

**DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2500 SANITARY SEWERS**

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**KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION**

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SECTION 2501 GENERAL

2501.1 Scope

This section governs the furnishing of all labor, materials and equipment for the complete installation of sewers and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2501.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

APWA

Section 2100	Grading and Site Preparation
Section 2150	Erosion and Sediment Control
Section 2200	Paving
Section 2300	Incidental Construction
Section 2400	Seeding and Sodding

ASTM

A 48	Standard Specification for Gray Iron Castings
A 139	Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 184	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
A 307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
A 449	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 32	Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)
C 33	Standard Specification for Concrete Aggregates
C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C 150	Standard Specification for Portland Cement
C 191	Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 260	Standard Specification for Air-Entraining Admixtures for Concrete
C 270	Standard Specification for Mortar for Unit Masonry
C 361	Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
C 443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C 478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
C 827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
D 450	Standard Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing
D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft ³ (600 kN-m/m ³))
D 1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

- D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
- D 1784 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- D 2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- D 2235 Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
- D 2240 Standard Test Method for Rubber Property—Durometer Hardness
- D 2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- D 2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- D 2584 Standard Test Method for Ignition Loss of Cured Reinforced Resins
- D 2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
- D 2661 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
- D 2837 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D 3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- D 3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
- D 3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- D 3262 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
- D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
- D 3754 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
- D 3839 Standard Guide for Underground Installation of “Fiberglass” (Glass-Fiber Reinforced Thermosetting-Resin) Pipe
- D 4101 Standard Specification for Polypropylene Injection and Extrusion Materials
- D 4161 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
- D 5685 Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
- D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- F 477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- F 628 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
- F 679 Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
- F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
- F 1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air
- F 3125 Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

ANSI/AWWA

- C 104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
- C 105/A21.5 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
- C 110/A21.10 American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In.
- C 111/A21.11 American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
- C 115/A21.15 American National Standard for Flanged Ductile-Iron Pipe with Threaded Flanges
- C 150/A21.50 American National Standard for Thickness Design of Ductile-Iron Pipe
- C 151/A21.51 American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water
- C 153/A21.53 American National Standard for Ductile-Iron Compact Fittings for Water Service

AWWA

- C 302 Reinforced Concrete Pressure Pipe, Noncylinder Type
- C 600 Installation of Ductile Iron Water Mains and Their Appurtenances
- C 950 Fiberglass Pressure Pipe

ANSI

- Z 60.1 American Standard for Nursery Stock

- MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern. Reference December 2000 Specifications if most recent version does not contain specified mix designs.

KCMMB Kansas City Metro Materials Board Specifications

2501.3 Cleanup

Cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, equipment, tools, surplus or discarded materials, and temporary construction items.

Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt or mud. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians.

All work shall comply with Section 2150 "Erosion and Sediment Control".

SECTION 2502 MATERIALS

2502.1 Scope

This section governs the furnishing of all labor, materials and equipment that may be required to complete pipeline construction, exclusive of structures, as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

- A. Requirements: Furnish pipe of materials, joint types, sizes, and strength classes indicated or specified. Higher strengths may be furnished at the Contractor's option at no additional cost to the Owner.
- B. Manufacturer: The manufacturer shall be experienced in the design, manufacture and commercial supplying of the specific material.
- C. Inspection and Testing: Inspection and testing shall be performed by the Manufacturer's quality control personnel in conformance with applicable standards. Testing may be witnessed by Owner, Engineer, or approved independent testing laboratory. The Contractor shall provide three (3) copies of certified test reports indicating the materials conform to the specifications.
- D. Handling: The manufacturer and contractor shall use equipment and methods shall be adequate to protect the pipe, joint elements and prevent shock contact of adjacent units during moving or storage. Damaged sections that cause reasonable doubt as to their structural strength or water-tightness will be rejected. No pipe or fitting shall be delivered until the certified test reports are approved by the Engineer.

2502.2 Pipe, Fittings, Joints, Coatings and Linings

- A.** General: Furnish pipe and fittings of materials, joint types, sizes, strength classes, coatings and linings as indicated and specified.
- B.** Ductile-Iron Pipe and Fittings: Pipe and fittings shall conform to ANSI/AWWA C151/A21.51, ANSI/AWWA C110/A21.10, and ANSI/AWWA C153/A21.53 except as otherwise specified herein.
1. General: Furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures and specials.
 2. Design: All ductile iron pipe shall meet the requirements of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51 and shall be of the thickness class specified herein or shown on the drawings. The minimum thickness allowed shall be Special Class 50.
 3. Joints: Mechanical and push-on joints for pipe and fittings shall conform to the requirements of ANSI/AWWA C111/A21.11. Flanged joints for ductile iron pipe and fittings shall conform to the requirements of ANSI/AWWA C115/A21.15. Gaskets shall be neoprene or other synthetic rubber material. Natural rubber gaskets will not be accepted.
 4. Fittings: Fittings shall be in accordance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 and shall have a pressure rating of not less than that specified for the pipe. Fittings used with ductile iron pipe shall be ductile iron. Fittings for pipe with mechanical joints shall have mechanical joints. Fittings for pipe with push-on joints shall have either mechanical joints or push-on joints.
 5. Coatings: Pipe and fittings shall be furnished with exterior bituminous coating conforming to ANSI/AWWA C151/A21.51.
 6. Linings: Pipe and fitting interior linings shall be hydrogen sulfide resistant and conform to the following:
 - a. Calcium aluminate-mortar lining conforming to AWWA/ANSI C104/A21.4, a 40 mil ceramic quartz filled amine cured novalac epoxy lining, a 40 mil polyethylene lining in accordance with ASTM D 1248, or be PVC (polyvinyl chloride) lined.
 7. Polyethylene Encasement: Pipe and fittings shall be installed with a polyethylene tube encasement having a thickness of 0.008" (8 mils) and conforming to Section 4.1.1 of ANSI/AWWA C105/A21.5.
- C.** Polyvinyl chloride (PVC) Pressure Rated Plastic Pipe (SDR) and Fittings: Pipe and fittings shall conform to ASTM D 2241, except as otherwise specified herein.
1. General: Furnish maximum pipe lengths normally produced by the manufacturer, except for fittings, closures and specials. Pipe shall be used only for pressure flow systems.
 2. Materials: The pipe shall be made of PVC plastic pipe having a cell classification of 12A54 B or 12A54 C as defined in ASTM D 1784.
 3. Design: Pressure flow systems, i.e., force mains, shall have the wall thickness shown on the plans, with a minimum wall thickness not less than SDR 32.5 with a minimum burst pressure not less than 400 psi conforming to pipe materials designation codes PVC 1120, PVC 1220, or PVC 2120.

4. Joints: Pressure flow systems shall be joined in accordance with ASTM D 3139 with particular attention given to Section 5.3. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seals (gaskets) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets will not be accepted.
 5. Fittings: Fittings for pressure flow systems shall be ductile iron or PVC. Ductile iron fittings shall be mechanical joint conforming to Section 2503.D.3. PVC fittings shall have a minimum wall thickness conforming to SDR 32.5 and a minimum hydrostatic design stress of 400 psi conforming to pipe materials designation codes PVC 1120, PVC 1220, and PVC 2120.
- D.** Type PSM polyvinyl chloride (PVC) Sewer Pipe and Fittings: 4 through 15 inch diameter pipe and fittings shall conform to ASTM D 3034 and pipe having a diameter 18 inches through 27 inches shall conform to ASTM F 679 except as otherwise specified herein.
1. General: Furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures and specials.
 2. Materials: The pipe shall be made of PVC plastic having a cell classification of 12454 B or 12454 C or 13364 B as defined in ASTM D 1784.
 3. Design: Pipe shall have an integral bell and spigot joint. Wall thickness shall be SDR 35, SDR 26, or SDR 21 as shown on plans. If for any reason the depth of cover on SDR 35 pipe becomes greater than 15 feet, the Contractor shall immediately notify the Engineer.
 4. Joints: Joint tightness shall conform to ASTM D 3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seal (gasket) shall have a basic polymer of synthetic rubber conforming to ASTM F 477. Natural rubber gaskets will not be accepted.
 5. Fittings: Fittings defined as tee (T) or wye (Y) connections suitable for assembly to four (4) inch or six (6) inch building service lines shall be bell-end with a minimum wall thickness conforming to SDR 35 and shall be furnished by the pipe manufacturer. A special design is required for service connections 8 inches and larger. Saddle tees or wyes will not be permitted during sewer main installation.
- E.** Reinforced Concrete Pipe and Fittings: Pipe and fittings shall conform to ASTM C 76 except as otherwise specified herein.
1. General: Furnish maximum lengths normally produced by the manufacturer except for fittings, closures and specials.
 2. Design: Pipe shall be Class III, Class IV, or Class V, wall B as shown on Plans. Fine aggregate shall be natural sand conforming to the requirements of ASTM C 33. Reinforcement shall be circular. Modified or special designs are prohibited unless so specified in the Special Provisions.
 3. Joints: Pipe and fittings shall be furnished with either spigot groove type joint with O-ring gasket or steel end joint with spigot groove and O-ring gasket conforming to ASTM C 361 and ASTM C 443. The basic polymer for O-ring gaskets shall be synthetic rubber and shall conform to AWWA C 302.
 4. Fittings and Specials: Provide strength equal to design D-loads of adjacent pipe and be fabricated as one of the following types:

- a. Steel cylinder segments not less than U.S. No. 16 gauge lined with three-fourths (3/4) inch concrete or mortar and reinforced concrete exterior.
- b. Concrete pipe sections shall be cut while still green, reinforcing exposed and welded together at junctions and miters. Splice shall be built up to nominal wall thickness with mortar or concrete. Miters shall not exceed 30 degrees at deflection angles between segments. Minimum center line curve radius shall not be less than twice the pipe diameter.

F. Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Wastewater Pipe (8-inch diameter and larger)

1. General: This specification designates requirements for fiberglass glass-fiber reinforced thermosetting-resin pipe (RTRP) for the conveyance of wastewater. Pipe for gravity application shall conform to ASTM D 3262 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. Pipe for force main applications shall conform to ASTM D 3754 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe. If ASTM D 3754 pipe is selected, its actual outside diameter shall be in accordance with AWWA C 950 Fiberglass Pressure Pipe.
2. Materials: Material used in the manufacture of the pipe, fittings and specials shall conform to the following:
 - a. Resin Systems: The manufacturer shall use only polyester resin system with a proven history of performance in corrosive environments found in wastewater collection systems. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product. Certification of resin compounding shall be provided by the pipe manufacturer prior to shipment to the job site. One test to verify resin compounding may be required by the Engineer. The test shall be performed by an independent testing laboratory approved by the Engineer and shall be performed upon a sample of pipe obtained from the job site. The cost of the test shall be paid for by the Contractor and shall be included with the bid price for pipe. The test shall be performed in accordance with ASTM D 2584 Standard Test Method for Ignition Loss of Cured Reinforced Resins.
 - b. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.
 - c. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.
 - d. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product.
 - e. Elastomeric Gaskets: Gaskets shall meet ASTM F 477 and be supplied by qualified gasket manufacturers and be suitable for the service intended.
3. Stiffness: Pipe shall conform to the requirements of AWWA M45 for the size and strength. Minimum pipe stiffness at 5-percent deflection shall be 46-psi (3.2-kg/cm²) for gravity and pressure wastewater conduit as specified for all sizes when calculated in accordance with ASTM D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
4. Joints: Joint tightness shall be tested in accordance with ASTM D 4161 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals. Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint water-tightness.
5. Fittings: Fittings shall conform to ASTM D 5685 Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings or D 3840 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Non-pressure Applications.

G. High Density Polyethylene (HDPE)

1. General: Furnish maximum lengths normally produced by the manufacturer except for fittings, closures and specials.
2. Materials: All new pipe and fittings shall be solid wall high density polyethylene (HDPE) pipe, meeting the requirements of ASTM F 714 Polyethylene (PE) Plastic Pipe (SDR-PR) based on outside diameter, ASTM D 1248, ASTM D 3350. All HDPE pipe shall be marked with a green stripe to signify its use for sanitary sewer utilities.
 - a. The pipe shall be manufactured from high density high molecular weight polyethylene resin which conforms to ASTM D 1248. The pipe produced from this resin shall have a minimum cell classification of 345434C under ASTM D 3350.
 - b. The HDPE pipe shall have a wall thickness as shown on the Plans or Standard Drawings with a minimum wall thickness conforming to DR11 with a working pressure rating of 160 psi. HDPE pipe diameters shown on plans are iron pipe sizes which provide the nominal inside diameter necessary to exceed the flow capacity of cement lined ductile iron pipe.
 - c. The pipe and fitting manufacturer shall certify that samples of his production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D 2837 and PPI TR-3. Under these procedures, the minimum hydrostatic design basis shall be certified by the pipe manufacturer to be 1600 psi at 73.4°F and 800 psi at 140°F.
 - d. As approved by the Engineer, electrofusion fittings may be allowed in lieu of fittings designed for butt fusion.
 - e. The HDPE pipe shall be provided to the project site in straight sections and shall not have been coiled at any time.

H. Polypropylene Pipe

1. General: Furnish maximum lengths normally produced by the manufacturer except for fittings, closures and specials.
2. For 12-inch to 24-inch pipe, polypropylene pipe shall have a double wall with a smooth interior and annular exterior corrugations and conform to ASTM F2764. For 30-inch and larger pipe sizes, polypropylene pipe shall have a triple wall with smooth interior and exterior surfaces with inner corrugations and conform to ASTM F 2764. The pipe shall not be perforated unless otherwise specified.
3. For 12-inch to 60-inch pipe, pipe shall be joined with a dual-gasketed integral bell and spigot joint meeting the requirements of ASTM F2764.
4. The joint shall be watertight according to the requirements of ASTM D3212 and ASTM F2764 Section 7.10. Gaskets shall meet the requirements of ASTM F477. 12- through 60-inch diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.

I. Tees, Wyes, And Building Service Lines

1. General: All service lines are gravity. Tees, wyes, and building service lines shall be installed as shown on the Plans and Standard Drawings or specified herein. Saddles will only be allowed with the approval of the Engineer.

2. Materials: Material used in the manufacture of the pipe, fittings and specials shall conform to the following:
 - a. Acrylonitrile-Butadiene-Styrene (ABS) Service Line Pipe and Fittings
 - i. Pipe and fittings shall conform to ASTM F 628 Foamed Core DWV, ASTM D 2661 DWV.
 - ii. Joints: Joints shall be solvent-cemented. The cement shall conform to the requirements of ASTM D2235.
 - b. Polyvinyl Chloride (PVC) Service Line Pipe and Fittings
 - i. Pipe and fittings shall be made of PVC plastic pipe having a minimum cell classification of 12454 as defined in ASTM D 2241 or ASTM D 3034 for SDR26.
 - ii. Joints: Joints shall be of a push-on type with a bell-end grooved to receive a synthetic rubber gasket. Solvent welded joints are not allowed. The joint shall be made in accordance with ASTM D 3212.
 - c. High Density Polyethylene (HDPE) Service Line Pipe and Fittings
 - i. The pipe shall be manufactured from high density high molecular weight polyethylene resin which conforms to ASTM D 1248. The pipe produced from this resin shall have a minimum cell classification of 345434C under ASTM D 3350.
 - ii. As approved by the Engineer, electrofusion fittings may be allowed in lieu of fittings designed for butt fusion.
 - d. Ductile Iron Pipe (DIP) Service Line Pipe and Fittings: Refer to paragraph 2502.2.B of this Section for requirements for DIP service line pipe and fittings.

2502.3 Pipe Embedment Materials

- A. Granular Bedding Material: All materials used for granular embedment for pipe bedding shall conform to the requirements of ASTM C 33 and shall meet the gradation identified in Section 2102.4.G.:
- B. Concrete for embedment and encasement:
 1. Concrete shall test not less than a twenty-eight (28) day compressive strength of 3000 psi and shall otherwise conform to Section 2509.3.E.
 2. Reinforcing steel when required shall be placed as shown on the Plans and shall conform to Section 2509.3.F.

2502.4 Backfill Materials

- A. Granular Backfill Material: Granular backfill material shall meet the gradation requirements as outlined in Section 2102.4.
- B. Flowable backfill (CLSM): Flowable backfill (CLSM) shall meet the requirements as outlined in Section 2102.2.E.
- C. Select Earth Backfill Material: Select earth backfill shall be finely divided job excavated material free from debris, organic matter, rocks larger than one (1) inch and/or frozen materials.
- D. Other Earth Backfill: Other backfill may be job excavated material free from debris and organic matter. No rock greater than three-inches in diameter shall be placed in any trench excavation as backfill unless approved by the Engineer.

2502.5 Tunneling, Boring and Jacking Materials

- A.** General: Furnish materials and necessary accessories with strengths, thicknesses, coatings, and fittings indicated, specified and/or necessary to complete the work.
- B.** Steel Liner Plate: Steel tunnel liner plates shall be new and with minimal oxidation. The design and shape of the liner plates shall be such that assembly can take place entirely from within the tunnel liner. Liner plates shall be capable of withstanding the ring thrust load and transmitting this from plate to plate. The minimum outside diameter shall be four (4) feet and the minimum wall thickness shall be United States Standard Gauge 12 (0.1094 inches). Sufficient sections shall be provided with one and one-half (1½) inch or larger grouting holes located near the centers so that when plates are installed there will be one line of holes on either side of the tunnel and one at the crown; the lower line of holes on each side shall not be more than eighteen (18) inches above the invert. The holes in each line shall not be more than five (5) feet apart and unless otherwise approved, shall be staggered. Bolts and nuts shall conform to ASTM A 153, A 307, F 3125 and A 449 as applicable. Steel liner plates shall have bolted joints in both longitudinal and circumferential planes. Stagger longitudinal joints in adjacent rings when assembling.
- C.** Steel Casings: Steel casings for bored or jacked construction shall be steel pipe conforming to ASTM A 139 with a minimum diameter as shown on the Plans.

