

**SECTION 500**

**SANITARY SEWER AND FORCE MAIN**

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## SECTION 500

### SANITARY SEWER AND FORCE MAIN

#### 500 GENERAL

- A. Sanitary sewer and force main construction shall consist of all excavation, materials, installation, restoration, and related work as specified herein or shown on the drawings.
- B. The term "sanitary sewer" shall refer to all nonpressurized gravity flow sanitary sewers. The term "force main" shall refer to all pressurized conduits conveying wastewater from a pumping station.
- C. CONTRACTOR shall comply with requirements of Sections 200 and 600 for all sanitary sewer construction.

#### 501 MATERIALS

- A. Unless otherwise specified, all sanitary sewers up through 15-inch-diameter shall be composite pipe or solid wall PVC. Approved adapters shall be provided for transitions to other types of pipe.
- B. All force main shall be ductile iron or PVC pipe.
- C. Reinforced Concrete Pipe:
  - 1. Reinforced concrete pipe shall meet the Standard Specifications for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe of the ASTM C76 for circular pipe, ASTM C507 for elliptical pipe, or ASTM C655 for D-load pipe.
  - 2. All reinforced concrete pipe used in the work shall be of adequate strength to support the trench loads applied, minimum Class III. Unless otherwise shown or specified, all reinforced concrete pipe shall be of the class as shown on the drawings and shall have a minimum "C" wall construction
  - 3. Lift holes will not be permitted in sanitary sewers.
  - 4. All reinforced concrete pipe and fittings shall be provided with joints that meet the Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe of ASTM C443. Joints shall be sealed with rubber gaskets having a continuous O-ring cross section meeting requirements of ASTM C361. All pipe shall be specifically built to fit the gasket used.
  - 5. Concrete pipe shall be provided with either a tongue and groove joint (i.e., no bell), or with an R-4 big bell joint (for pipe diameters less than 36 inches). Joints for all tongue and groove joint sanitary sewer pipe (except where open cut is not allowed) shall be provided with an external bitumastic wrap, MacWrap, or equal. Wrap shall be minimum 12 inches wide and shall be secured on the pipe with a minimum of one steel band seal connector on each side of the joint.
  - 6. All reinforced concrete sanitary sewer pipe shall be vacuum tested from end to end at the factory to 15 psi. Test vacuum shall be held for two minutes with no loss in vacuum. Test result, date, pipe class, date of manufacture, and individualized pipe identification shall be clearly marked on each pipe. Written vacuum test results for each pipe identification shall be submitted to ENGINEER. ENGINEER shall be provided an opportunity to observe all tests.

7. Acceptance of reinforced concrete pipe shall be on the basis of plant load-bearing tests, material tests, vacuum testing, and inspection of manufactured pipe for visual defects and imperfections.
  8. Reinforced concrete fittings shall be manufactured to provide for the required transitions as shown on the drawings. Sufficient additional reinforcement shall be added to prevent shearing after installation. Repairs to complete fabricated pipe fittings shall be such that the completed unit shall have the same strength as that of the remainder of the pipe barrel and the concrete used to complete the section shall not spall or separate.
- D. Composite Pipe (PVC and ABS Truss):
1. Composite pipe shall meet the requirements of ASTM D2680.
  2. Fittings for PVC composite pipe shall conform to Section 500-E.
  3. Resin used in the manufacture of PVC composite sewer pipe shall meet the requirements of ASTM D3034.
  4. Attachment of couplings and saddle fittings and field joining of pipe sections and fittings shall be accomplished by solvent welding or rubber gaskets in accordance with the recommendations of the pipe manufacturer. All exposed filler material shall be field coated with ABS or PVC Solvent Cement.
  5. Pipe shall be subject to rejection for failure to conform to material requirements stated above or for any of the following reasons:
    - a. Distortion or puncture of the inner plastic shell. Distortion or punctures of the outer shell shall not be reasons for rejection if the inner shell is unaffected and such exterior distortion or puncture is suitably repaired with a solvent welded patch to the satisfaction of ENGINEER.
    - b. Voids in the concrete filler at pipe ends exceeding 1-inch in depth as measured from the pipe end and exceeding 10% of the pipe circumference. However, this pipe may be used if the faulty pipe end is sawed off and coated to the satisfaction of ENGINEER.
    - c. Cracks in coupling.
    - d. Failure to meet test requirements.
- E. Polyvinyl Chloride (PVC) Gravity:
1. Solid Wall PVC:
    - a. Polyvinyl Chloride (PVC) pipe fittings shall meet the requirements for type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings of ASTM D3034 for pipe sizes up through 15 inches and ASTM F679 for pipe sizes 18 inches through 36 inches. All PVC sanitary sewer pipe shall have a maximum standard dimension ratio (SDR) of 26.
    - b. The wall thickness shall conform to requirements for a T-1 wall per ASTM F69-01. PVC material shall have cell classification 12454-B or 12454-C as defined in ASTM D1784 with minimum modulus of elasticity of 400,000 psi in tension. Pipe stiffness shall be minimum 46 psi when tested in accordance with ASTM D2412.
    - c. Acceptance of piping shall be subject to tests conducted by an approved testing agency.
    - d. Pipe and fittings shall be the product of one manufacturer and the manufacturer shall have experience records substantiating acceptable performance of the pipe to be furnished.
    - e. Fittings such as saddles, elbows, tees, wyes and others shall be of material and construction corresponding to and have a joint design compatible with the adjacent pipe. Approved adapters shall be provided for transitions to other types of pipe. Fittings shall be injection molded PVC.

