SECTION 02450
DUCTILE IRON SEWER PIPE

PART 1 - GENERAL

1.1 Description

A. Scope:

1. Contractor shall furnish all labor, materials, equipment and incidentals as shown on the Contract Drawings, specified and required to provide ductile iron sewer pipe, fittings and specials necessary to complete the Work.
2. The extent of the piping Work is shown on the Contract Drawings.

B. Related Work Specified Elsewhere:

1. Section 02200, Earthwork.

1.2 Quality Assurance

A. Source Quality Control: Obtain pipe and fittings from one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C110 (ANSI A21.10), Gray-Iron and, Ductile-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
3. AWWA C111 (ANSI A21.11), Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
4. AWWA C115 (ANSI A21.15), Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges.
5. AWWA C150 (ANSI A21.50), Thickness Design of Ductile-Iron Pipe.
6. AWWA C151 (ANSI A21.51), Ductile Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
7. ANSI B18.2.1, Square and Hex Bolts and Screws.
8. ANSI B18.2.2, Square and Hex Nuts.
9. ASTM A 307, Carbon Steel Externally Threaded Standard Fasteners.
10. ASTM A 354, Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.

1.3 Submittals

A. Shop Drawings: Submit for approval Shop Drawings showing the following:

1. Catalog Data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various piping components and accessories. The illustrations shall be of sufficient detail to serve as a guide for assembly and disassembly.
2. Complete layout and installation drawings with clearly marked dimensions. Piece numbers which are coordinated with the tabulated pipe layout schedule shall be clearly marked. Scale and size of the drawings shall conform to the specifications in the Supplementary Conditions.

B. Tests: Submit description of proposed testing methods, procedures and apparatus. Submit copies of all test reports.

C. Certificates: Submit certificates of compliance with referenced standards.

D. Record Drawings: Submit in accordance with the requirements of the Specifications.

1.4 Product Delivery, Storage and Handling

A. Handle all pipe, fittings and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks. Do not otherwise drop, roll or skid pipe. Materials that are cracked, chipped, gouged, dented or otherwise damaged will not be approved.

B. Store pipe and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

C. Pipe, fittings and specials shall be unloaded as close to the place where they are to be laid as is practical, at a location which has been approved by the Engineer. Interiors shall be kept completely free from dirt and foreign matter.

D. No material furnished under this specification shall be shipped to the job site until all submittals have been approved.

PART 2 - PRODUCTS

2.1 Materials

A. General:

1. Joints shall be as specified. If not specified, use flanged joints for exposed piping and mechanical joints for buried piping.
2. Pipe Marking:
   a. Class designation shall be cast or painted on each piece of pipe and fitting.
   b. Each piece of pipe and fitting shall be clearly marked with a designation which shall conform with designations shown on the Shop Drawings.

B. Ductile Iron Pipe and Fittings:

1. Pipe:
   a. Gravity Sewer Pipe: Conform to AWWA C150 and C151 for material, thickness, dimensions, tolerances, tests, markings and other requirements.
      1) Thickness: Ductile iron pipe and fittings shall be minimum Class 53, unless otherwise specified.
2. Joints:
   a. Mechanical Joints: Conform to AWWA C111.
      1) Gaskets: Plain tip.
      2) Bolts and Nuts: High strength, low alloy steel.
      3) Glands: Ductile Iron Retainer Gland with heat treated parkerized steel set screws.
   b. Restrained Joints:
      1) Restrained joints for mechanical joint piping shall be:
         a) Locked mechanical joint style F-127-D by Clow Cast Iron Pipe and Foundry Division of the Clow Corporation.
         b) Lok-Fast Joint by American Cast Iron Pipe Company.
         c) Mechanical joint with retainer glands with alloy steel set screws.
         d) Or equal.

3) Coatings and Linings:

a) Ductile iron pipe and fittings, except as shown on the drawings or directed by the Engineer, shall be lined with a bituminous seal coated cement-mortar lining in accordance with AWWA C104. This lining shall be twice the standard thickness specified in AWWA C104.

b) Buried pipe and fittings shall be coated on the outside with a bituminous coating, approximately 1-mil thick. Exposed pipe shall be prime coated.

C. Couplings:

1. Sleeve Type, Flexible Couplings:

a. Pressure and Service: Same as connected piping.

b. Materials: Steel (with bitumastic coating).

c. Gaskets: Suitable for service intended.

d. Bolts and Nuts: Type 304 stainless steel bolts and nuts.

e. Couplings shall be as manufactured by Dresser Industries or equal.