- 1. Minimum wall thickness shall be in accordance with the following table:

<u>Diameter of Casing-Inches</u>	<u>Nominal Wall Thickness-Inches</u>	
	<u>Under Railroads</u>	<u>All Other Uses</u>
16	0.312	0.188
18	0.312	0.250
20	0.375	0.250
22	0.375	0.250
24	0.406	0.281
26	0.438	0.281
28	0.469	0.312
30	0.469	0.312
32	0.500	0.312
34	0.500	0.312
36	0.500	0.344

- 2. Steel shall be Grade B with a minimum yield strength of 35,000 psi under railroads and Grade A on all other uses.
- 3. Steel pipe shall have welded joints in accordance with AWWA C 206.
- D.** Reinforced Concrete Pipe: Reinforced concrete pipe used as casing shall conform to ASTM C 76 except as otherwise specified under Section 2502.2.E and as specified herein.
 - 1. Design: Provide ASTM C 76 circular pipe of the strength class required for the jacking of pipe when determined by method set forth in the latest printing of Concrete Pipe Design Manual prepared by the American Concrete Pipe Association.
 - 2. Joints: Reinforced concrete pipe used for casing pipe shall be provided with steel end joint with a

groove in the spigot end for an O-ring gasket. The O-ring gasket shall be synthetic rubber. Both joint and gasket shall otherwise conform to ASTM C 361.

3. Interior Protection: Interior protection is NOT required for reinforced concrete pipe used for casing conduit.
- E.** Casing Conduit Grout: Casing conduit grout shall be a pumpable grout resulting in minimum set strength of 400 psi in 28 days.
- F.** Sand: Sand used as fill in casing conduits shall be a clean sand and thoroughly dry. All sand fill shall conform to the requirements under Section 2509.3.E.5.
- G.** Pipe Supports shall conform to the following:
1. Casing Spacers: Casing spacer shall be a two-piece shell or band made from T-304 stainless steel of a minimum 14 gauge thickness. The shell/band shall have risers made of 10 gauge T-304 stainless steel and have a PVC liner. The bearing surface (skid or runner) shall be made of an ultra-high molecular weight polymer, glass reinforced polyester, or fiberglass reinforced nylon. The shell/band shall be bolted together with T-304 stainless steel bolts. The configuration of the carrier pipe in the casing pipe shall be centered. End seals shall be made by the same manufacturer as the casing spacers and shall use stainless steel bands to hold end seals to pipes.
 2. Wood Skids: Wood skids shall be provided as indicated on the Plans. The wood shall be treated with a preservative as approved by the Engineer. Cut surfaces shall be given two (2) heavy brush coats of the same preservative. If PVC pipe is used as the carrier pipe, the wood skids shall be compatible with the PVC pipe.

SECTION 2503 SITE PREPARATION

2503.1 Scope

This section governs the furnishing of all labor, materials and equipment for Site Preparation as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2503.2 General

- A.** See Section 2101 for Site Preparation.

SECTION 2504 EXCAVATION

2504.1 Scope

This section governs the furnishing of all labor, materials and equipment for pipeline excavation for open cut, tunneling, boring, and jacking as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2504.2 General

The terms "excavation" and "trenching" shall mean the removal and subsequent handling of all material required to perform the work.

- A. All pipeline excavation work shall be accomplished under supervision of a person experienced with the materials and procedures which will provide protection to existing improvements, including utilities and the proposed pipeline.
- B. The alignment, depth, and pipe subgrades of all sewer trenches shall be determined by a laser beam parallel to the sewer invert.
- C. When pipe is to be installed in embankment or fill, the embankment shall be constructed in accordance with APWA section 2102.6 and shall be built up to a plane at least 18 inches above the top of the pipe prior to the excavation of the sewer trench.
- D. The Contractor shall not open more trench in advance of pipe laying than is necessary. Four hundred (400) feet will be the maximum length of open trench allowed on any line under construction. All open trenches shall be adequately protected.
- E. In the event hazardous wastes as defined by the Resource Conservation and Recovery Act of 1976 (PL94-580) are encountered, work shall be halted and the Engineer shall be notified. Work shall be resumed only after the Engineer notifies the Contractor. Regulation of removal, handling and disposal of hazardous wastes is the responsibility of Federal and State agencies.

2504.3 Classification of Excavated Material

No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work regardless of the type, character, composition, or condition thereof. See Section 2100 "Clearing and Site Preparation".

2504.4 Removal of Water

The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below static groundwater elevations shall be dewatered by lowering and maintaining the groundwater surface beneath such excavations a distance of not less than 12-inches below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

2504.5 Blasting

Blasting: When blasting is permitted by the Engineer, the Contractor shall use the utmost care to protect life and property. The Contractor shall obtain any required permits from the agency having site jurisdiction and shall comply with all laws, ordinances, and the applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and he shall be responsible for all damage caused by his or his subcontractor's operations.

The Contractor shall provide insurance as required by the Contract Documents before performing any blasting. The governing agency shall be notified at least 24 hours before blasting operations begin.

2504.6 No Blasting Areas

No Blasting Areas: No blasting of any kind for rock excavations or any other purpose will be allowed unless noted otherwise on the Plans or permitted by the Engineer.

2504.7 Open-Cut Method (Trenching)

- A.** General: Excavations for pipelines shall be accomplished by the open-cut method (trenching) except as specified or approved by the Engineer. Trenching shall be with a minimum inconvenience and disturbance to the general public.

The Contractor shall sort and stockpile the excavated material so the proper material is available for backfill.

- B.** Trench Depths: All trenches shall be excavated to depths required for proper pipe embedment. Overdepth excavation shall be required when the subgrade is unstable. Overdepth excavations shall be backfilled with granular pipe embedment material unless otherwise directed by the Engineer.
- C.** Trench Walls: Undercutting of trench walls is not permitted.
- D.** Trench Widths
1. Minimum Widths: Minimum trench widths shall be in accordance with the Plans, Standard Drawings, and manufacturers' recommendations.
 2. Maximum Widths: The allowable maximum trench widths hereinafter specified apply only to that portion of the trench below the horizontal plane parallel to and six (6) inches above the top of the pipe. The allowable maximum widths may be exceeded at manholes, bore pits, tees, and in unstable earth material. Where the maximum trench width is exceeded the Contractor shall provide the appropriate strength class of pipe embedment to provide safe support strength to the pipeline.
 3. When the side clearance exceeds two and one-half (2.5) times the outside pipe diameter at either side of a flexible conduit, it shall be the Contractor's responsibility at no additional cost to the Owner to provide bedding adequate to develop the required lateral support for the pipe and/or provide a pipe of sufficient strength class to accommodate the loading conditions as approved by the Engineer.
 4. Trench Slope: The trench width above a horizontal plane six (6) inches above the top of the pipe may vary and side sloping is permissible unless otherwise specified.
 5. Trench Shields: When trench shields are utilized by the Contractor, said shields or any part thereof shall not extend lower than twelve (12) inches above the top of the proposed pipeline nor shall the maximum allowable trench width be exceeded.
 6. Sheet piling and Shoring: Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, or shored as necessary to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheet piling, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure and shall be rigid, maintaining shape and

position under all circumstances.

Trench sheeting shall not be pulled unless pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting.

Sheeting shall not be pulled after backfilling.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

- E. Maximum Trench Widths for Reinforced Concrete and Ductile Iron Pipe: When reinforced concrete and ductile iron pipe is utilized, the strength class and the maximum allowable trench width will be shown on the Plans.
- F. Option to Trenching: Contractor may perform excavation by tunneling methods as set forth herein at no additional cost to the Owner provided prior written approval for each such location is obtained from the Engineer.

2504.8 Tunneling, Boring and Jacking

- A. General: Tunneling includes all underground horizontal excavations necessary to install the pipeline. The Contractor shall submit to the Engineer, prior to actual work, a written description of his proposed tunneling operation. It shall include the types and locations of shafts, methods to provide safe support strength for the pipeline when the shafts or bore pits exceed maximum allowable trench widths and other features that would affect the pipeline.

Tunneling shall be done with a minimum inconvenience and disturbance to the general public and abutting property owners.