- f. Joints shall be of the elastomeric type. Elastomeric joints shall be a bell and spigot joint conforming to ASTM D3212 sealed by a rubber gasket conforming to ASTM F477 so that the assembly will remain watertight under all conditions of service, including the movements resulting from the expansion, contraction, settlement and deformation of the pipe. Bells shall be formed integrally with the pipe and shall contain a factory installed positively restrained gasket.
2. Open Profile Wall PVC (18-inch and larger pipe only):
- a. Open profile PVC sewer pipe and fittings shall meet the requirements of ASTM F794. Fittings shall conform to ASTM D3034 SDR 35. Pipe shall have smooth interior with a ribbed exterior. Exterior ribs shall be perpendicular to the axis of the pipe to allow placement of gaskets without additional cutting or matching. Pipe shall have solid cross section wall; no voids between inner and outer surfaces of pipe wall.
  - b. PVC materials shall have cell classification 12454-B or 12454-C as defined in ASTM D1784 with minimum modulus of elasticity of 400,000 psi in tension. Pipe stiffness shall be minimum 46 psi when tested in accordance with ASTM D2412. Impact strength shall equal or exceed values given in ASTM D3034 or ASTM F679.
  - c. The pipe wall shall be homogeneous and contain no seams. Minimum pipe stiffness per ASTM D2412 shall be 60 psi for 18-inch and 46 psi for 21-inch and larger pipe sizes. Pipe shall withstand impact of 210 foot-pounds for 8-inch and 220 foot-pounds on larger sizes. Pipe shall withstand flattening up to 60% without cracking, splitting or breaking and pass acetone immersion per ASTM D2152.
  - d. Acceptance of piping shall be subject to tests conducted by an approved testing agency.
  - e. Pipe and fittings shall be the product of one manufacturer and the manufacturer shall have an experience record substantiating acceptable performance of the pipe to be furnished.
  - f. All joints shall be of the flexible elastomeric type with bells and spigots conforming to ASTM D3212. Gaskets shall conform to ASTM F477. All bells shall be formed integrally with the pipe. Elastomeric gasket shall be positively restrained in ribs on spigot of pipe.
  - g. Fittings shall be injection molded. Fittings such as saddles, elbows, tees, wyes and others shall be of material and construction corresponding to, and have a joint design compatible with the adjacent pipe. Approved adapters shall be provided for transitions to other types of pipe.
- F. Ductile Iron Pipe (Gravity and Force Main):
- 1. Pipe furnished under these specifications shall conform to the requirements of AWWA C151 and ASTM A746. Pipes and fittings shall be lined with the following products, or approved equal:
    - a. Pipe and fittings lined with Protecto 401™ ceramic epoxy as manufactured by U.S. Pipe.
      - (1) Within 8 hours following surface preparation, the interior of the pipe and fittings shall receive 40 mils nominal dry film thickness of Protecto 401™.
      - (2) Due to the tolerances involved, the gasket area and surface within 6 inches of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto joint compound. The joint compound shall be applied by brush to ensure coverage. Care shall be taken that the joint compound is smooth without excess buildup in the gasket seat or on the spigot end. Coating of the gasket seat and spigot end shall be done after the application of the lining.

