

Section 302 – Ductile Iron Water Mains

In Accordance With:
Installation of Ductile-Iron Water Mains And their Appurtenances
ANSI/AWWA C600 (Latest Revision)

Description of Work

The work to be done in accordance with these specifications and the accompanying plans consists of furnishing all labor, materials, and accessories necessary to extend and/or replace the existing water main system as shown on the plans to the work to be done in accordance with these specifications. The work will include: excavation, sheeting, shoring and dewatering as required; furnishing, laying and joining pipes; making connections with existing water mains as may be required; protecting gas and water services, underground telephone or electric cables; backfilling the trench; and such other work as may be necessary in order that the water main be made serviceable and that the work be completed in a satisfactory manner.

302.1 – Materials

302.1.1 – General

All ductile iron pipe shall be centrifugally cast according to the latest revisions of ANSI/AWWA C151/A21.5, in lengths not less than eighteen (18) feet long. All water mains shall be cement-lined in accordance with ANSI/AWWA C104/A21.4-90.

All ductile iron pipe 6" in diameter and larger shall be Min. Class 50, or as determined in accordance with the appropriate drawings for a particular installation. In case there is any question as to the class of pipe to be used in connection with a particular installation, it shall be the duty of the party or firm supplying ductile iron pipe to obtain written verification from the Water Department of the class of pipe in the question.

The bell end of all ductile iron pipe shall be cast for either a mechanical joint or for an approved push-on (slip) joint or groove gasket, including all joints.

302.1.2 – Ductile Iron Pipe with Mechanical Joints

Ductile iron pipe with mechanical joints, for normal water main installations, shall be complete with accessories, including corrosion resistant bolts and nuts and lead-rubber gaskets, in accordance with the latest revisions of ANSI/AWWA C111/A21.51. The bolts and nuts used with this type of joint shall be made in accordance with the above specifications except the material from which they are made shall be Cor-Ten, Austloy, Aclapcoy, or approved equal, corrosion-resistant steel.

All flexible joints used on river-crossing pipe shall be of "Rubber" type or approved bedding and shall be equipped with joint rubber gaskets.

302.1.3 – Ductile Iron Pipe with Push-On Joints

Ductile iron pipe with push-on (slip) joints shall be complete with appropriate rubber gaskets in accordance with the latest revisions of ANSI/AWWA C111/A21.11.

Pipe with this type of joint shall be furnished and installed with at least two (2) serrated brass wedges in each joint, for 3" through 12" pipe; four (4) for larger diameter pipe, or the rubber gasket shall be made with three or more contact strips molded into it (or other approved method) to effect conductivity of electricity across the joint for throwing purposes. The wedges or strips shall be of sufficient size and number to carry a minimum of four hundred (400) amperes of direct current and to limit the voltage drop to not more than one-tenth (1/10) of one (1) volt per joint, and there shall be no perceptible temperature rise and no evidence of smoking, arcing or fuming.

302.1.4 – Fittings

All fittings connected to ductile iron water mains shall be mechanical joint or push-on joint ductile or gray cast-iron made in accordance with the latest revisions of ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, and equipped with mechanical or push-on joints in accordance with Sections 1.1.2 and 1.1.3 of this specification, and cement-lined according to the latest revisions of ANSI/AWWA C104/A21.4.

302.2 – Installation

302.2.1 – General

All ductile iron water mains, fittings, hydrants, and valves shall be installed in accordance with ANSI/AWWA C600—latest revision, unless otherwise specified.

All pipe, fittings, valves, hydrants, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the owner or his representative.

All lumps, blisters, and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and be free from dirt, sand, grit, or any foreign materials before the pipe is laid.

302.2.2 – Excavation

The excavation shall be at the locations as shown on the plans. The trench shall be excavated so that the pipe can be laid to such alignment and depth that a minimum of 5"–10" of cover is maintained over the top of the pipe, and as per City Ordinance a maximum depth of 6.5 feet. Trenches for water mains shall be excavated such that the walls of the trench are vertical from the bottom of the trench to a point one foot above the top of the pipe. Trench width shall be no more than two feet greater than the outside diameter of the pipe being laid.