2. Adapters:

a. Provide appropriate adapter couplings for the connection of different pipe materials and sizes, subject to the Engineer's approval. All hardware including band, bolts, nuts, etc., shall be 304 stainless steel.

b. Ends shall conform to Specifications for the appropriate type joint.

2.2 Identification

A. All pipeline material shall be stamped, marked or identified with the following:

1. Name of manufacturer.
2. Pipe size.
3. Pipe material.
4. Wall thickness.
5. Rating.

PART 3 - EXECUTION

3.1 Inspection

A. The Contractor shall inspect all piping to ensure that piping is free from defects in material and workmanship. The compatibility of all pipe, fittings and coatings shall be verified.

3.2 Installation

A. General:

1. Install piping as shown on the Contract Drawings, specified and as recommended by the manufacturer.
2. Request instructions from Engineer before proceeding if there is a conflict between the manufacturer's recommendations and the Contract Drawings or Specifications.
3. Pipe, fittings and accessories that are cracked, damaged or in poor condition or with damaged linings will be rejected at the time of laying, the pipe shall be examined carefully for defects, and should any pipe be discovered to be defective after being laid, it shall be removed and replaced with sound pipe by the Contractor at his expense.
4. For specially fabricated piping Contractor shall provide the services of a competent manufacturer's installation specialist when pipe installation begins, unless otherwise approved by Engineer.
5. Conflicts between piping systems and equipment or structures shall be presented to Engineer for determination of corrective measures before proceeding.
6. Minimum cover over piping shall be three feet unless otherwise shown or approved by the Engineer.
7. Earthwork required is specified in Section 02200.

B. Piping:

1. Install straight runs true to line and elevation.
2. Provide temporary caps or plugs over all pipe openings at the end of each days work and when otherwise required or directed by Engineer.
3. Cutting: Cut pipe from measurements taken at site, not from Drawings.
4. Bed pipe with materials as specified below and as shown on the Contract Drawings.

a. Trenches shall be excavated below the pipe bottom by an amount sufficient for the placement of granular embedment material (Select Fill) for pipe bedding as shown on the drawings or as specified. All loose and unsuitable material shall be removed from the trench bottom.

b. Granular embedment material (Select Fill) shall be placed in accordance with the requirements of Section 02200, Earthwork, within the following limits:

1) Six (6) inches below the bottom of the pipe to six (6) inches above the crown of the pipe for pipe sizes of 30 inch diameter and smaller.

2) Twelve (12) inches below the bottom of the pipe to twelve (12) inches above the crown of the pipe for pipe sizes greater than 30 inches in diameter.

c. Granular embedment shall be placed in maximum 6-inch layers and compacted for the full width of the trench. Recesses in the embedment shall be provided around each joint to allow space for making joints and inspection.

5. Carefully and thoroughly compact all pipe bedding and fill.
6. No piping shall be laid until Engineer approves the bedding condition.
7. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.

C. Laying Pipe:

1. Conform to manufacturer's instructions and to AWWA C600, AWWA M9, AWWA M11, AWWA M23 where applicable.
2. Install all pipe accurately to line and grade shown unless otherwise approved by Engineer. Remove and relay pipes that are not laid correctly.
3. Slope piping uniformly between elevations given.
4. Ensure that water level in trench is at least 12 inches below bottom of pipe. Do not lay pipe in water. Maintain dry trench until jointing and backfilling are complete.
5. Start laying pipe at lowest point and proceed towards the higher elevations, unless otherwise approved by Engineer.
6. Place bell and spigot pipe so that bells face upstream unless otherwise approved by Engineer.
7. Excavate around joints in bedding and lay pipe so that only the barrel receives bearing pressure from the trench bottom.