- (3) Protecto joint compound shall be used for touch-up or repair (including sealing all cut ends) in accordance with manufacturer's recommendations.
  2. The exterior surfaces of pipe and fittings shall be coated with a minimum of 1 mil of bituminous paint per AWWA C151.
  3. Other requirements of the materials and installation of ductile iron force main shall conform to Section 400, including providing polyethylene encasement.
- G. Polyvinyl Chloride (PVC) Force Main:
  1. Pipe furnished under these specifications shall conform to the requirements of AWWA C900 for 4-inch through 12-inch and AWWA C905 for 14-inch through 36-inch.
  2. All joints shall be integral elastomeric bell and spigot joints conforming to ASTM D3212. Gaskets shall conform to ASTM F477.
  3. PVC pipe diameter shall conform to the O.D. of ductile iron pipe. The type of PVC material, nominal pipe size, standard dimension ratio, and pressure rating shall not be less than pressure class 150. The standard dimension ratio shall not exceed 18.
  4. Markings on the pipe shall include the following: Nominal pipe size, type of plastic pipe material, SDR number, AWWA Designation with which the pipe complies, manufacturer's name, and the pressure rating.
- H. Sanitary Sewer Service Laterals:
  1. CONTRACTOR shall provide sanitary sewer service laterals as shown on the drawings and as requested by ENGINEER. Service laterals shall be installed to serve all existing buildings and all platted lots. Service laterals shall consist of a branch fitting at the main and extension of the specified lateral pipe.
  2. Unless otherwise shown on the drawings, service laterals shall be solid wall Schedule 40 PVC conforming to ASTM D1785, D1784 Class 12454-B, D2665 and D3311.
  3. Wherever shown on the drawings or requested by ENGINEER, wye or tee branches shall be built into the main for use in making service connections.
  4. Unless otherwise shown, the openings in the wyes or tees for new sanitary service laterals to single-family residences shall be 4 inches in diameter. In all other cases, unless otherwise shown, the wye or tee openings shall be 6 inches in diameter or sized to match the existing lateral pipe, whichever is greater.
  5. New laterals shall be capped with an air-tight fitting and tested with the new sanitary sewer before being connected to private service lines. For sewer replacement projects, the new sewer shall be segment tested as necessary to avoid lengthy disruptions to existing service.
  6. Except for RCP sewer pipe, factory fabricated wye branches shall be installed on the new sewer main for each lateral connection in accordance with the standard details. Connections to RCP sewer pipe shall be made with Kor-N-Tee connectors manufactured by NPC, Inc.
  7. Where the new wye and lateral, or new lateral and existing lateral are dissimilar materials, CONTRACTOR shall provide a rigid transition coupling. For situations where rigid couplings are not available, CONTRACTOR shall provide Fernco, or equal, transition coupling designed to join the two pipe materials. All fittings used, including type of jointing, are subject to review by ENGINEER.
- I. Manholes: Sanitary sewer manholes, including castings and adjusting rings shall conform to the material requirements of Section 300 and the standard detail drawings.
- J. Manhole Frame/Chimney Seal:

1. CONTRACTOR shall provide an internal manhole frame/chimney seal for each new sanitary sewer manhole. ENGINEER may determine that a chimney seal is not required for a manhole not susceptible to high groundwater conditions.
2. Chimney seal shall be made of a rubber type product, with a minimum thickness of 3/16 inches, a minimum unstretched width of 8 inches and be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C923. The bands used for compressing the sleeve against the manhole shall be fabricated from stainless steel conforming to ASTM A240, Type 304, for sheet and ASTM A479, Type 304, for rods. Any screws, bolts, or nuts used on these bands shall be stainless steel conforming to ASTM F593 and 594, type 304. The internal seal or its appurtenances shall not extend far enough into the manhole opening to restrict entry into or exit from the manhole.
3. Manhole frame/chimney seal shall be designed to prevent the leakage of water into the manhole at the area of the joint between the casting frame and manhole chimney continuously throughout a 20-year design life. The seal shall remain flexible, allowing repeated vertical movements of the frame due to frost lift, ground movement, or other causes of up to 2 inches and/or repeated horizontal movements of the frame due to thermal movement of the pavement or other causes of up to 1/2 inch, both rates of movement occurring at rates not less than 0.10 inch per minute.
4. The seal shall be made of materials that have been successfully used in sanitary sewer construction for at least ten years and have proven to be resistant to sanitary sewerage; corrosion or rotting under wet or dry conditions; the gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide and other trace gases at the sites of installations; the biological environment in soils and sanitary sewers; chemical attacks by road salts, road oil and common street spillages or solvents used in street construction or maintenance; the temperature ranges, variations and gradients in and between manhole frames and chimneys in the climate of the location of construction; variations in moisture conditions and humidity; fatigue failure caused by a minimum of 30 freeze-thaw cycles per year; or vibrations due to traffic loadings; fatigue failure due to repeated variations of tensile, compressive and shear stresses and repeated elongation and compression; and any combination of the foregoing. The materials used shall be compatible with each other and the manhole materials.
5. The seal shall be designed to continuously prevent the leakage of water from outside the manhole into the manhole at the joint where the manhole frame meets the chimney or cone. At the same time the seal shall remain flexible allowing repeated vertical movements of the frame, due to frost heave of the pavement or the frame or due to other causes, from 0 to 2 inches above the top of the chimney or cone and repeated horizontal movements of the frame with respect to the top of the chimney or cone, due to pavement movements or other causes, of from 0 to 1/2 inch, or both simultaneously with both types of movement occurring at rates not greater than 1/10 inch per minute.

K. Kor-N-Seal Connectors:

1. All pipe connections to new or existing sanitary sewer manholes shall be made with NPC Inc., Kor-N-Seal connectors.
2. Connectors shall consist of a 304 series non-magnetic stainless steel Korband and pipe clamp, an EPDM rubber connector and a reinforced nylon wedge. The rubber connector, Korband and pipe clamp shall conform to ASTM C923. The Korband and pipe clamp shall also conform to ASTM A167.