- B. Tunnel Cross Section: The tunnel shall be circular in cross section and of the size specified. Alternate size and shape may be submitted for consideration by the Engineer.
- C. Construction
 1. General: All tunnel excavation shall provide an excavation conforming to the outside diameter of the casing and/or carrier conduit. The excavation shall be to an alignment and grade which will allow the carrier conduit to be installed to proper line and grade as shown on the Plans and as established in Section 2505.4.
 2. Excavation: Conduct excavation in a manner to prevent disturbing overlying and adjacent material. Perform dewatering and chemical soil stabilization or grouting if necessary, due to existing field conditions.

SECTION 2505 INSTALLATION

2505.1 Scope

This section governs the furnishing of all labor, materials and equipment for the installation of gravity and pressure pipelines and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications

and the Special Provisions.

2505.2 General

All pipeline installations shall conform to the following requirements:

- A. Governmental Requirements: Sanitary sewer line installation shall comply with applicable State and County Health and Environment Department requirements.
- B. Trench Dewatering: Contractor shall maintain a dry and stable trench, obtain necessary permits, and provide for the proper method of discharging such water from the work site at all times until pipeline installation is completed to the extent that hydrostatic pressure flotation or other adverse effects will not result in damage to the pipeline.

Proper dewatering techniques are the Contractor's responsibility. All work performed by the Contractor which is adversely affected by his failure to adequately dewater trenches will be subject to rejection by the Engineer. The Contractor shall repair and/or replace the affected pipeline without additional compensation.

- C. Drainage Course Crossing Encasement: Any pipeline crossing a well-defined drainage course having less than three (3) feet of cover over the pipe shall be encased in concrete. The length of encasement shall be as shown on the Plans or if not shown as specified by the Engineer.
- D. Trench Shoring and Bracing: All shoring, bracing or blocking shall be furnished and installed as necessary to preserve and maintain exposed excavation faces, to protect existing improvements, to protect the proposed pipeline and to provide for safety.

Shoring or other methods for support of trench walls is the responsibility of the Contractor and shall be accomplished by methods that will not adversely affect pipeline alignment, grade and/or structural integrity.

All bracing, sheeting and/or shoring installed below a horizontal plane six (6) inches above top of proposed pipe shall not be disturbed or removed after pipe and/or pipe embedment has been installed unless otherwise specified. The bottom skids of a trench shield shall not extend lower than twelve (12) inches above top of proposed pipe.

- E. Pipe Embedments: All pipe embedment shall conform to Class B First Class Modified unless otherwise specified. Installation shall be in strict conformance with instructions for the appropriate Class being utilized.
- F. All Class A concrete embedments for rigid conduits shall begin and end at a pipe joint.
- G. Bedding Installation
 1. The trench subgrade shall be prepared to provide a uniform and continuous pipe support between pipe bells and joints.
 2. Place and densify embedment material by shovel slicing or vibrating and prepare embedment material so that the pipe will be true to line and grade after installation.
 3. After each pipe has been brought to grade, aligned, and placed in final position, deposit and densify by shovel slicing sufficient bedding material under the pipe haunches and on each side of the pipe to hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations. Place

bedding material uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

4. Place pipe that is to be bedded in Class A (concrete) embedment in proper position on temporary supports consisting of wood blocks or bricks with wood wedges. When necessary, anchor or weight the pipe to prevent flotation when the concrete is placed.
5. Place concrete for Class A (concrete) embedment or encasement uniformly on each side of the pipe and deposit at approximately its final position. Do not move concrete more than five (5) feet from its point of placement.
6. If unstable subgrade conditions are encountered and it is determined by the Engineer that the bedding specified will not provide suitable support for the pipe, additional excavation to the limits determined by the Engineer will be required. This additional excavation shall be backfilled with material approved by the Engineer.
7. Pipe Embedment Designations and Descriptions

- a. Class A. Embedment - Concrete Cradle. Arch or Encasement
 - i. All Class A embedments require a MCIB A 480-1-4-0.542 concrete mix as designated by the Mid-West Concrete Industry Board, Inc., Kansas City, Missouri, except as otherwise specified. After initial set of concrete, one (1) foot of backfill material should be placed over the conduit or concrete. The backfill above this point shall not be placed nor sheeting removed until at least forty-eight (48) hours after placement of the concrete. Time requirements may be adjusted by the Engineer to obtain structural integrity.
 - ii. Class A embedments for all pipe shall be installed with reinforcing steel of not be less than $p = 0.4\%$, where p is the ratio of the area of steel to the area of concrete, or as otherwise specified. Reinforcing steel shall be uniformly spaced and have a minimum lap of sixteen (16) bar diameters.
- b. Class B Embedment - The pipe shall be bedded in granular material, with a minimum thickness below the pipe as specified in Section 2104.
 - i. First Class: The granular material shall be placed to the horizontal center line of the pipe. The backfill from the horizontal center line to a level not less than twelve (12) inches above the top of pipe shall be carefully placed select earth backfill compacted to eighty-five percent (85%) of maximum density at an optimum moisture $\pm 2\%$ as defined in AASHTO T 99 or ASTM D 698. The select material shall be free from debris, organic matter, frozen material and rocks larger than one (1) inch. Class IV and Class V embedment materials, as defined in ASTM D 2321, shall not be used for bedding, haunching, or initial backfill of flexible pipe.
 - ii. First Class Modified: The backfill shall be the same as for First Class except all of the material used to a level not less than six (6) inches above the top of the pipe bell coupling shall be bedding aggregate.
 - iii. Class C Embedment The pipe shall be bedded in granular material with a minimum thickness beneath the pipe as specified in Section 2104.

It shall be sliced under the haunches of the pipe to a height one-sixth (1/6) of the outside diameter of the pipe. Backfill above the bedding to a point twelve (12) inches above the top of pipe, shall be carefully placed select earth backfill compacted to eighty-five percent (85%) of maximum density as defined in AASHTO T 99 or ASTM D 698.

- H. Tees, Wyes and Building Service Lines:** Tees, wyes, and building service lines shall be installed as shown on the Plans or specified herein.
1. Tees, wyes and saddles shall be installed at forty-five (45) degrees with pipe springline for pipe sizes 8 through 16 inch diameter. Tees, wyes and saddles shall not be installed in pipe sizes greater than or equal to eighteen (18) inch diameter.
 2. Building service lines shall be installed with a straight alignment and at a uniform grade not less than two (2) percent unless otherwise specified and shall be embedded with Class B embedment. When a building service line grade exceeds twenty (20) percent, pipeline anchors shall be installed as required under Section 2505.J, with the first anchor not more than twelve (12) nor less than seven (7) feet upstream of the tee or wye.
 3. The Contractor shall maintain an accurate record for submittal to the Engineer of location, size and direction of each tee, wye, saddle and/or location, size and length of each building service line. Locations shall use the pipeline stationing as shown on the Plans or the distance from the first downstream manhole. In the event such records are not kept or are lost before final acceptance of the work, the required information shall be redetermined by the Contractor at no additional cost to the Owner.
 4. Saddles will not be allowed unless approved by the Engineer.
 5. Service lines shall be terminated and capped one foot on the public side of Right of Way or easement lines.
 6. Tracer wire shall be installed along the top of service laterals. The wire shall have HDPE insulation, be no smaller than 12 gauge, and intended for underground applications. The tracer wire shall be green in color. Tracer wires shall terminate at the ground surface inside a tracer box. Tracer box lids shall be green in color. Tracer wire shall be grounded to a minimum one pound magnesium anode at the sewer line.

- I. Gravity Sewers:** All gravity sewers shall be installed to the alignment, elevation, slope, and with pipe embedment as specified and/or shown on the Plans. Maintain the following tolerances from true alignment and grade between adjacent manholes:

Alignment	6 inches
Grade	+1 inch

Joint deflection shall not exceed the maximum allowable deflection per joint according to AWWA C 600. Only one correction for alignment and/or grade shall be made between adjacent manholes.

- J. Pressure Sewers (Force Main):** All pressure sewers shall be installed with required pipe embedment to depths shown on the Plans (not less than 42 inches) and to a continuous slope when not shown. Approved air relief valves shall be installed at all locations shown on the Plans or where required by the Engineer.
- K.** The Contractor shall block and anchor the pipeline to accommodate thrust and testing forces at pipe deflections, bends, tees, and plugs in accordance with the Contract Documents. All damage caused by the Contractor's failure to provide adequate thrust supports shall be corrected by the Contractor at no additional cost to the Owner.

L. Anchors: Pipelines shall be anchored in accordance with the table below:

PIPELINE ANCHORS	
<u>Percent of Grade</u>	<u>Center to Center Max. Spacing (Feet)</u>
20 – 35	36
35 – 50	24
50	16

The anchor shall be of concrete or other material approved by the Engineer. Concrete anchors shall have a minimum thickness of twelve (12) inches. The anchor shall extend not less than one (1) foot into undisturbed earth on the sides and bottom and one (1) foot above top of pipe. In incompressible material, the above dimensions may be six (6) inches each side and bottom. The anchor shall support a joint fitting.