8. Permissible deflections at joints shall not exceed 75 percent of the amount allowed by manufacturer.
9. Prior to laying pipe, every precaution shall be taken to ensure that no foreign material enters the piping.
10. All pipe and fittings shall be carefully examined for cracks, damage or other defects while suspended above the trench, before installation. Defective materials shall be immediately removed from site.
11. Interior of all pipe and fittings shall be inspected and all dirt, gravel, sand, debris or other foreign material shall be completely removed from pipe interior before it is moved into the trench.
12. Field cutting pipe, where required, shall be made with a machine specially designed for cutting piping. Cuts shall be carefully done, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cut ends shall be tapered and sharp edges filed off smooth. Flame cutting will not be allowed.
13. Blocking under piping shall not be permitted unless specifically accepted by Engineer for special conditions. If permitted, conform to requirements of AWWA C600.
14. Repair protective coatings and linings in a satisfactory manner prior to backfilling. Refer to specific pipe specifications for coating systems required.
15. Where connecting new pipe to existing manholes, the demolition of existing manhole walls shall be done in a neat, workmanlike manner, and limited in size to the minimum necessary to remove the existing pipe and install the new sewer pipe. Grout shall be nonshrink type with 1/4-inch overlay of polyester patching system such as Quick-Rok manufactured by Fosroc, Sikadur Le Mod Gel Mortar 1:1 Gel/Sand manufactured by Sika, or equal. After the new pipes are in place and grouted, the molded concrete invert fill shall then be replaced as required, true to the sewer pipe invert elevations, and shall be well shaped to smoothly channel the flow into the outlet pipe. Bypassing shall be maintained until the new concrete invert has cured, to the satisfaction of the Engineer.

D. Joints:

1. General:
   a. Make joints in accordance with the pipe manufacturer's recommendations and the requirements below.
   b. Cut piping accurately and squarely and install without forcing or springing.
   c. Ream out all pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
   d. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing. Bell and spigot mating surfaces shall be thoroughly wire brushed and wiped clean and dry immediately before pipe is installed.
2. Gaskets shall be suitable for service intended in accordance with manufacturer's ratings and instructions.
3. Lubricate and adjust gaskets and "O" rings as recommended by manufacturer.
4. After "O" rings are compressed and before pipe is brought fully home, each gasket shall be carefully checked for proper position around full circumference of the joint.
5. Conform to AWWA C111 and to all applicable manufacturer's recommendations pertaining to jointing pipe.
6. For mechanical joints the plain end shall be centered and pushed into the bell and the gasket shall be firmly pressed evenly into the bell. The gland shall be slid to the bell for bolting. All bolts with oiled threads shall be alternately torque tightened 180 degrees opposite to each other to seat the gasket evenly. The maximum torque shall be as follows:

Bolt Size (inches)	Applied Torque (ft-lbs)
5/8	50
3/4	80
1	90
1-1/4	l50

   All bolts and nuts shall be heavily coated with an approved bituminous coating.
7. Clean and lubricate bolt threads and gasket faces for flanged joints.
8. All bolts and nuts for underground service on valves, hydrants, mechanical joint fittings, pipe joint and other ferrous metal appurtenances shall be packed in an asphaltic material. After the joint has been made and the bolts drawn to the proper tension, the joint, including glands, flanges, bolt heads and nuts shall be packed to a minimum thickness of one inch over all surfaces with Talcote, or other equal asphaltic material. Alternatively coat all joint areas and fasteners with two heavy coats of coal tar epoxy.

E. Backfilling:

1. Conform to applicable requirements of Section 02200.
2. Backfill by hand until pipe is covered by at least one foot of fill.

F. Transitions from One Type of Pipe to Another:

1. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.
2. Where new pipe is to be connected to existing pipe, the existing pipe shall be cut straight and smooth. The two pipes shall be joined with a flexible neoprene boot with stainless steel compression straps. This boot shall be manufactured by Fernco, or approved equal. Contractor shall verify type, size and class of existing sewer where replacement pipe is being installed and order the appropriate "Fernco Coupling" as necessary. Be advised that standard style couplings will not be permitted to be installed on sewers of different materials, class or size.

G. Restraints, Supports and Thrust Blocks:

1. Provide concrete and metal cradles, collars, kickers, and blocks as shown or otherwise required and approved by Engineer.

3.3 Testing of Piping

A. General:

1. Test all piping as specified below unless otherwise authorized by Engineer.
2. Notify Engineer 48 hours in advance of testing.
3. Provide all testing apparatus including pumps, hoses, gages, and fittings including temporary restraints, etc.

4. Pipelines shall hold the specified test pressure for a period of four hours.
5. Pipelines which fail to hold specified test pressures or which exceed the allowable leakage rate shall be repaired and retested.
6. Test pressures required are at the lowest elevation of the pipeline section being tested, unless otherwise specified.
7. Unless otherwise approved, conduct all tests in the presence of the Engineer.
8. All pipe shall be tested between manholes.