- A. Sanitary Sewer Mains: Alignment and grade of all sewer lines shall be checked with a laser device unless otherwise approved by ENGINEER.
- B. Connections to Main: All connections to sanitary sewer mains shall be made using a factory fabricated wye or Kor-N-Tee connector. ABS wyes shall be used for all ABS mains. PVC wyes shall be used for all cast iron, ductile iron, PVC and clay mains. Kor-N-Tee connectors shall be used on all concrete mains.
- C. Service Laterals: Sewer laterals shall be installed as shown on the drawings or as requested by ENGINEER. CONTRACTOR shall provide a 4-inch by 4-inch by 8-foot timber at the end of each unconnected lateral. Timber shall be placed so that its top is 1 foot above the finished ground surface and painted APWA green.
- D. Location of Service Laterals: State Statute 182.0175(2r) requires that an effective means for locating nonconductive sewers (including sanitary sewer laterals and private sanitary sewers) be provided. The City shall maintain records of the location of all sanitary service laterals by the following means:
  - 1. Field measurements shall be made by the designated project field engineer during construction to provide measurement from the downstream manhole to the lateral wye. These measured distances shall be shown on the record drawing in proximity to each sewer lateral.
  - 2. Field measurements shall be made by the designated project field engineer during construction to obtain coordinates to Dane County Datum of the center of each sanitary sewer manhole. The coordinates shall be used to draw the location of each manhole to scale on the record drawing.
  - 3. Field measurements shall be made by the designated project field engineer during construction to obtain coordinates to Dane County Datum of the location at which the lateral crosses beneath the curb and gutter of the street. This may require obtaining additional measurements, such as the upstream end of the lateral, so as to enable the recovery of the lateral's location at a later time after the curb is constructed.
  - 4. The coordinates thus obtained shall be used along with the wye locations to draw the lateral locations to scale on the record drawing. The coordinates shall also be used to locate in the field the location on the curb at the vertical projection of the point where the sewer lateral crosses beneath the curb and gutter of the street. The top of curb at these locations shall be stamped with the letters "SAN." If the curb is not so marked while still plastic, it shall be marked after curing by cutting the letters into the top of curb (1/4" min. depth) with a small radius grinding wheel, Dremel tool, or other means acceptable to ENGINEER.
- E. Manholes: All manhole openings, including lift holes, adjustment rings, and pipe connections shall be sealed watertight with approved materials. Manhole barrel section joints are to be sealed watertight with O-ring gaskets, Ram Nek, Mas Tik, or approved equal.
- F. Repairs and Replacement: Pipe repairs shall be made by replacement of the defective pipe section with new pipe of equivalent inside diameter. Piping alignment, grade, bedding, cover, and backfilling shall be provided in accordance with these specifications.
  - 1. Field cuts of all types of pipe shall provide a straight true cut without chipping or cracking pipe.
  - 2. For replacement of reinforced concrete, composite (truss), PVC or ductile iron pipe, the new pipe shall be made of the same material, unless otherwise approved. For replacement of clay pipe, the new pipe shall be ABS composite truss pipe.

3. Replacement sections shall be connected with rigid couplings whenever possible.
  - a. If rigid coupling of same material as pipe is not available for main repair, connect to existing pipe with Hymax<sup>®</sup> 2000, manufactured by Total Piping Solutions, Inc.
  - b. If rigid connection cannot be made on a lateral, connect to existing pipe with Fernco, Mission, or equal coupling to provide a watertight connection.
- G. Except as modified herein, all pressure pipe shall be installed in accordance with AWWA C600 and AWWA C900 for ductile iron and PVC pipe, respectively.

#### 503 ABANDONMENT OF EXISTING SANITARY SEWER FACILITIES

- A. Where existing sanitary sewer facilities are shown on the drawings to be abandoned, or where existing abandoned facilities are discovered during construction, CONTRACTOR shall abandon these facilities as follows:
  1. Remove existing pipes or fill them with sand or grout and seal ends with a minimum 2-foot-thick grout plug.
  2. Remove existing manholes to at least 2 feet below finished grade. Provide a minimum 6-inch hole in the bottom of the structure and fill the remaining portion with bedding stone.
  3. Salvage all castings, and any other appurtenances identified for salvage in the Special Provisions, and deliver them to OWNER at the City Water Utility yard behind the water tower at 3640 High Road.
- B. For sanitary laterals that are to be abandoned, the lateral shall be cut or disconnected at the main. Both exposed ends of the lateral pipe shall be sealed with a cap (for pipe spigot ends) or plug (for pipe bell ends). On PVC or ABS pipe, the caps shall be glued.
- C. Cost for abandonment, as identified on the drawings, shall be paid for according to the lump sum bid.

#### 504 TESTING

- A. CONTRACTOR shall prepare all pipeline for testing and shall furnish all equipment, materials, tools, and labor necessary for performance of the tests.
- B. All gravity sanitary sewer shall be tested as specified below. For sewers that are not connected to existing buildings, testing shall be completed after laterals have been installed. For new sewers where buildings are to be reconnected to the sewer, testing shall be completed without subjecting the service lateral to the test, either by segmenting the main or by reconnecting the service lateral after testing is completed on the sewer main. CONTRACTOR shall be responsible for maintaining temporary service to all existing buildings at all times during construction and testing without backups or overflows.
  1. Sanitary Sewer Gravity Mains 18-inch and Smaller: Leakage testing of sanitary sewer gravity mains less than 18 inches shall be conducted by the low pressure air test method as specified in ASTM C828 for vitrified clay pipe, or ASTM F1417 for PVC pipe or ABS truss pipe, or ASTM C924 for concrete pipe. Equipment for the low pressure air test of gravity mains shall be equal in all operational aspects to that as furnished by Cherne Industrial, Inc., or United Survey, Inc.
  2. Sanitary Sewer Gravity Mains 18-inch and Larger: These mains shall be tested for leakage by exfiltration. If groundwater is less than 2 feet above the sewer, the stretch of sewer shall be plugged at its downstream end and water shall be placed inside the sewer to provide a minimum of 4 feet of head above the upstream end. CONTRACTOR shall furnish all labor and materials necessary for making the tests.