M. Pipe Laying: All pipe shall be installed in accordance with the pipe manufacturer's recommendations, except as modified herein.

1. Pipe laying shall not proceed if the trench width as measured at the top of pipe exceeds the maximum allowable trench width. If this occurs, the Contractor shall submit to the Engineer for approval a better bedding for the pipe or a pipe that provides safe supporting strength.
2. All pipe and fittings shall be stored and handled with care to prevent damage thereto. Do not use hooks to transport or handle pipe or fittings. Do not drop pipe or fittings.
3. Rejected pipe and fittings shall be marked and removed from the Project Site at no cost to the Owner. All pipe and fittings shall be examined for soundness and specification compliance prior to placement in the trench, and rejected pipe or fittings shall not be incorporated into the pipeline. Check the class or pipe strength to be sure proper pipe is installed.
4. Clean joint contact surfaces prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer.
5. Pipe installation shall begin at the lowest point and precede uninterrupted upgrade without gaps unless otherwise approved, in writing, by the Engineer.
6. Unless otherwise required, lay all pipe straight between manholes. Excavate bell holes for each pipe joint. When jointed, the pipe shall form a true and smooth pipeline.
7. Pipe connecting to a structure shall be supported with Class A embedment, cradle or encasement to the first joint outside the structure excavation. If flexible wall connections are used, Class B embedment may be used in lieu of concrete embedment provided the height of backfill does not result in loads exceeding the pipe's safe supporting strength.
8. All pipelines shall be plugged at the end of each day's progress. Plugs or other positive methods of sealing shall be utilized at all times to protect any existing system from entrance of storm water or other foreign matter.
9. When a sanitary sewer line crosses an existing pipeline and the clearance is less than two (2) feet, special embedment may be required.

N. Connection of Pipes of Dissimilar Materials: The connection of pipes of different materials shall be made using

an approved transition coupling and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure and prevent the offset of the joint within the coupling.

2505.3 Detailed Installation Requirements

All pipes shall be installed in accordance with the following standards:

- A.** ASTM D 2321 ADS Solid Wall, ADS Composite Wall
ASTM D 2321 PVC Solid Wall, PVC Composite Wall
- B.** ANSI/AWWA C 600 Ductile Iron Pipe
- C.** Reinforced Concrete Pipe: Installed in accordance with American Concrete Pipe Association's "Installation Manual"
- D.** Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Wastewater Pipe
 - 1. Gravity Sewer: Installed in accordance with ASTM D 3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
 - 2. Force Main: Installed in accordance with AWWA Manual M45, Fiberglass Pipe Design
- E.** High Density Polyethylene (HDPE) Joints: Assembled in accordance with ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings

2505.4 Casing and Carrier Conduits

Casing and carrier conduits shall be installed at required locations by methods acceptable to the Engineer. Installation of the carrier conduit shall be completed prior to installation of the adjacent portions of the pipeline to allow for adjustments.

- A.** Casings Types
 - 1. Steel Casing Pipe: Steel casing pipe is a flexible conduit and shall be designed to conform with one of the following design concepts (other methods may be submitted to the Engineer for approval).
 - a. Method A: The steel casing conduit is considered a temporary construction means for the installation of the carrier conduit; therefore cathodic and corrosion protection is not required provided that the carrier and its joints are structurally designed to withstand all possible loadings (live, earth and superimposed) which would otherwise be supported by the casing conduit, and to withstand all pressures necessary to install the required grout. All exterior voids around the casing conduits shall be filled with casing conduit grout (see Section 2502.5.E). Interior void between the carrier and casing conduits shall be filled with sand conforming to Section 2509.3.E.5. Sand shall be applied under pressure to fill all of the voids without adversely affecting the carrier conduit, joints, alignment and grade.
 - b. Method B: The steel casing conduit is considered a permanent installation to protect the carrier conduit and to support all loads; therefore cathodic and corrosion protection and watertight removable end seals are required for the casing conduit. Care shall be exercised to prevent the carrier conduit from floating and receiving any load transfer from the casing conduit unless it is designed for such loading. The void between casing and carrier conduits shall be treated as shown on the Plans or Standard Drawings. Cathodic and corrosion

protection for method B shall be provided by two magnesium anodes, one at each end of the casing pipe, with a lead wire connected to the encasement pipe by thermite welding.

2. Reinforced Concrete Casing Pipe: Reinforced concrete casing pipe is a rigid conduit and shall be installed in accordance with recommended procedures in the latest printing of the Concrete Pipe Design Manual prepared by American Concrete Pipe Association.
- B.** Casing Installation: Installation of casing shall be supervised by a foreman experienced in such work. Casing shall be installed by a combination of augering and jacking. Alignment and gradient shall be such that the carrier conduit can be installed to line and grade shown on the Plans.
- Welding shall be performed by a person experienced with the type of welding necessary. All welds shall conform to AWWA C 206.
- C.** Liner Plate Installation: Liner plates shall be assembled immediately following the excavation. Advance liner plates or casing continuously with excavation. All voids between liner and surrounding earth shall be filled with casing conduit grout forced in under pressure. As the pumping through any hole is completed, it shall be plugged to prevent the back-flow of grout. After lining installation is complete, it shall be cleaned of all debris and all leaks sealed.
- D.** Carrier Conduit Installation: After completion of the installation of the casing, the carrier conduit shall be carefully pushed or pulled through the casing in a manner that will maintain proper jointing of the pipe joints and provide required gradient and alignment. Pipe skids shall be provided as indicated on the Plans. The skids shall be securely strapped to the pipe with steel strapping material at least three-quarters (3/4) inch wide.
- E.** Sand Fill: The annular space between lining and sewer pipe shall be filled with sand from end seal to end seal unless otherwise specified. The fill shall be placed inside the casing in a manner that will not disturb the alignment and/or grade of the sewer pipe. Sand used in casing conduits shall be as specified in Section 2509.3.E.5. Sand shall be blown into the casing so that all space is filled.
- F.** End Seals: Construct end seals after sewer pipe has been installed and approved. End seals shall be manufactured end seals, concrete plugs with allowances for water flow, or brick shall be in accordance with ASTM C 32, Grade SS or SM and mortar in accordance with ASTM C 270.
- G.** Initial Testing: Air pressure and/or exfiltration test as required shall be successfully performed on the carrier conduit prior to filling the void between casing and carrier conduits with sand or the sealing of the ends of the casing conduit.
- H.** Carrier Conduit Installed Without Casing: Carrier conduits installed without casing shall be assembled at the entrance to the auger hole and carefully pushed or jacked through the opening using a method designed to prevent disturbing the assembled joints. Auger holes shall be sized to accommodate the carrier conduit with a minimum of annular space around the conduit. When finally in place, carrier conduit shall be true to the line and grade required on the Plans.

SECTION 2506 BACKFILL

2506.1 Scope

This section governs the furnishing of all labor, materials and equipment to properly backfill trenches and structures as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2506.2 General

Trench backfill shall be in accordance with Section 2102.4.I except as modified herein.

2506.3 Backfilling in Street or Alley Right of Way and Under Pavement

Backfill under areas to be paved shall be in accordance with Section 2102.4.J.

2506.4 Backfill Around Structures

- A.** No backfill shall be placed over or around any structure until the concrete or mortar has attained a minimum strength of 2000 psi and can sufficiently support the loads imposed by the backfill without damage.
- B.** The Contractor shall use utmost care to avoid any wedging action between the side of the excavation and the structure that would cause any movement of the structure. Any damage caused by premature or unbalanced backfill or by the use of equipment on or near a structure will be the responsibility of the Contractor.
- C.** No rock larger than three (3) inches maximum dimension shall be placed within one (1) foot of the exterior surface of any structure.
- D.** Backfill around structures in street or alley Right of Way from the bottom of the structure to the bottom of the subgrade shall meet the requirements of Section 2102.4.J.

SECTION 2507 RESTORATION

2507.1 Scope

This section governs the furnishing of all labor, materials and equipment for the surface restoration of private and public properties that are disturbed by construction as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2507.2 General

The Contractor shall restore the project site to conditions equal to or better than those existing prior to entry unless otherwise specified.

- A.** Maintain adequate safety signs, barricades and lights until final restoration of work area is completed.
- B.** Public property shall be restored to the requirements of the public body having jurisdiction.

2507.3 Clean-Up

The Contractor, upon completion of installation and backfill operations, shall prepare the area for final grading including but not limited to the following items:

- A.** Clean-up shall follow the backfilling operations as closely as possible.
- B.** Excess material shall be removed from the site including material that has washed into the stream beds, storm water facilities, streets, etc.

