force mains shall not terminate directly into a gravity sewer line. Force mains shall enter the terminal facility, gravity sewer manhole, pumping station wet well or other, at a point equal to the operational water level of said receiving unit and not more than 1 foot above the flow line. The receiving manhole shall be either lined with an approved liner or be constructed of an approved material that prevents degradation due to the creation of gas in the structure. Should an elevation drop be required to obtain the outlet connection, the prior down-slope of the force main shall not exceed 45°. Adequate air venting shall be provided at the profile break-point.

**Section**      **29.06      IDENTIFICATION**

In order to preclude possible domestic water tapping, all installed underground PVC sanitary sewer force mains shall be green in color. DIP or HDPE pipe shall be marked with a continuous stripe painted in accordance with 62-655-320 (21) (b) 3 F.A.C. Said stripe shall be a minimum 2 inches in width and shall be green in color. Backfill shall not be placed for 30 minutes following paint application. In addition, all pipe shall be buried with non-metallic warning/identification tape above the top of the pipe, see the Typical City Details. The tape shall indicate the presence of a sanitary force main plainly on the tape face. PVC pipe shall be buried with a locating wire properly affixed to the main.

**Section 29.07 CROSS CONNECTION CONTROL**

In order to protect the public water supply system from contamination due to cross connections, the Developer shall install City approved backflow prevention devices where there is the potential of a non-potable substance coming into contact with the public water system. All backflow prevention devices shall comply with the City of Ocoee's Manual of Cross Connection Control and the Foundation for Cross Connection Control and Hydraulic Research, University of Southern California (FCCCHR)

**Section 29.08 HYDROSTATIC TESTING**

This test shall be performed by the Contractor, with the Contractor's labor and equipment, in the presence of the City Engineer or his Designee. No testing shall proceed until all restraining devices are installed or thrust blocks have cured. Clean and flush all piping thoroughly prior to testing. The amount of water to be used shall be twice the volume of the pipe being tested and the velocity of flow shall be a minimum of 3 fps. During filling of water, all air shall be carefully permitted to escape through release cocks installed as required.

The hydrostatic test shall be performed at 150 psi for a period of 2 hours per AWWA C-600. The maximum allowable leakage shall not exceed that determined by the following formula:

$$L = \frac{(N)(D)(P)^5}{3700} = \text{Allowable leakage in gals per 2 hr}$$

$$L = 0.00270 ND; \text{ for 100 psi test for 2 hours}$$

N = Number of joints in the section tested

D = Nominal pipe diameter in inches

P = Average test pressure maintained during the leakage test in psig (gauge)

During the 2 hour period of the test, the Contractor shall maintain a continuous pressure of 150 psi by means of a pump taking supply from a container suitable for the measurement of water loss. Should the test fail, the leak shall be located and repaired and the test performed again until it meets the above specified limits.