The allowable leakage shall be as indicated for infiltration test. If groundwater is 2 feet or more above the sewer, the exfiltration test is not required.

3. Infiltration Test: At the conclusion of construction and before final acceptance of the work, the downstream end of all new gravity sewer mains will be measured for infiltration. Allowable infiltration shall not exceed 200 gallons/inch of pipe diameter/mile/day for the entire system under groundwater, including manholes. If infiltration is exceeded, the leak or leaks shall be located and repaired. All leakage tests shall be witnessed by ENGINEER. Where infiltration is observed, all sewers shall be tested by measuring the infiltration through the use of a weir installed in the manhole at the downstream end of the sewer being tested.
- C. Leakage Testing - Force Main: Leakage and pressure testing of all force mains shall be completed in accordance with Section 403.
  - D. Deflection Test: All non-composite PVC sanitary sewer pipe shall be tested for deflection. Maximum deflection after completion of backfilling shall be 5% of the inside pipe diameter. Deflection shall be measured by pulling a mandrel with a vertical diameter equal to 95% of the pipe inside diameter through the line, after thoroughly flushing the lines to be tested. The testing device shall be controlled using cables at both the upstream and downstream manholes. The testing device must pass freely through the sewer without the use of unreasonable force on the control cables. Any line which will not pass the test cylinder will not be accepted until the faulty sections have been removed and replaced and the line retested.
  - E. Sanitary sewer shall be videotaped by CONTRACTOR one month after testing unless otherwise allowed by ENGINEER to accommodate an earlier restoration schedule. Videotaping shall be required of all new construction, replacements and repairs, including sewer laterals. All sanitary sewers up through 12-inch diameter that are found to have standing water during videotaping shall be relaid to eliminate standing water, or, if approved by OWNER, CONTRACTOR, in lieu of relaying pipe, shall pay OWNER 50% of the bid price for that length of pipe with standing water.
  - F. Utility installations which fail to meet the test limits shall be repaired in a manner acceptable to ENGINEER. Defective pipe installations should be uncovered and relaid with new pipe, to repair the defect. Under no circumstances shall defects be sealed from the interior of the pipe, and only where specifically allowed by ENGINEER shall defects be sealed from the exterior of the pipe.

## 505 MEASUREMENT AND PAYMENT

- A. Sanitary Sewer Mains: Sanitary sewer mains shall be measured by length in feet of each of the various types and sizes of pipe installed. Measurements shall be along the centerline of the pipe center-to-center of manholes or to connection to existing sewer, including fittings. Construction through manholes shall be included in the length measured for payment. The price bid shall include furnishing all equipment, labor and materials necessary to perform the work including excavation, bedding, sewer main, fittings, cover, insulation, backfilling, installation, testing and restoration.
- B. Sanitary Sewer Manholes:
  1. Sanitary sewer manholes shall be measured and paid for according to the unit price bid for the various sizes installed including dewatering, excavation, bedding, castings, steps, adjusting rings, Kor-N-Seal pipe connections, chimney seals and backfill.

2. The Contract price shall include furnishing all equipment, labor and materials, necessary to perform the work.
- C. Sanitary Sewer Laterals:
1. Sanitary sewer laterals shall be measured by length in feet of each of the various types and sizes of pipe from the end of wye to the end of the lateral pipe.
  2. The Contract price shall include furnishing all equipment, labor and materials, including required fittings necessary to perform the work in accordance with the specifications and drawings.

END OF SECTION