- C. Tools, equipment and construction material shall be removed except for in designated storage areas along the pipeline route.
- D. Restore surface and sub-surface drainage and provide temporary erosion control measures in accordance with Section 2150.

2507.4 Finished Grading

The Contractor shall finish grade the area to lines and grades shown on the Plans or if not shown to those that existed prior to the area being disturbed. Special attention shall be directed to assure surface drainage. The area shall be smoothed by raking or dragging.

2507.5 Seeding

Seeding shall be in accordance with Section 2400.

2507.6 Sodding

Sodding shall be in accordance with Section 2400.

2507.7 Pavement Replacement

A. General

1. Replacement of pavement shall proceed in accordance with the traffic control plans and/or approved construction schedule.
2. Prior to pavement replacement, all edges that were previously cut but have been subsequently damaged shall be recut and all adjacent undermined and heaved pavement shall be removed.
3. Removed pavement shall be replaced in conformance with the requirements of applicable portions of Section 2200 "Paving" or Section 2300 "Incidental Construction".
4. Non-Standard Pavement: Pavement sections not conforming to Section 2200 of these specifications shall be replaced in accordance with requirements of the jurisdictional agency.

2507.8 Fences

See Section 2307.

2507.9 Walls

Retaining and architectural walls, if disturbed or damaged, shall be restored architecturally and structurally to conditions not less than that which existed prior to construction.

2507.10 Trees, Shrubs, and Bushes

Any tree, shrub, or bush as shown on the Plans as "replaced" shall be of the same species as the removed tree, shrub,

or bush. Any tree, shrub, or bush species that is prohibited by local restrictions shall be substituted with a related species. Replacement planting shall conform to the guidelines ANSI-Z60.1-2004 "American Standard for Nursery Stock" specified by the American Nursery and Landscape Association.

SECTION 2508 TESTING

2508.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of any and all acceptance tests as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2508.2 General

The Contractor shall furnish all labor, equipment, materials and reports for the required acceptance tests. All pipelines, including building service lines, shall undergo and pass all required tests to determine soundness and workmanship. Pipelines that do not conform to the project requirements shall be repaired and/or replaced and shall be retested until the pipeline meets the project requirements. Test results shall be recorded by the Contractor and a copy shall be submitted to the Engineer. No testing of the piping system shall be performed before backfill and compaction operations have been completed.

2508.3 Alignment and Grade

Alignment, grade and visible defects shall be checked as follows:

A. Visual Internal Inspection

1. Contractor shall clean pipe of excess mortar, joint sealant and other dirt and debris prior to inspection.
2. Sewer will be inspected by flashing a light between manholes and/or by physical passage to determine the presence of any misaligned, displaced, or broken pipe and other defects.

B. Television Inspection: Sewer line installations shall be inspected by closed circuit television at the Contractor's expense.

2508.4 Infiltration - Exfiltration

Hydrostatic or air pressure tests shall be conducted on sewers before acceptance by the Owner. For sewers with a diameter less than twenty-four (24) inches, the infiltration-exfiltration shall not exceed fifty (50) gallons per day per inch of nominal diameter per mile of sewer line for any section of the system. For sewers with a diameter twenty-four (24) inches or greater, infiltration-exfiltration shall not exceed three thousand six hundred (3600) gallons per day per mile of pipe.

- #### **A. Infiltration: Where sewers are laid within the ground water table, infiltration testing shall be conducted. Where evidence of infiltration is discovered by the Engineer, the Contractor shall install weirs or other suitable flow rate measuring devices adequate to determine to the satisfaction of the Engineer that the specified infiltration limit is not exceeded for that section of gravity sewer. Where the specified infiltration limit is exceeded, the Contractor shall repair or replace the defective section of pipeline at no additional cost to the Owner. Following repair of the pipeline, the Contractor shall remeasure infiltration flow rates and make additional repairs until an acceptable infiltration flow rate is achieved.**

B. Exfiltration: Exfiltration tests shall be performed by the Contractor using one or a combination of methods as set forth below. Each section of gravity pipeline between manholes and/or structures shall be tested after backfill has been completed.

1. Hydrostatic Tests for Gravity Systems

- a. Test section shall be filled not less than twelve (12) hours prior to testing. Refill test section prior to performing test.
- b. Perform at depths of water as measured above center line of pipe of not less than 2 feet nor more than 10 feet (consideration shall be given for water table above said center line). Maintain test as necessary to locate all leaks but not less than two hours.

2. Hydrostatic Tests for Pressure Systems

- a. Conformance Procedure: Perform hydrostatic pressure and leakage tests. Conform to AWWA C 600 procedures as modified herein. Tests shall apply to all pressure sewers.
- b. Sectionalizing: Test in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Contractor shall furnish and install test plugs at no additional cost to the Owner, including all anchors, braces, and other devices to withstand hydrostatic pressure on plugs. Contractor shall be responsible for any damage to public or private property caused by failure of plugs. Limit fill rate of line to available venting capacity.

- c. Pressure Test: Conduct at 1.5 times maximum operating pressure determined by the following formula:

$$P_{pt} = (1.5) (.433) (OP-GE), \text{ in which}$$

P_{pt} = test pressure in psi at gauge elevation

OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line

GE = elevation in feet at center line of gauge.

Perform pressure tests satisfactorily prior to determining leakage.

- d. Leakage Test: Conduct at the maximum operating pressure as determined by the following formula:

$$P_{lt} = 0.433 (OP-GE), \text{ in which}$$

P_{lt} = test pressure in psi at gauge elevation

OP and GE – as defined from pressure test formula (see above)

All joints shall be watertight and free from leaks

3. Air Testing of Gravity Systems

- a. Contractor may perform air tests for all pipe (except concrete and fiberglass) for all sizes.
- b. Furnish all facilities required including necessary piping connection, test pumping equipment, pressure gauges, bulkheads, regulator to avoid overpressurization, and all miscellaneous

items required.

- c. The pipe plug for introducing air to the sewer line shall be equipped with two taps. One tap will be used to introduce air into the line being tested through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. Additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer line.
- d. The pressure test gauge shall meet the following minimum specifications:

Size (diameter)	4.5 inches
Pressure Range	0 -15 psi
Figure Intervals	1 psi increments
Minor Subdivisions	0.05 psi
Pressure Tube	Bourdon Tube or diaphragm
Accuracy	± 0.25% of maximum scale reading
Dial	White coated aluminum with black lettering, 270° arc and mirror edge
Pipe Connection	Low male 1/2 inch N.P.T.

Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification and calibration data will be available to the Engineer whenever air tests are performed.

Gravity sewer pipe shall be air-tested in accordance with the requirements of ASTM F 1417.

- e. Plug ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor air pressure so that internal pressure does not exceed 5.0 psig. After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 2.5 psig. If the time in seconds for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

Pipe Diameter (in)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec) L = Total Length
4	3:46	597	0.380 * L
6	5:40	398	0.854 * L
8	7:34	298	1.520 * L
10	9:26	239	2.374 * L
12	11:20	199	3.418 * L
15	14:10	159	5.342 * L
18	17:00	133	7.692 * L
21	19:50	114	10.470 * L
24	22:40	99	13.674 * L
27	25:30	88	17.306 * L
30	28:20	80	21.366 * L
33	31:10	72	25.852 * L
36	34:00	66	30.768 * L
42	39:48	57	41.883 * L
48	45:34	50	54.705 * L

If air test fails to meet above requirements, repeat test as necessary after all leaks and defects have been repaired and backfilled. Prior to acceptance, all constructed sewer lines shall satisfactorily pass the low pressure air test.

- f. If the maintenance of existing flow in a pipe is necessary and air pressure testing is not possible, the Contractor shall perform closed circuit television inspection of the pipe at the Contractor's expense.
4. In areas where ground water is known to exist, install a one-half inch diameter capped pipe nipple approximately 10" long through manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer is installed. Immediately prior to the performance of the line acceptance test, ground water level shall be determined by removing pipe cap, blowing air through pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to pipe nipple. The hose shall be held vertically and a measurement of height in feet of water shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings.

2508.5 Deflection Test

A. General: Flexible pipelines shall be tested for deflection by pulling a mandrel through the entire length thereof.

- 1. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with nine (9) evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. The rigid mandrel shall have an outside diameter (O.D.) equal to 95 percent of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe, dimensions per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing. The dimensions of the mandrel for PVC pipe shall be as listed in the accompanying table. The "D" mandrel dimension shall carry a tolerance of ± 0.01 inch. Allowances for pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the "D" dimension but

shall be counted in as a part of the five (5) percent or lesser deflection allowance. Contact length (L) shall be measured between points of contact on the mandrel arm. The length shall not be less than as shown in the accompanying table.