B. Test Requirements:

1. All sanitary sewers shall be tested for watertightness throughout their entire length.
2. Each section of pipe between manholes shall be tested individually for infiltration and exfiltration and for a length of time as specified and/or as directed by the Engineer. No specific allowance will be made for manholes, except that they will not be subtracted from the overall length of pipe under test in computing the total allowance for the section under test.
3. The Contractor will furnish all necessary and approved material, equipment, labor and other facilities required to satisfactorily perform the tests and shall make all necessary repairs or replacements and retests, as required, at his own expense.
4. After pipe trenches have been satisfactorily backfilled to full depth and groundwater has been allowed to rise to normal levels, the sewer shall be checked by the Engineer to determine if any displacement of the pipe has occurred. A bright light shall be flashed between manholes. If the illuminated interior of the pipe shows poor alignment, displaced pipe or any other defects, the defects as designated by the Engineer shall be remedied as directed, at no additional cost.
5. An infiltration test will be used when normal water level is above the pipe invert and when the normal groundwater level is at normal levels for the entire section of pipe tested during the period of the test. Groundwater observations at the time of testing will be determined by means of test holes made by the Contractor at appropriate locations, if ordered by the Engineer, at no additional cost.
6. Each section of pipe between manholes will be tested individually. That is, separate measurements will be taken for each link between two consecutive manholes. This may be done using a system of two weirs (or other Engineer approved devices) and recording the infiltration, if any, flowing over the weir at the upstream manhole and subtracting that amount from the reading taken at the downstream manhole. If the test has been satisfactory to the Engineer, the weir located at the upstream manhole may now be moved to the next consecutive manhole downstream (leaving the center weir in place) and the process repeated for each link. The weirs will be moved in such a manner that all manholes have been included for testing. Other methods may be acceptable to the Engineer provided that they meet the objectives of this specification.
7. Infiltration tests will be made as soon thereafter as the groundwater has risen to its normal level to the satisfaction of the Engineer, and all necessary facilities for conducting the test are in position. The weir, or weirs, will be in position for at least 24 hours before the test begins. The test will be conducted for a duration acceptable to the Engineer, but will not be less than four hours in duration, during which five consecutive hourly readings shall be taken.
8. The maximum allowable quantity of infiltration or leakage into the section of sewer under test shall be 200 gallons per inch of internal diameter per mile of pipe per day (0.1578 gal/100 lf/inch/hr). Tributary house connections shall be included with the sewer in determining the allowable leakage if they are in groundwater.
9. An exfiltration test shall be made by filling the pipe and manholes with water to provide a positive differential head of at least two feet above the exterior crown of the pipe at the highest point of the line under test. If groundwater levels are found to be above the exterior crown of this pipe, but not as much as two feet above, the positive differential head referred to above shall be two feet above the elevation of the groundwater. The test shall be carried out for a period acceptable to the Engineer, but will in no case be less than four hours in duration.
10. The line shall be vented to permit all air to escape and a waiting period of at least one hour shall elapse from the time the section has been completely filled with water, vented, and subjected to the required internal pressure before the test begins.
11. The maximum allowable quantity of exfiltration or leakage out of the section under test shall be 200 gallons per inch of internal diameter per mile of pipe per day (0.1578 gal/100 lf/inch/hr).
12. If the measured infiltration or exfiltration exceeds the specified allowance, the necessary repairs or replacements shall be made immediately and as directed by the Engineer. The tests shall be repeated as many times as necessary, at no additional cost, until the requirements hereinbefore specified have been met. The above notwithstanding, all visible leaks shall be repaired. When a section under test fails to meet the specified requirements and therefore must be retested, the retest shall not extend beyond the portion of the sewer tested in the original test.
13. As specified above, all infiltration/exfiltration tests leading to acceptance of the work shall be performed after the trench has been backfilled to full depth. This is not meant to preclude independent tests performed by the Contractor for his own information prior to backfilling.
14. The cost of all labor, materials, equipment and incidentals, whether or not here specified, necessary for the testing, retesting and repairing of the sewer system consistent with the intent of this section is deemed included under the appropriate contract bid item(s) for furnishing and installing the pipe being tested. Waterproofing of existing manholes shall be provided as required to obtain acceptable leakage rates, at no additional cost to the Owner.

3.4 Cleaning

A. All piping shall be thoroughly cleaned and flushed prior to placing in service in a manner approved by Engineer.