Trench preparation shall proceed ahead of the pipe-laying by the relevant governmental agencies.

302.2.3 – Sheeting, Shoring, and Bracing

All trenches and other excavations shall be properly sheeted and braced, when and where necessary to provide safe working conditions and to protect the new or existing structures. No unreasonable width of trench shall be permitted to avoid use of sheeting. Bracing shall be so arranged as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength to avoid possible damage. Any damage to new or existing structures whatsoever occurring through settlements due to failure or lack of sheeting or bracing shall be repaired by the Contractor at his own expense.

In general, the sheeting and bracing shall be removed, as the trench or excavation is refilled in accordance with the approved covering in the work. The voids left by the withdrawal of the sheeting shall be carefully filled by ramming, or otherwise as directed. Where the sheeting or shoring cannot be removed without injury to the new work or existing structures, it shall be left in place at the Contractor's expense.

302.2.4 – Removal of Water

The Contractor shall at all times during construction provide and maintain ample means and devices with which to promptly remove and dispose of all water entering the excavations or other parts of the work and shall keep such excavations dry until the structures to be built therein are completed. No masonry shall be laid in water nor shall water be allowed to rise over masonry, until the concrete and mortar has attained a sufficient and satisfactory set. In no event shall water be allowed to rise over masonry if there is danger of flotation or of setting up unequal pressures in the concrete, until the concrete has set at least 24 hours and any danger of flotation has been removed.

In order to provide a dry foundation, the Contractor, if required by the Engineer, shall pre-drain all water tables (except hard pan or rock) by lowering the ground water to a depth of at least one foot below the deepest point of the structure. The work of pre-draining shall be done by the use of a well point system, or by any other method approved by the Engineer that will permit the construction work to be carried on under dry foundation conditions. All discharge water shall be piped to the nearest point of disposal in order to prevent such water from again entering the excavation. Any method or system that may be used to lower the ground water shall be kept in operation continuously unless otherwise especially permitted. The approval of the Engineer for the use of any proposed system shall not relieve the Contractor from the responsibility of providing and maintaining dry excavations as required.

The Contractor shall dispose of water from the work in a suitable manner without damage to adjacent property or sewers. No water shall be drained into work built or under construction unless the consent of the Engineer is first obtained.

All removal and handling of water required to maintain dry trenches or other excavations for the construction of sewers, water mains, or other structures in the work shall be at the expense of the Contractor.

302.2.5 – Pipe Bedding and Backfilling

The pipe shall be bedded in accordance ANSI/AWWA C150/A21.5 for laying condition Type 4, unless otherwise noted. All pipe shall rest on a firm bedding which supports the pipe over its entire length. The bedding shall be sand, pea gravel, or crushed stone, placed from the trench bottom to a depth of one-inch (1/8) the outside pipe diameter or four (4) inches, whichever is greater.

The Contractor shall be responsible for informing the Engineer if an unsuitable bedding is encountered which would cause excessive pipe settlements and deflections. If unsuitable material is encountered, such material shall be removed to a minimum of at least six (6) inches below the trench bottom or to a depth as indicated by the Engineer. The removed material shall be replaced, under the direction of the Engineer, with clean, stable backfill material.

All backfill for water mains shall be material excavated from the trenches, free from rocks, boulders, large or frozen lumps, wood, or other extraneous material, unless otherwise specified.

All trenches or excavations shall be backfilled to the original surface of the ground or such other grades as shown or directed. The Engineer has final approval on the type of backfill and may substitute an alternative backfill if the excavated material is deemed unsuitable.

In cases where the proposed water main will be installed under existing or proposed asphalt roadways, concrete curbs, or sidewalks, the pipe will be bedded and the trench backfilled with 10.0% B-Borrow in lifts not exceeding six (6) inches and compacted to 95% Standard Proctor Density. The granular backfill will be placed in the order of the proposed, or replacement, structure.

The Owner may, at his option, conduct compaction tests of the trench backfill and require the Contractor to remove and recompact, at the Contractor's expense, any backfill found to be compacted to a density less than that specified.

302.2.6 – Existing Utilities

Location of existing water mains are shown on the plans and are based on all approved information. The exact location to determine details of interconnections between existing and new lines, it will be necessary to locate the existing mains both vertically and horizontally and the Contractor shall make all the necessary investigations promptly to avoid ample time for the details to be worked out and the other arrangements for making the connections to be obtained.

Where the water mains are to be constructed parallel to and above existing sewers or drains, the exact location of which is unknown, an adjustment of alignment of the new water main will be made so as to least interfere with the existing sewer or drain. In general, the Contractor shall determine the exact location of existing sewers, drains, gas lines, underground power cables, telephone and television cables before starting construction of any water mains.

302.2.7 – Pipe Deflection

When pipe must be laid such that there are deflections imposed at the pipe joints, these deflections shall not exceed the maximum allowable amounts as shown in the following Tables:

Pipe Diam.	Max. Deflection		Curve Radius	
	18"	20"	18"	20"
6"	5"	19"	21'	205'
8"	5"	19"	21'	205'
10"	5"	19"	21'	205'
12"	5"	19"	21'	205'
14"	5"	19"	21'	205'
16"	3"	11"	12"	340'
			12"	340'
			12"	340'
			12"	340'

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14"	5"	19"	21'	205'
16"	3"	11"	12"	340'
			12"	340'
			12"	340'
			12"	340'

302.2.8 – Thrust Restraint

All plugs, caps, tees, reducers, and bends, unless otherwise specified, shall be provided with restrained joints as shown on the plans.

Restraint mechanisms for push-on or mechanical joints may be used. All tie rods, clamps, glands, bolts, etc. used in the restraining mechanism shall be made of non-corrosive material, not plated.

302.2.9 – Separation of Water and Sewer Lines

Water mains, where possible, shall be laid such that the minimum horizontal separation from sanitary sewers be ten (10) feet. If this lateral separation cannot be maintained the water main may be laid closer than ten feet to the sewer provided the following requirements are met:

- a. The main is laid in a separate trench, or
- b. The main is laid in the same trench with the sewer but located at one side on a ledge of undisturbed earth.

302.3 – Disinfection of Water Mains

The public utility owning the new water mains shall maintain a minimum free chlorine residual of 0.5 parts per million in the distribution system during construction and for a period of thirty (30) days following the last connection to the distribution grid.

302.3.1 – Filling and Contact

When installation has been completed, the main shall be filled with water of a rate such that water within the main will flow at a velocity no greater than 1 ft/s. Precipitations shall be taken to assure that air pockets are eliminated. This water shall remain in the pipe for at least 24-hours. If the water temperature is less than 40°F, the water shall remain in the pipe for at least 48-hours. Valves shall be positioned so that the strong chlorine solution in the treated main will not flow into water mains in active service.

302.3.2 – Forms of Chlorine for Disinfection

The forms of chlorine that may be used in the disinfection operations are liquid chlorine, sodium hypochlorite solution, and calcium hypochlorite granules or tablets.

Liquid chlorine shall be used only (1) in combination with appropriate gas-flow chlorinators and ejectors to provide a controlled high-concentration solution feed to the water to be chlorinated; (2) under the direct supervision of a person who is familiar with the physiological, chemical, and physical properties of liquid chlorine, and who is trained and equipped to handle any emergency that may arise; and (3) when appropriate safety practices are observed to protect working personnel and the public.

Sodium hypochlorite is available in liquid form in glass, rubber-lined, or plastic containers (typically ranging in size from 1 qt. to 5 gal.). Sodium hypochlorite contains approximately 5-percent to 15-percent available chlorine, but care must be used in control of conditions and length of storage to minimize deterioration.

Calcium hypochlorite is available in granular form or in approximately 5-g tablets, and contains approximately 65-percent available chlorine by weight. The material should be stored in a cool, dry, and dark environment to minimize its deterioration.

302.3.3 – Air Removal

Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, the contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. It is good practice to allow the system to stabilize at the test pressure before conducting the leakage test.

302.3.4 – Examination

Any exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until it is satisfactory to the owner.

302.3.5 – Leakage Defined

Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

302.3.6 – Allowable Leakage

No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \left[\frac{50 \sqrt{P}}{V} \right] \times 133,200$$

Where: L = allowable leakage, in gallons per hour
S = length of pipe tested in feet
D = nominal diameter of the pipe (in.)
P = average test pressure during the leakage test (p.s.i.)

Pipe Diameter (in.)	Calcium Hypochlorite Granules (oz.)
4	0.5
6	1.0
8	1.5
12	4.0
16	8.0

302.4.1 – Placing of Calcium Hypochlorite Granules

During construction, calcium hypochlorite granules shall be placed at the upstream end of the first section of pipe, at the upstream end of each branch main, and at 500-ft. intervals. The quantity of granules shall be as shown in Table 1.

302.4.2 – Acceptance of Installation

Acceptance shall be determined on the basis of allowable leakage. If any test of laid pipe discloses leakage greater than that specified, the contractor shall, at his own expense, locate and make approved repairs as necessary until the leakage is within the specified allowance. All visible leaks are to be repaired, regardless of the amount of leakage.

Pipe	13	18	20	30	40
or less					

Pipe (in.)	Number of 5-g Calcium Hypochlorite Tablets				
	1	1	1	1	1
4	1	1	1	1	1
6	1	1	1	1	2
8	1	2	2	3	4
10	2	3	3	4	5
12	3	4	4	6	8
16	4	6	7	10	13

302.4 – Disinfection of Water Mains

The public utility owning the new water mains shall maintain a minimum free chlorine residual of 0.5 parts per million in the distribution system during construction and for a period of thirty (30) days following the last connection to the distribution grid.

302.4.1 – Filling and Contact

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302.4.3 – Basic Disinfection Procedure

The basic disinfection procedure consists of:

- (1) Preventing contaminating materials from entering the water main during storage, construction, or repair; (2) Removing, by flushing or other means, those materials that may have entered the water main; (3) Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main; (4) Determining the bacteriological quality of laboratory test after disinfection.

Two successive tests of samples collected at 24-hour intervals from the new water main extension shall produce bacteriologically satisfactory water before the new water main extension is released for use.

Plans and descriptions of the boring arrangement to be used shall be submitted to the Engineer for approval. No work shall proceed until such approval is obtained.

Bored or jacked installations shall have a bored hole essentially the same size as the outside diameter of the pipe. If holes would develop if the bored hole diameter is greater than the outside diameter of the pipe by more than one (1) inch, grouting or other approved methods shall be employed to fill such voids at the expense of the Contractor.

After installation of the carrier pipe, the casing ends shall be sealed using pre-manufactured casing seals or by grouting around the carrier pipe. Grout shall be placed around casing to a distance no less than two (2) feet from the casing end.

Section 300 – Jacking and Boring Pipe

Heavy particulates generally contain bacteria and prevent even very high chlorine concentrations from contacting and killing such organisms. It is essential that the procedures of this specification be observed to assure that the water main and its appurtenances are thoroughly clean for the final disinfection by chlorination.

300.1 – General

An approach trench shall be dug at the forward end of the proposed pipe to a depth sufficient to form a vertical face of at least one foot higher than the top of the pipe and large enough to provide ample working room. The size and height of this vertical face may be varied, but in all cases the roadbed and shoulders shall be adequately protected. If the pipe is installed, the excavated area not occupied by the pipe shall be backfilled with suitable material and thoroughly compacted into place.

Sheeting and bracing shall be provided if the nature and conditions of the soil or height of exposed faces is such as to endanger either the traveling public or the integrity of the road surface.

When ground water is known or anticipated, a dewatering system of sufficient capacity to handle the flow shall be installed at the site until its operation can be safely halted. The dewatering system shall be equipped with screens or filter media sufficient to prevent the displacement of fines.

300.2 – Jacking

This method shall consist of pushing steel or reinforced concrete pipe into the embankment. All pipe shall be unloaded, unloaded, and stacked so as to prevent any damage to the joints of the pipe.

Excavation shall be undertaken with a steel cutting edge or shield attached to the front section of pipe to form and to cut the required opening for the pipe. Excavation shall be undertaken with the shield and shall not be carried ahead of the pipe for enough to cause loss of soil. When jacking in granular, or runty soils, the shield shall have inserts for inserting steel baffle plates and shelves for the purpose of preventing voids.

The Contractor's superintendent and/or engineer experienced in jacking techniques, shall be present at all times while work is in progress and shall be responsible for checking the line and grade.

The thrust will shall be adequate for installation of the jacked pipe. It shall be constructed normal to the proposed line of thrust.

A suitable lubricant, such as bentonite, may be applied to the outside surface of the jacked pipe to reduce friction forces. This shall be accomplished by the use of pressure equipment which pumps the lubricant to the outside of the shield on the lead pipe or the lubricant may be pumped to the outside surfaces of the pipe through groat holes.

The Contractor shall use jacking equipment which is designed to provide the forces necessary for installation of the pipe. The thrust load shall be imparted to the pipe through a suitable thrust ring which shall be sufficiently rigid to ensure distribution of the load without creating point loading.

When necessary to prevent loss of soil at the heading, the face of the excavation shall be adequately bulkheaded when work is shut down at the end of the working day.

Bracing and backfills shall be so designed and jacks of sufficient capacity to support the weight of the pipe and water without slippage (except for odding lengths of pipe) until the leading edge of the pipe is the specified distance beyond the leading edge of the excavation.

300.1.1 – Jacking Steel Pipe

Pipe jacks shall be welded in accordance with the relevant I.D.O.T. Standard Specification. Pipe jacks shall be self-aligning and shall be equipped with a minimum of 12 steel reinforcement concentric with the pipe wall, and where required, additional reinforcement at the ends of the pipe. The pipe shall be in accordance with ASTM C 76.

To avoid concentrated loads at the joints from pipe to pipe, areas of plywood, asphalt roofing paper, or other similar resilient materials shall be inserted around the circumference in the joints as each pipe is placed ahead of the thrust ring. Resilient material must also be used between the pipe and the thrust ring.

300.1.2 – Jacking Concrete Pipe

Only reinforced concrete pipe sized 30 inches inside diameter and over may be jacked, and shall be class I or better with laps and groove joints. All pipes shall have steel reinforcement concentric with the pipe wall, and where required, additional reinforcement at the ends of the pipe. The pipe shall be in accordance with ASTM C 76.

300.2 – Boring

This method shall consist of pushing the pipe into the soil with a boring auger rotating within the pipe to remove the soil. Advancement of the cutting head ahead of the pipe will not be permitted except for that distance to permit cutting head teeth to cut clearance for the pipe. In the event granular, loose, or unstable soil is encountered during the boring operation, the cutting head shall be retracted if the casing a distance that permits a balance between pushing pressure and the ratio of pipe advancement to quality of soil to assure no voiding is taking place. The excavation by the cutting head shall not exceed the outside diameter of the pipe by more than 1/2 inch. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow of soil or porous material.

The use of water or liquids to soften or wash the face will not be permitted. Water may be used in slurry slugs to facilitate soil removal providing water introduced behind the cutting head. Lubricating agents, such as bentonite, may be used to lubricate the casing and reduce friction between casing and embankment.

Plans and descriptions of the boring arrangement to be used shall be submitted to the Engineer for approval. No work shall proceed until such approval is obtained.

Bored or jacked installations shall have a bored hole essentially the same size as the outside diameter of the pipe. If holes would develop if the bored hole diameter is greater than the outside diameter of the pipe by more than one (1) inch, grouting or other approved methods shall be employed to fill such voids at the expense of the Contractor.

After installation of the carrier pipe, the casing ends shall be sealed using pre-manufactured casing seals or by grouting around the carrier pipe. Grout shall be placed around casing to a distance no less than two (2) feet from the casing end.

302.4.7 – Bacteriological Tests

Bacteriological tests of the water in the mains shall be taken after final flushing and prior to the main being placed in service. Bacteriological samples shall be taken and tested in accordance with the requirements of the City of Angola Water Department.

Two successive tests of samples collected at 24-hour intervals from the new water main extension shall produce bacteriologically satisfactory water before the new water main extension is released for use.

Plans and descriptions of the boring arrangement to be used shall be submitted to the Engineer for approval. No work shall proceed until such approval is obtained.

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