2. The Engineer shall be responsible for approving the mandrel. Proving rings shall be used to verify this.
3. The mandrel shall be hand-pulled by the Contractor through all flexible sewer lines. Any sections of sewer not passing the mandrel test shall be uncovered and the Contractor, at no additional cost to the Owner, shall reround or replace the sewer to the satisfaction of the Engineer. These repaired sections shall be retested.
4. The testing shall be conducted after final trench backfill has been in place for a minimum of 30 days, unless approved otherwise by the Engineer.

**D and L Dimensions For
9 Arm Mandrel**

<u>Nominal Diameter (L)</u>		D		
		ASTM D3034 <u>SDR 35</u>	ASTM D3034 <u>SDR 26</u>	ASTM D2241 <u>SDR 21</u>
8"	8"	7.52"	7.37"	7.41"
10"	10"	9.40"	9.21"	9.24"
12"	12"	11.19"	10.96"	10.96"
15"	15"	13.70"	13.42"	N/A
18"	18"	16.76"	N/A	N/A
21"	21"	19.74"	N/A	N/A
24"	24"	22.21"	N/A	N/A
27"	27"	25.03"	N/A	N/A

5. Mandrel outside diameters for flexible pipe types not listed in the table shall be calculated as described in paragraph 2508.5.A.1 above.
6. Mandrel outside diameters for HDPE and Fiberglass Wastewater Pipe shall be calculated as described in paragraph 2508.5.A.1 above. For Fiberglass Wastewater Pipe, the outside diameter of the mandrel shall be 97% of the inside diameter of the pipe.

2508.6 Soil Density Tests

- A. General: Compaction tests shall be performed as specified in Section 2102.4.I and 2102.4.J.

SECTION 2509 MANHOLES AND SPECIAL STRUCTURES

2509.1 Scope

This section governs the furnishing of all labor, materials and equipment and the performance of all work incidental to the construction of manholes, drop manholes and special sewer structures complete with covers, steps, fittings and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2509.2 General

As used herein special structures refers to manholes on large sewers, special junction structures, metering stations and similar structures constructed on the pipeline.

Manholes and special structures may be constructed of pre-cast concrete sections or cast-in-place concrete, unless otherwise noted on the Plans, Standard Drawings, or Contract Documents.

2509.3 Manhole Materials

- A. Mortar and plaster coating: Mortar and plaster coatings for masonry manhole units shall conform to ASTM C 270. The mix shall consist of two (2) parts portland cement to one (1) part masonry cement to six (6) parts standard plaster sand. No mortar or plaster mixed more than thirty (30) minutes shall be incorporated in the work.
- B. Non-Shrink Grout: Non-shrink grout shall be in the plastic state and show no expansion after set as tested in accordance with ASTM C 827 and shall develop compressive strength not less than three thousand (3,000) pounds per square inch with a trowelable mix within twenty-four (24) hours per ASTM C 109. The placement time shall be not less than forty-five (45) minutes based on initial set per ASTM C 191.
- C. Waterproofing: Waterproofing shall be a coal-tar coating and conform to ASTM D 450. Exterior surfaces shall be coated with Tnemec "46-450 Heavy Tnemecol" or approved equal. Where specified, interior surfaces (which are exposed to raw sewage and sulfide gases) shall be coated with Tnemec "46-449 Heavy Duty Black" or approved equal. The minimum dry thickness for all waterproofing shall be 14.0 mils.
- D. Precast Concrete: Precast concrete manholes shall conform to ASTM C 478 with the following modifications.
 - 1. Wall thickness shall not be less than one-twelfth (1/12) of inside diameter plus one (1) inch or five (5) inches, whichever is greater.
 - 2. Cement, Fine Aggregate, Coarse Aggregate and Water used in the manufacture of precast manholes shall be as specified in Section 2509.3.E.
 - 3. Developed bases shall be used where practical. The floor of developed base manholes shall have a minimum thickness of twelve (12) inches. The bottom wall section shall be embedded a minimum of five (5) inches into the cast base. The diameter of the base pad shall be eight (8) inches greater than outside diameter of the manhole.
 - 4. Pipe openings: The first riser (barrel) section shall be provided with circular openings with continuous, circular, resilient connectors cast into the riser wall. Horseshoe-shaped boxouts, or doghouses, shall not be allowed except when approved by the Engineer. Flexible gaskets shall be used with developed base manholes. Flexible gaskets shall be Press-wedge, A-Lock, or approved equal.
 - 5. The minimum distance from the invert of the downstream pipe to the top surface of the base shall be three (3) inches.
 - 6. Joints between manhole sections, adjustment rings, and below the ring and cover shall be sealed with preformed bitumastic sealants, Kent-Seal, RamNet, E-Z Stick or approved equal. The minimum bead dimension shall be one inch.

7. Both the bell and spigot ends of the manhole sections shall be primed with a liquid primer that is compatible with bitumastic sealants, Kent-Seal, RamNet, E-Z Stick or approved equal.
 8. Reducing sections may be used at six (6) feet or more above the invert.
 9. Eccentric cone sections shall be used unless noted otherwise on the Plans.
- E. Manhole and Special Concrete:** Manhole and special concrete shall conform to "The Mid-West Concrete Industry Board Incorporated" (MCIB) Specifications and to the requirements therein for the MCIB Mix Number or KCMMB mix as shown on the Plans or as specified herein.
1. **Standard Concrete:** Standard concrete used for concrete encasements and embedments, thrust blocks, pipe anchors, pipe collars, etc. shall be MCIB Mix Number A 480-1-4-0.542, or KCMMB 3K unless otherwise specified.
 2. **Structural Concrete:** Structural concrete used for aerial crossing piers, wetwell walls, manhole walls, bases, inverts, and flat slabs, etc. shall be MCIB Mix Number A 558-1-2-0.421 or KCMMB 4K, unless otherwise specified.
 3. **Concrete Materials and Admixtures**
 - a. For KCMMB mixes, concrete shall be an approved mix with admixtures that are approved for use in that mix design.
 - b. For MCIB mixes:
 - i. Air-entraining admixtures shall provide an air content within the range of 4 1/2 to 7 1/2 percent by volume as measured by the pressure method (ASTM C 231). The air entraining admixtures shall meet the requirements of ASTM C 260.
 - ii. Portland Cement: Portland cement shall conform to ASTM C 150 Type I. Where high early strength is desired, Type III can be used.
 - iii. Fine Aggregate: Fine aggregate shall be clean, natural sand meeting the requirements of ASTM C 33. Grading shall be within the limits as set forth by MCIB.
 - iv. Coarse Aggregate: Coarse aggregate shall be limestone meeting the requirements of ASTM C 33. The sum total of all deleterious material shall not exceed the requirements of ASTM C 33.
 - v. Water: Water shall be clean and free from deleterious substances. Only potable water will be acceptable without testing.
- F. Reinforcement steel:** Reinforcement steel shall conform to the following minimum requirements and as shown on the Plans or Standard Drawings.
1. **Design:** Reinforcing steel shall conform to one of the following.
 - a. Welded Wire Fabric - ASTM A 1064.
 - b. Reinforcing Bars - ASTM A 615, Grade 40, or Grade 60.
 - c. Fabricated Steel Bar and Rod Mats - ASTM A 184, Grade 40, or Grade 60.
 2. **Fabricating Tolerances:** Tolerances for concrete reinforcement shall conform to the following requirements.
 - a. Sheared length = ± 1 inch.
 - b. Stirrups, ties, and spiral = ± 2 inches.

- c. All other bends = \pm 1 inch.
- G.** Iron Castings: Casting shall conform to the requirements of ASTM A 48, Class 30B. Castings shall be clean and without surface defects that will impair serviceability. Plugging or filling of holes or other defects will not be permitted. Parting fins and pouring gates shall be removed.
- 1. Rings and Covers: Rings and covers shall meet the following minimum requirements.
 - a. Bearing surfaces between the ring and cover shall be machine finished or ground to assure interchangeability and a non-rocking fit in any position.
 - b. Provision shall be made for opening, such as concealed pick hole(s).
 - c. Bolt-down type manhole rings shall be anchored to the manhole walls with not less than four (4) three-fourths (3/4) inch diameter steel bolts embedded a minimum of four (4) inches, except where the entire ring is embedded in a concrete top slab.
 - d. Rings and bolt-down covers shall be provided with machined surfaces, O-ring gaskets and five-eighths (5/8) inch hex head brass cover bolts. Cover bolt heads shall fit flush or below the top of the cover. The O-ring rubber gasket shall be neoprene or other synthetic, sixty (60) plus or minus five (5) hardness when measured by ASTM D 2240 type Durometer.
 - 2. Steps
 - a. Cast-Iron Steps are not allowed.
 - b. Steel core, plastic coated steps: Steel core plastic coated steps shall meet the following minimum requirements.
 - i. The plastic coating shall be a copolymer polypropylene meeting ASTM D 4101.
 - ii. The steel core shall be a minimum of 1/2 inch in diameter and Grade 60.
 - iii. The requirements of ASTM C 478 shall be met except minimum pull-out strength shall be 1,000 pounds.

2509.4 Manhole Site Preparation

Manhole site preparation shall be governed by Section 2503.

2509.5 Manhole Excavation

- A.** Excavation: Excavation for manholes and special structures shall be governed by this section and Section 2504. It shall be achieved in a suitable and orderly manner providing a minimum disturbance to the general public.
- B.** Depth of Excavation: Depth of excavation shall be to that required for proper installation of the manhole or structure. Over-depth excavation may be required by the Engineer if the subgrade is unstable. Over-depth excavation due to unstable subgrade shall be backfilled as required by the Engineer. Over-depth excavation occurring through an oversight by the Contractor shall be backfilled as required by the Engineer at no additional cost to the Owner.
- C.** Side Clearances: Side clearances outside the manhole and/or structures shall be no greater than to allow for forming, connection of piping, proper application of special coatings, if required, and to permit inspection. When concrete is to be placed directly against excavated faces, excavation shall be sufficiently outside of the manhole or structure to provide not less than three (3) inches of concrete cover over the steel reinforcement.

2509.6 Manhole Installation

Manhole installation shall be governed by this Section and Section 2505. It shall be performed by the Contractor on a schedule that will provide an orderly progression of the work.

A. Bases

1. Precast developed bases shall be reinforced in accordance with ASTM C 478.
2. If preferred developed bases are not used, poured concrete bases shall be used. Developed bases shall be installed on a maximum of 4 inches of crushed rock. Depths exceeding this amount shall be filled with mass concrete.
3. Poured-in-place bases shall have a minimum thickness of eight (8) inches. When poured-in-place bases are used, the invert shall be poured monolithically with the base. The bottom wall sections shall be embedded in the base section a minimum of three (3) inches. The bottom precast wall section shall not be set upon a previously poured base. Solid concrete blocks shall be used for supporting and leveling the wall section prior to pouring the base.

B. Inside Dimensions: The minimum horizontal clear distance in the barrel of the manholes shall not be less than four feet unless otherwise specified on the Plans.

C. Brick shall not be used for new manhole construction.

D. Precast

1. Delivery: Precast concrete components shall not be delivered to the job until representative concrete control cylinders have attained at least 80 percent of the specified minimum design strength.
2. Inspection: Precast concrete shall be inspected when delivered. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C 478.
3. Wall Thickness: Wall thickness shall conform to the requirements of Section 2509.3.D.
4. Construction: Precast sections shall be cleaned of all dirt, grass, and other deleterious matter. Seal each joint (including adjustment rings and castings) with a double bead of preformed bitumastic joint sealant sections shall be placed such that steps are aligned but without rotation or damage to sealant integrity. Lift holes shall be patched with non-shrink grout.

E. Cast-In-Place

1. Wall Thickness: Wall thickness shall conform to the dimensions as shown on the Plans or Standard Drawings.
2. Construction: Reinforcement steel shall be placed as shown on the Plans or Standard Drawings. Tie-holes shall be patched with non-shrink grout. Wall sleeves, where required, shall be installed as shown on the Plans or Standard Drawings. Water stops shall be installed at the wall and slab connection and shall be of the size, thickness and material as shown on the Plans or Standard Drawings.
3. Waterproofing: Interior protective coatings, where required, shall conform to the material specifications of Section 2509.3.C. Application shall conform to the manufacturer's recommendation.

- F. Top Slabs: Thickness shall conform to the dimensions and reinforcement steel shall be placed as shown on the Plans or Standard Drawings.
- G. Pipe Stubs: Stubs shall be installed at the locations, angles, elevations and of the materials as shown on the Plans or Standard Drawings. A water-tight removable stopper shall be installed in each pipe stub. Pipe stubs shall be installed so that a pipe joint will be two (2) feet or less from the outside manhole wall.
- H. Inverts: Inverts shall be structural concrete and steel-troweled to produce a dense, smooth finish. The invert channel shall be "U" shaped in cross-section and extend upward one-half of the inside pipe diameter. Smooth transitions shall be formed for pipes of different sizes, elevation and bends. The invert bench shall be sloped to drain.
- I. Steps: Steps shall be aligned vertically below the casting and spaced at sixteen (16) inch centers. The top step shall be not more than one (1) foot below the top of the cone. The lowest step shall be not more than two (2) feet above the invert bench. Field drilled step holes are not permitted in precast concrete manholes.
- J. Top Elevation: The finished top elevation of manhole castings shall conform to the following unless otherwise shown on the Plans or directed by the Engineer.
 1. In paved or future paved areas, the top of the casting shall conform to the slope of the pavement and be 1/8 inch below the finished pavement elevation.
 2. In non-pavement areas, the top of the casting shall be not more than six (6) inches above the surrounding ground or less than the sod's upper root limit. The final elevation shall be at a point where water will not pond over the manhole cover.
- K. Manhole Adjustment: All new manholes will be provided with adjustment ring(s) underneath the casting as shown on Plans. The joints shall be sealed with preformed bitumastic sealant. The maximum allowable adjustment distance between the top of the cone and the bottom of the casting shall be 12 inches. If the top of an existing manhole is required to be raised to an elevation that will exceed the maximum adjustment distance or lowered more than the adjustment rings will allow, all vertical adjustments shall be made to the barrel of the manhole.
- L. Castings: Castings shall be installed with the mud ring inserted inside the manhole opening and resting on a minimum of two rows of preformed bitumastic seals. Bolt-down castings shall be held in place as shown on the Plans or Standard Drawings.

2509.7 Manhole Backfilling

Manhole backfilling shall be governed by Section 2506.

2509.8 Restoration

Restoration shall be governed by Section 2507.

2509.9 Manhole Testing

- A. Scope: This section governs the furnishing of all labor, materials for the required testing of manholes and

structures as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

- B. General: All manholes shall be tested for infiltration and inflow.
- C. Infiltration and Inflow Testing: All manholes shall be vacuum tested in the presence of the Engineer.
 - 1. Each manhole shall be tested after backfilling to, at least the level of the bottom adjustment ring.
 - 2. The vacuum test shall include testing of the seal between the cast iron frame and the concrete cone, slab or top adjustment ring.
 - 3. All pipes entering the manhole shall be plugged at least eight inches into the sewer pipe. The plug must be inflated at a location beyond the manhole/pipe gasket.
 - 4. All plugs shall be adequately braced to prevent the plug or pipe from being dislodged and drawn into the manhole.
 - 5. A vacuum of at least 10.5 inches of mercury shall be drawn on the manhole. Shut the valve on the vacuum line to the manhole and disconnect the vacuum line. Open the vacuum line valve and adjust the vacuum to 10 inches of mercury.
 - 6. The pressure gage shall be liquid filled having a 3.5-inch diameter face with a reading from zero to thirty inches of mercury.
 - 7. The time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury must be equal to or greater than the following values for the manhole to be considered as passing the vacuum test:

<u>Manhole Depth</u>	<u>Time (minutes)</u>
10 feet or less	2
10.1 to 15 feet	2.5
15.1 to 25 feet	3
 - 8. If a manhole fails the vacuum test the manhole shall be uncovered and the leak repaired by patching the exterior of the manhole. The manhole shall then be backfilled and re-tested.
 - 9. The vacuum testing of manholes shall be done prior to air testing the sewer lines that enter or exit the manhole.

SECTION 2510 MEASUREMENT AND PAYMENT

2510.1 Method of Measurement

The quantities of completed work will be measured in the following units:

- A. Pipe
 - 1. Open Trenched: Measurement of various size, type and depth of pipe will be to the nearest 0.1 foot for each line between structures and made to the inside face of the connecting structure.

2. Tunneled, Bored, or Jacked: Measurement will be to the nearest 0.1 foot for the limits of tunneling, boring, or jacking as shown on the Plans.
 3. Embedment or Encasement: Concrete embedment or encasement will be measured by the lineal foot of each size and type.
- B. Manholes**
1. Measurement will be made for the applicable type, size and depth of manhole as listed in the Contract Documents. The depth shall be determined by measuring from the top of the casting to the outlet pipe flow line to the nearest 0.1 foot where applicable.
 2. Measurement will be made for the applicable type, size and depth of manhole as listed in the Contract Documents per each.
- C. Seeding:** Measurement will be made in accordance with Section 2400.
- D. Sodding:** Measurement will be made in accordance with Section 2400.
- E. Pavement and Curbing:** Measurement will be made in accordance with Section 2200.
- F. Driveways and Sidewalks:** Measurement will be made in accordance with Section 2300.

2510.2 Payment

Payment will be made at the respective unit or lump-sum price listed in the Contract Documents and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the Contract Documents, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the Contract Documents. At the Engineer's option, partial payment may be made for any lump sum item listed in the Contract Documents, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION