

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

Approved and Adopted this 16th day of December, 1992

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2501 SCOPE

This Division governs all work, materials and testing required for installation of gravity and pressure pipelines of the respective types and sizes shown on the Plans for the particular location and conforming to the requirements of these specifications. All pipelines shall be constructed to proper line and grade as shown on the Plans and shall result in an unobstructed, smooth and uniform conduit.

SECTION 2502 GENERAL

2502.1 Description: Sanitary sewer construction shall consist of furnishing all labor, materials and equipment for the complete installation of sewers and appurtenances in accordance with the contract documents, standard drawings, approved shop drawings, General Provisions and these specifications.

2502.2 Specification Modifications: It is understood that throughout this section these Specifications may be modified by appropriate items in the Special Provisions or notes on the Contract Drawings.

2502.3 Revisions of Standards: When reference is made to a Standard Specification i.e. ASTM, ANSI, AWWA, MCIB, the Specification referred to shall be understood to mean the latest revision of said specification as amended at the time of the Notice to Bidders, except as noted on the Plans or in the Special Provisions.

SECTION 2503 MATERIALS

2503.1 General: This section governs materials that may be required to complete pipeline construction, exclusive of structures, as shown on the Plans and/or as provided for in 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:** 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.

2503.2 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. **Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Pipe and Fittings:** Pipe and fittings shall conform to ASTM D 2680, except as otherwise specified herein.
1. **General:** Furnish maximum pipe lengths, normally produced by the manufacturer except for fittings, closures and specials. All field cuts that result in an exposed end section shall be sealed in accordance with the manufacturers' recommendation.
 2. **Design:** Pipe shall consist of two concentric thermoplastic tubes integrally braced across the annulus with resultant annular space filled with inert material to provide continuous support between inner and outer tubes. Bell-end shall be factory attached solvent weld coupling.
 3. **Joints:** Pipe joints and fittings shall be solvent cement or elastomeric type conforming to ASTM D 2680. Natural rubber gaskets will not be accepted.
 4. **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 provided 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.
- C. **Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings:** Pipe and fittings shall conform to ASTM D 2751, except as otherwise specified here-in.
1. **General:** Furnish maximum pipe lengths, normally produced by the manufacturer, except for fittings, closures and specials.
 2. **Design:** Pipe shall have an integral wall bell and spigot joint and a minimum wall thickness conforming to SDR 23.5.
 3. **Joints:** Pipe joints and fittings shall be solvent-cement or elastomeric conforming to ASTM D 2680. Gaskets for elastomeric joints shall conform to ASTM F477. Joint tightness shall also conform to ASTM D 3212. Natural rubber gaskets will not be accepted.
 4. **Fittings:** Fittings defined 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 23.5 and shall be provided by the pipe manufacturer.
- D. **Ductile-Iron Pipe and Fittings:** Pipe and fittings shall conform to ANSI A21.51, 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 *be Class 52 meeting the requirements of AWWA C150 (ANSI A21.50) and AWWA C151 (ANSI A21.51) or as* shown on the drawings.
 3. Joints: Mechanical and push-on joints for pipe and fittings shall conform to the requirements of ANSI A21.11. Flanged joints for ductile iron pipe and fittings shall conform to the requirements of A21.10. Gaskets shall be neoprene or other synthetic rubber material. Natural rubber gaskets will not be acceptable.
 4. Fittings: Fittings shall be in accordance with ANSI/AWWA C110 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 and cast 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 A 21.51.
 6. Linings: Pipe and fitting linings shall conform to the following:
 - a. Pipe shall have an interior *Calcium Aluminate-mortar lining conforming to AWWA C104 (ANSI A21.4), a 40 mil. Polyethylene lining in accordance with ASTM D 1248 or be PVC (polyvinyl chloride) lined.*
 - b. Pipe and fittings shall have an interior coating not less than one (1) mil in thickness which conforms to all appropriate requirements for seal coat in ANSI/A 21.4.
 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 ASTM D-1248, Type 1, Class C, Grade E-1 material.
- E. 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 12454 B or 12454 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 PVD 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.
 5. Fittings: Fittings for pressure flow systems 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.
- F. Type PSM polyvinyl chloride (PVC) Sewer Pipe and Fittings: 4 through 15 inch diameter pipe and fitting shall conform to ASTM D 3034 and pipe having diameter eighteen (18) through twenty seven (27) inch 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 D1784.
 3. Design: Pipe shall have an integral bell and spigot joint. Wall thickness shall *conform to SDR 26, for ASTM D 3034 pipe. Wall thickness shall be SDR 21 for ASTM D 2241 pipe. Wall thickness shall be T-1 for ASTM F 679 pipe. The maximum cover depth for SDR 26 pipe shall be twenty two (22) feet and the maximum cover depth for SDR 21 pipe shall be thirty (30) feet. If for any reason, the maximum cover depth is exceeded, the Contractor shall suspend pipe installation and notify the design engineer and the City.*
 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 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 26 and shall be furnished by the pipe manufacturer. A special design is required for service connections 8 inches and larger. Saddle connections will not be permitted during sewer main installation.*
- G. 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 MCIB Section 1 Concrete Materials. Reinforcement may be circular or elliptical. Elliptically reinforced pipe shall be marked in accordance with Section 17.2, ASTM C 76 for correct installation. 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 ASTM C361 and ASTM C 443.
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. Mitters shall not exceed 30 degrees at deflections angles between segments. Minimum center line curve radius shall not be less than twice the pipe diameter.

H. Vetrified Clay Pipe and Fittings: Pipe and fittings shall conform to ASTM C 700 Extra Strength except as otherwise specified herein.

1. General: Furnish maximum pipe lengths normally produced by the manufacturer with either bell-end or plan-end except for fittings, closures and specials.
2. Joints: All pipe joints shall conform to ASTM C 425 with synthetic rubber seals. All compression couplings for clay plain-end pipe shall conform to ASTM C-594.

2503.3 Pipe Embedment Materials.

- A. **Scope:** Pipe embedment materials shall be furnished and installed to complete the work shown on the Plans or as called for in the Contract Documents.
- B. **Granular Bedding Material:** *Granular bedding material shall be crushed clean limestone aggregate meeting one of the following gradations:*

Sieve Size	¾"	½"	3/8"
1"	100		
¾"	90-100	100	
½"		80-100	
3/8"	20-55	40-70	100
No. 4	0-10	0-15	30-40
No. 8	0-5	0-5	0-4

In areas where the pipe trench is below the potential high point of the water table, only three-eighths (3/8" bedding may be used.

- C. **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 2510.3.6.
2. Reinforcing steel when required shall be placed as shown on the Plans and shall conform to Section 2510.3.7.

2503.4 Backfill materials:

- A. **Scope:** Backfill materials shall be as required and/or permitted to complete the work shown on the Plans or called for in the Contract Documents.
- B. **Granular Backfill Material:** Granular backfill material shall meet the gradation requirements as outlined in Section 2202.2
- 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 one foot in its longest axis shall be placed in any trench excavation as backfill.

2503.5 Tunneling, Boring and Jacking Materials:

- A. **Scope:** This section governs the furnishing of all materials necessary for the construction of tunnels at locations shown on the Plans or where constructed at the Contractor's option when approved by the Engineer.
- B. **General:** Furnish materials and necessary accessories with strengths, Thicknesses, coatings, and fittings indicated, specified and/or necessary to complete the work.
- C. **Steel Liner Plate:** Steel tunnel liner plates shall be Armco "Standard" Commercial Shearing and Stamping Company "Commercial," Republic "Truscon Paneled Out," or equal and shall be galvanized in accordance with ASTM A 123. 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 erring 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 (0.246 inches). Sufficient sections shall be provided with one and one-half (1 ½) inch or larger grouting holes located near the centers so that when the 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 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, A 325 and A 449 as applicable. Steel liner plates shall have bolted joints in both longitudinal joints in adjacent rings when assembling.
- D. **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.

Corrugated steel casing pipe will be considered on a case-by-case basis.

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

Diameter of Casing-Inches	Nominal Wall Thickness-Inches	
	Under Railroads	All Other Uses
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 under railroads and Grade A on all other areas.
 3. Steel pipe shall have welded joints in accordance with AWWA C 206.
- E. **Reinforced Concrete Pipe:** Reinforced concrete pipe used as casing shall conform to ASTM C 76 except as otherwise specified under Section 2503.2.7.
- F. **Casing conduit Grout:** Casing conduit grout shall be a pumpable grout resulting in minimum set strength of 400 psi. in 28 days.
- G. **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 2510.3.6.
- H. **Wood Skids:** Wood skids shall be provided as indicated on the Plans. The wood shall be pressure-treated with a preservative in accordance with ASTM D 1760. Cut surfaces shall be given two (2) heavy brush coats of the same preservative.

SECTION 2504 SITE PREPARATION

2504.1 Scope: This section governs normal project site preparation for construction.

2504.2 General:

- A. Contractor shall do all clearing necessary for performance of his work and shall confine his operations to that area provided through easements, licenses, agreements and rights-of-way. The Contractor's entrance upon any lands outside of that area provided by easements, licenses, agreements or public rights-of-way, shall be at the Contractor's sole liability.
- B. The Contractor shall not occupy any portion of the Project Site prior to the date established in the Notice to Proceed without prior approval of the Engineer.

2504.3 Obstructions:

- A. **General:** Natural obstructions, existing facilities and improvements encountered during site preparation shall be removed, relocated, reconstructed or worked around as herein specified. Care shall be used while performing site preparation work adjacent to any facilities intended to remain in place. Except as otherwise specified, the Contractor shall be responsible for any damage to existing facilities and improvements and any repairs required shall be promptly made at the Contractor's expense. Waste materials shall be disposed of in a satisfactory manner off the work site. Restoration of utilities damaged by the Contractor shall be restored as directed by the utility company at no additional cost to the Owner. Unless otherwise provided in Basis of Payment no separate or additional payment will be made for any work in connection with removal, relocation or restoration of obstructions and existing facilities.
- B. **Surface Obstructions:**
 - 1. Sidewalks, curbs and gutter, drainage structures and similar obstructions shall be tunneled under if tunneling is best suited, otherwise the obstruction shall be cut in straight lines or removed to the nearest construction joint if located within five feet of the center-line of the trench. In no case shall the joint or line of cut be less than one foot outside the edge of the trench. Surface obstructions removed to permit construction shall be reconstructed as specified and to the dimensions, lines and grades of original construction. Back-fill of tunneled sections shall be performed in accordance with Section 2507. All restoration shall be in accordance with Section 2508.
 - 2. Mailboxes shall be maintained in the manner that the Postal Service requires to prevent interruption of mail delivery.
 - 3. Site preparation shall include where necessary and permitted the removal of trees, shrubs, brush, crops, and other vegetation within the limits of the easements (right-of-way) or as may be provided for in licenses, permits and agreements. The following procedures for protection of existing greenery are required.

- a. Trees: All reasonable effort shall be made to save as many trees as possible. Trees are defined as six inches in diameter and greater when measured at a point three feet above the ground surface. If trees can be saved by trimming, this shall be done in accordance with acceptable pruning practices.

All trees within easements or right-of-way provided, which are specifically to be removed or saved have been marked on the plans with the following notations:

- 1) Trees marked "S" shall be saved.
- 2) Trees marked "X" shall be removed.
- 3) Trees marked "R" shall be removed and replaced.

Trees to be removed shall be completely removed, including stump and large roots, unless such removal may result in damage to existing pipelines. In that event, trees shall be sawn off not more than four (4) inches above the ground and the stump shall be removed to twelve (12) inches below finish grade. Any tree replaced shall be outside the permanent sewer right-of-way and shall be like species of nursery stock. (Generally, 2 to 2 ½ inch caliper)

- b. Small Plants and Flowers: At least two weeks prior to the start of construction, property owners shall be notified by the contractor of the proposed starting date. The purpose of this notification is so that the property owners can remove any small plants or flowers that they, the property owners, desire to save.
4. Fences: Fences interfering with construction, and located within public rights-of-way or as may be allowed for in permits or agreements, may be removed by the Contractor only if the opening is provided with a temporary gate that will be maintained in a closed position except to permit passage of equipment and vehicles unless otherwise herein specified. Fences within temporary construction easements may be removed by the Contractor provided that temporary fencing is installed in such a manner as to serve the purpose of the fencing removed. The contractor shall locate and record all fence corners prior to removal. All fencing removed shall be restored by the Contractor to the condition existing prior to construction unless otherwise specified in the Special Provisions. The Contractor is and shall be solely liable for the straying of any animal's protected or corralled or other damage caused by any fence so removed.
 5. Property Pins: The Contractor shall preserve all property corners, pins or markers. In the event any property corners, pins or markers are removed by the Contractor, such property points shall be replaced at the Contractor's expense and shall be reset by competent surveyors properly licensed to do such work. In the event such points are section corners or Federal land corners, they shall be referenced and filed with the appropriate authority.
 6. Sodded and Landscaped Areas: Sodded and/or landscaped thoroughfares and area on or adjacent to improved property shall be disturbed only to the extent required to permit construction. Such areas shall not be used as storage sites for

construction supplies and insofar as practicable shall be kept free from stockpiles or excavated materials.

C. Subsurface Obstruction:

1. Where existing utilities and service lines are to be encountered, the Owner thereof shall be notified by the Contractor at least 48 hours (not including weekends and/or holidays) in advance of performing any work in the vicinity. All excavation, pipeline installation and backfilling work in the vicinity of such utilities shall be accomplished in the manner required by the respective Owner and, if requested, under their direct supervision. The Contractor shall be responsible for any and all damages to a public or private utility that may occur as the result of the construction.
2. The Contractor shall make a reasonable effort to ascertain the existence of obstructions and shall locate obstructions by digging in advance of machine excavation where definite information is not available as to their exact location. Where such facilities are unexpectedly encountered and damaged, responsible officials and other affected parties shall be notified and arrangements made for the prompt repair and restoration of service.
3. Private Sewer Facilities: The Contractor shall make every reasonable effort to protect private sewer facilities. They are not shown on the Plans. When these facilities are disturbed or damaged by the work, the Contractor shall make necessary repairs to the facilities for continuous service prior to the close of the work day at no cost to the Owner.

SECTION 2505 EXCAVATION

2505.1 Scope: This section governs the methods and procedures required for pipeline excavations for open cut and tunneling.

2505.2 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 subgrade of all sewer trenches shall be determined by overhead grade lines 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.

2505.3 Unclassified Excavation: Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be Considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.

2505.4 Rock Excavation: Rock excavation is defined as the removal of all rock ledges 6 inches or more in thickness, detached rock or boulders having a volume of more than 1 ½ cubic yards and shale occurring in its natural state, hard and unweathered. A rock ledge is defined as a continuous body of rock that may include interbedded seams of soft materials. Such interbedded soft material less than 12 inches in thickness will be included in the measurement of rock excavation. Such seams 12 inches or greater in thickness will be included only in the measurement of earth excavation.

2505.5 Earth Excavation: Earth excavation is defined as the removal of all material not defined as rock.

2505.6 De-Watering: The Contractor shall remove any water that may accumulate or be found in the trenches and other excavations made under the Contract.

The Contractor shall form all dams, flumes or other works necessary to keep the excavation clear of water while the sewers and their foundations, and other foundation works, are being constructed. All water shall be removed from such excavation in a manner that will not damage property.

2505.7 Blasting: When blasting is permitted by the Engineer, the Contractor shall use the utmost care to protect life and property. The Contractor 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 thereto caused by his or his subcontractor's operations.

The Contractor shall provide insurance as required by Section 00700 Construction General Conditions, 00800 Construction Supplementary Conditions and Special Provisions. The governing agency shall be notified at least twenty four (24) hours before blasting operations begin.

2505.8 No Blasting Areas: No blasting of any kind for rock excavations or any other purpose will be allowed if so noted on the Plans.

2505.9 Open-Cut Method (Trenching):

- A. **Scope:** This item establishes the requirements to be flowed for pipeline excavation performed by the open-cut method (trenching).
- B. **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.

- C. **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.
- D. **Trench Walls:** Undercutting of trench walls is not permitted.
- E. **Trench Widths:**
 - 1. **Minimum Widths:** Trench widths and pipe clearances shall be not less than that shown in the following table.

MINIMUM TRENCH AND PIPE CLEARANCES (INCHES)			
Nominal Pipe Diameter	Trench Width ¹	Pipe Slide Clearance ²	Soil/Incompressible Pipe Bottom Clearance
4	22	6	4/6
6	22	6	4/6
8	22	6	4/6
10	24	6	4/6
12	27	6	4/6
15	30	6	4/6
18	34	6	4/6
21	39	7	4/9
24	43	7	4/9
27	48	8	4/9
30	54	8	4/9

Measured below a horizontal plane six (6) inches above the top of the pipe line.
Measured from the outside face of pipe barrel to inside face of trench.

- a. **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.

When trench width exceeds those in the tables shown for Vitrified Clay Pipe or when the side clearance exceeds two and one-half (2 ½) times the outside pipe diameter at either side of the 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.

- b. **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.
- c. **Trench Shields:** When trench shields are utilized by the Contractor, said shields or any part thereof shall not extend lower than six (6) inches above the top of the proposed pipeline nor shall the maximum allowable trench width be exceeded.
- F. **Clay Pipe Trench Width Tables:** The trench width tables list trench widths that are the minimum and maximum allowed. If the maximum trench width is exceeded, the Contractor shall so inform the Engineer prior to installation of pipe embedment material and/or pipe. Unless otherwise specified, H-20 Truck Loading Tables shall be used. All delays caused by the Contractor's failure to immediately notify the

Engineer when overwidth trenching occurs will not be grounds for an extension of the contract time limit or additional payment.

MAXIMUM TRENCH WIDTH (INCHES)

Pipe:	Extra Strength Vitrified Clay ASTM C 700								
Embedment:	Class B								
Soil:	Non-Cohesive ($K' = 0.165$) 120pcf (No Live Load)								
	<u>Nominal Pipe Size (inches)</u>								
<u>Cover Depth (feet)</u>	8	10	12	15	18	21	24	27	30
2.5-10	a	a	a	a	a	a	a	a	a
10-12	a	a	a	a	a	a	a	68	71
12-14	a	a	42	45	49	54	60	63	65
14-16	a	a	40	43	46	51	57	59	62
16-18	a	37	39	41	45	50	54	57	59
18-20	34	36	38	40	44	48	52	55	57
20-22	34	36	37	40	43	47	51	53	56
22-24	34	35	37	39	42	46	50	52	54
24-26	33	35	37	39	42	46	50	51	53
26-28	33	35	36	38	41	45	49	51	53
28-30	33	34	36	38	41	45	48	50	52

Cover depths designed "a" are not critical and width does not govern.

Cover depths designated "b" result in loads exceeding safe support strength.

MAXIMUM TRENCH WIDTH (INCHES)

Pipe:	Extra Strength Vitrified Clay ASTM C 700								
Embedment:	Class B								
Soil:	Non-Cohesive ($K' = 0.165$) 120pcf (H-20 Truck Loading)								
	<u>Nominal Pipe Size (inches)</u>								
<u>Cover Depth (feet)</u>	8	10	12	15	18	21	24	27	30
2.5-10	a	a	a	a	a	a	a	a	a
10-12	a	36	39	45	51	56	62	65	68
12-14	a	36	38	43	48	54	58	61	64
14-16	a	34	37	43	46	51	57	60	62
16-18	33	34	37	41	45	50	54	57	59
18-20	33	34	37	40	44	48	52	55	57
20-22	33	34	37	40	43	47	51	53	56
22-24	33	34	37	39	42	46	50	52	54
24-26	33	34	37	39	42	46	50	51	53
26-28	33	34	36	38	41	45	49	51	53
28-30	33	34	36	38	41	45	49	50	52

Cover depths designed "a" are not critical and width does not govern.

Cover depths designated "b" result in loads exceeding safe support strength.

MAXIMUM TRENCH WIDTH (INCHES)

Pipe:	Extra Strength Vitrified Clay ASTM C 700								
Embedment:	Class B								
Soil:	Non-Cohesive ($K' = 0.130$) 120pcf (No Live Load)								
	<u>Nominal Pipe Size (inches)</u>								
<u>Cover Depth (feet)</u>	8	10	12	15	18	21	24	27	30
2.5-10	a	a	a	a	a	a	a	a	a
10-12	a	a	a	a	4	54	60	64	67
12-14	a	a	38	42	46	50	55	59	61
14-16	a	33	37	39	43	48	53	55	57
16-18	a	33	36	38	41	46	50	52	55
18-20	31	32	35	37	40	44	48	50	53
20-22	30	31	34	36	39	43	47	49	52
22-24	30	31	33	35	38	42	45	48	b
24-26	29	31	33	34	37	41	44	47	b
26-28	29	30	32	34	37	41	44	b	b
28-30	29	30	32	34	36	40	43	b	b

Cover depths designed "a" are not critical and width does not govern.

Cover depths designated "b" result in loads exceeding safe support strength.

MAXIMUM TRENCH WIDTH (INCHES)

Pipe:	Extra Strength Vitrified Clay ASTM C 700								
Embedment:	Class B								
Soil:	Cohesive ($K' = 0.130$) 120pcf (H-20 Truck Loading)								
	<u>Nominal Pipe Size (inches)</u>								
<u>Cover Depth (feet)</u>	8	10	12	15	18	21	24	27	30
2.5-8	a	a	a	a	a	a	a	a	a
8-10	a	a	a	a	a	a	a	a	71
10-12	a	a	38	42	47	53	59	61	64
12-14	a	34	38	42	46	50	54	57	59
14-16	a	33	37	39	43	48	53	55	57
16-18	32	33	36	38	41	46	50	52	55
18-20	31	32	35	37	40	44	48	50	53
20-22	30	31	34	36	39	43	47	49	b
22-24	30	31	33	35	38	42	45	48	b
24-26	29	31	33	34	37	41	44	47	b
26-28	29	30	32	34	37	41	44	b	b
28-30	29	30	32	34	36	40	43	b	b

Cover depths designed "a" are not critical and width does not govern.

Cover depths designated "b" result in loads exceeding safe support strength.

G. 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 as established by the Engineer will be shown on the Plans.

- H. 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.

2505.10 Tunneling, Boring and Jacking:

- A. **Scope:** This item establishes the requirements to be followed for pipeline excavation performed by tunneling, boring and jacking methods.
- B. **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.

- C. **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.
- D. **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 2506.2.9-Installation.
 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 2506 INSTALLATION

2506.1 Scope: This section governs construction methods and procedures for the installation of gravity and pressure pipelines and appurtenances.

2506.2 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 Departments requirements. See Special Provisions for governing 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 six (6) 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.

All Class A concrete embedments for rigid conduits shall begin and end at a pipe joint.

F. 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 the 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.

G. Pipe Embedment Designations and Descriptions:

1. Class A. Embedment – Concrete Cradle, Arch or Encasement:
 - a. All Class A embedments require A 480-1-4 concrete 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.
 - b. Class A embedments for all pipe shall be installed with reinforcing steel of not 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.
2. Class B Embedment: The pipe shall be bedded in granular material, with a minimum thickness below the pipe as specified in Section 2505.9.5.

- a. **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 the pipe shall be carefully placed select earth backfill compacted to eighty-five percent (85%) of maximum density at an optimum moisture + or – 2% as defined in AASHTO T99 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, hunching, or initial backfill of flexible pipe.
 - b. **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 or coupling shall be bedding aggregate.
3. **Class C Embedment:** The pipe shall be bedded in granular material with a minimum thickness beneath the pipe as specified in Section 2505.9.5

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 T99 or ASTM D 698.

H. Tees, Wyes and Building Service Lines: Tees (Ts), wyes (Ys), 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 saddle 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 2506.2.11., which 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 predetermined by the Contractor at no additional cost to the Owner.
 4. Service lines shall be terminated and capped one foot on the public side of right-of-way or easement lines.
- 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 ASTM C 425, ASTM C 594 and 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.

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.

- K. **Anchors:** Pipelines shall be anchored in accordance with the table below:

PIPELINE ANCHORS	
Percent of Grade	Center to Center Max. Spacing (Feet)
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.

- L. **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 pipe of sufficient strength to provide 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 exceed the covers depths in Section 2505.9.6., which would 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 stormwater 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.

M. Connection of Pipes of Dissimilar Materials: The connection of pipes of different materials shall be made using approved transition coupling and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure.

2506.3 Detailed Installation Requirements: All pipes shall be installed in accordance with the following standards:

- A. ASTM D-2321 – ABS Solid Wall, ABS Composite Wall, ASTM D-2321 – PVC Solid Wall, PVC Composite Wall.
- B. ***ANSI/AWWA C 600-Ductile Iron Pipe and the following requirements for polyethylene tube protection.***
- C. ASTM C 12 – Vitrified Clay Pipe.
- D. Reinforced Concrete Pipe – Installed in accordance with American Concrete Pipe Association's "Installation Manual."
- E. ***Polyethylene tube protection shall be installed in accordance with ANSI/AWWA C105, Method A as outlined below.***
- F. ***Polyethylene tubing shall be approximately two (2) feet longer than the length of the pipe section to provide a one (1) foot overlap on each adjacent pipe section. Any rips, punctures, or other damage to the polyethylene shall be repaired with***

adhesive tape of with a short length of polyethylene tube cut open, wrapped around the pipe and secured with adhesive tape.

- G. Appurtenances such as bends, reducers and offsets shall be covered with polyethylene in the same manner as the pipe. Odd-shaped appurtenances such as valves, tees, and crosses, which cannot be wrapped in a tube, shall be wrapped with a flat sheet or split length of polyethylene tube. The sheet shall be passed under the appurtenance and brought up around the body. Seams shall be made by brining the edges together, folding them over twice, and taping them down. Polyethylene shall be securely taped in place of overlaps, valve stems and other penetrations.*
- H. Openings for branches, serve taps, air valves and similar appurtenances shall be made by making an x-shaped cut in the polyethylene and temporarily folding the film back. After the appurtenance is installed, tape the slack film securely to the appurtenance and repair the cut as well as any other damaged areas in the polyethylene with tape.*
- I. When joining with unwrapped pipe, extend the polyethylene tube to cover the unwrapped pipe a distance of at least two (2) feet and secure the end with circumferential turns of tape.*

2506.4 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 (2503.6). Interior void between the carrier and casing conduits shall be filled with sand conforming to Section 2510.3.6. 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 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.

- 1) **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 auguring and jacking. Alignment and gradient shall be such that the carrier conduit can be installed to line and grade shown on the drawings.

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 2510.3.6. 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. 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 2507 BACKFILL

2507.1 Scope: This section governs the furnishing of all labor, equipment, tools and materials to property backfill trenches and structures.

2507.2 General:

- A. All trash and debris shall be removed from the pipeline excavation prior to backfilling.
- B. Unless otherwise specified, all sewer trenches and excavation around structures shall be backfilled to the original surface of the ground with suitable earth or earth and rock. When an earth and rock mixture is used, it shall be placed and thoroughly consolidated with sufficient earth to completely fill all voids between the rocks.
- C. The backfill material shall be placed in lifts not to exceed 2 feet in depth. Each lift shall be compacted to the required density prior to the next lift being placed.
- D. Commercial sand backfill shall not be used.
- E. In areas marked “garden” or “flower garden”, the original topsoil shall be replaced to original elevation and depth. (Minimum depth shall be twelve (12) inches).
- F. Backfill material shall be carefully placed to avoid damage to or displacement of the pipe and other exposed utilities or structures.
- G. Backfill shall not be placed when material contains frost, is frozen, or a blanket of snow prevents proper compaction. Contractor shall remove waste material, trees, organic material, rubbish, or other deleterious substances.
- H. No rock whose greatest dimension exceeds six inches shall be placed within two (2) feet to the top of the pipe in any excavation as backfill. No rock greater than one foot in its largest axis shall be placed in any trench excavation as backfill.

2507.3 Backfilling In Street or Alley Right-of-Way and Under Pavement: Under areas to be paved, the backfill materials from the top of the pipe embedment (as defined in Section 2506.2.7.b.) to a point 6 inches below top of subgrade shall be compacted in such a manner so as to obtain 90% of maximum density at optimum moisture plus or minus 2% as determined by ASTM D 698. The top 6 inches of subgrade shall be compacted to 95% of maximum density at optimum moisture plus or minus 2%. Outside of areas to be paved the backfill material shall be compacted so as to obtain 90% of maximum density at optimum moisture plus or minus 2% as determined by ASTM D 698. Required compaction and percentage of maximum density must be obtained before pavement is placed.

2507.4 Backfilling In Areas Other Than Street or Alley Right-of-Way: From the top of the pipe embedment (as defined in Section 2506.2.7.b.) to a point at grade the backfill material shall be compacted to no less than 90% of maximum density at optimum moisture plus or minus 2% as determined by ASTM 698.

2507.5 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 four (4) inches maximum dimension shall be placed within one (1) foot of the exterior surface of any structure.

SECTION 2508 RESTORATION

2508.1 Scope: This section covers all work required in surface restoration on private and public properties that are disturbed by construction.

2508.2 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.

2508.3 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 wash checks where necessary.

2508.4 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.

2508.5 Seeding: The requirements set forth under Section 2401 – Seeding shall be used as if fully written herein.

2508.6 Sodding: The requirements set forth under Section 2402 – Sodding shall be used as if fully written herein.

2508.7 Pavement Replacement:

- A. **Scope:** This section covers the furnishing of all labor, equipment, tools and materials in the performance of all work for the replacement of pavement including sidewalks, driveways and curbing as shown on the Plans and in the Special Provisions.
- B. **Definition:** Pavement replacement as used herein shall mean reconstruction of the entire structural section of all pavements removed in excavated areas, including sidewalks, driveways and curbing and all damaged pavement surfaces outside of excavation limits.

C. 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.

2508.8 Fences: All fencing damaged and/or removed existing prior to construction shall be restored to a condition not less than that which existed prior to construction.

2508.9 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.

2508.10 Trees, Shrubs and Bushes: Any tree, shrub or bush replaced shall be planted outside the permanent sanitary sewer right-of-way and shall be of the same species as the removed tree, shrub or bush. Any tree, shrub or bush specie that is prohibited by local restrictions shall be substituted with a related species. Replacement planting shall conform to the guidelines ANSI-Z60.1-1980 of Nurserymen. The Contractor shall notify the property owners at least two weeks prior to the start of construction so property owners can remove small plants and flowers.

SECTION 2509 TESTING

2509.1 Scope: This section governs the furnishing of all labor, equipment, tools and materials, and the performance of any or all acceptance tests.

2509.2 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 shall be performed before backfill and compaction operation has been completed.

2509.3 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 lines installed under this project are subject to inspection by closed circuit television at the Owner's expense.

2509.4 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 two hundred (200) 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 six thousand (\$6,000) 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 reach of gravity sewer. Where the specified infiltration limit is exceeded, the Contractor shall repair or replace the defective reach of pipeline at no additional cost to the Owner. Following repair of the pipeline, the Contractor shall re-measure 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 after backfill 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: An allowable leakage test shall be conducted after the pressure test has been satisfactorily completed. The Contractor shall maintain on the new main for at least two (2) hours a minimum pressure of not less than that 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 in Section 2509.4.2.b (3) Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe to maintain the specified leakage test pressure after the air has been expelled and the pipe has been filled with water. No main or section thereof will be accepted if and while it has a leakage rate in excess of that determined by the following formula.

$L = 0.00007 N D P$, in which

L = allowable leakage in gallons per hour

N = number of joints in the length of main tested

D = nominal diameter of the pipe in inches

P = average test pressure during the leakage test in psig

Should the actual leakage exceed the allowable leakage, the test pressure shall be maintained so that the leakage may show up on the surface of the ground. All leaks shall be repaired and the leakage test repeated as necessary until the main passes the leakage test.

3. Air Testing of Gravity Systems:

- a. Contractor may perform air tests for all pipe (except concrete) for all sizes.
- b. Furnish all facilities required including necessary piping connection, test pumping equipment, pressure gauges, bulkheads, regulator to avoid over-pressurization, 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)	4-1/2 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, 270o 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.

- 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 Size	Required Time per 100 LF	Maximum Required Time
8"	70 sec.	227 sec.
10"	110 sec.	283 sec.
12"	158 sec.	340 sec.
15"	248 sec.	425 sec.
18"	356 sec.	510 sec.
21"	485 sec.	595 sec.
24"	634 sec.	680 sec.
27"	765 sec.	765 sec.
30"	851 sec.	851 sec.

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. 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.

2509.5 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 dimensions of the mandrel shall be as listed in the accompanying table. The "D" mandrel dimension shall carry a tolerance of +

or – 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 *without any mechanical assistance*, by *one of the Contractor’s personnel* 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 re-round 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.

D and L Dimensions For 9 Arm Mandrel					
Nominal Diameter	L (Min)	ASTM 3034 SDR 35	ASTM 3034 SDR 26	ASTM 2241 SDR 21	ASTM 679 T-1 Wall
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”	--	--
18”	18”	--	--	15.47”	16.76”
21”	21”	--	--	--	19.74”
24”	24”	--	--	20.63”	22.21”
27”	27”	--	--	--	25.03”

The above dimensions were determined using the following formula: .95 x (Average O.D.-2 x min. wall thickness).

2509.6 Soil Density Tests:

- A. General: Compaction tests shall be performed as specified in the Special Provisions. If so specified, all compaction tests shall be performed by a testing laboratory approved by the Engineer.
 1. Testing Methods: Testing shall be in accordance with the following:
 - a. Maximum Density: Maximum density shall be determined by the standard proctor analysis method as defined by AASHTO T99 or ASTM D 698.
 - b. Density of Soil in Place: The density of soil in place shall be determined by the analysis methods as defined by ASTM D 1556, or ASTM D 2167, or ASTM D 2922.
 2. Method of Payment: The Contractor shall pay all costs for density tests. Tests shall be required as follows:

- a. For pipelines located within street or alley rights-of-way, density tests representative of each three (3) foot of trench depth shall be taken at five hundred (500) linear foot intervals along the lines or at each cross street.
 - b. For pipelines located outside of street or alley rights-of-way, density tests representative of each three (3) foot of trench depth shall be taken at one thousand (1,000) foot intervals along the lines.
3. Additional Tests: The Engineer may require additional density tests with payment as follows:
- a. Test results conforming to specified densities will be paid for by the Owner.
 - b. Test results not conforming to specified densities shall be paid for by the Contractor at no additional cost to the Owner.

SECTION 2510 MANHOLES AND SPECIAL STRUCTURES

2510.1 Scope: This section governs the furnishing of all labor, equipment, tools, and materials, 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 required in accordance with the Plans and Special Provisions.

2510.2 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 precast concrete sections, cast-in-place concrete.

2510.3 Manhole Materials:

- A. Brick shall conform to ASTM C 32, Grade SS or SM, nominal size 2 ¼ x 4 x 8 inches. For grade SM, the maximum water absorption by five (5) hour boiling shall not exceed twelve (12) percent per individual brick or nine (9) percent for the average of five (5) bricks.
- B. **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.
- C. **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 forth-five (45) minutes based on initial set per ASTM C 191.
- D. **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.
- E. **Precast Concrete:** Precast concrete manholes shall conform to ASTM C 478 with the following modifications.
 - 1. Wall thickness not 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 2510.3.6.

3. Developed bases shall be used where practical. The diameter of the base pad shall be eight (8) inches greater than outside diameter of the manhole.
 4. Pipe opening shall be circular or horseshoe shaped with surfaces grooved or textured to improve mortar bond. 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, Ram-Nek, 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, Ram-Nek, 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 project plans.***
- F. **Manhole and Special Concrete:** Manhole and special concrete shall conform to “The Mid-Wet Concrete Industry Board Incorporated” (MCIB) Specifications and to the requirements therein for the MCIB Mix Number specified on the drawings or as provided herein.
- a. ***Standard Concrete: Standard concrete used for concrete encasements and embedments, thrust blocks, pipe anchors, pipe collars, etc. shall be MCIP Mix Number A 480-1-4-0.542, unless otherwise specified.***
 - b. ***Structural Concrete: Structural concrete used for aerial crossing piers, wetwell walls, manhole walls, bases, inverts, and flat slabs, etc. shall MCIB Mix Number A 558-1-2-0.421, unless otherwise specified.***
 - c. **Admixtures:** Air-entraining admixtures shall provide an air content within the range of 4 ½ to 7 ½ percent by volume as measured by the pressure method (ASTM C 231). The air entraining admixtures shall meet the requirements of ASTM C 260.
 - d. **Portland Cement:** Portland cement shall conform to ASTM C 150 Type I. Where high early strength is desired, Type III can be used.
 - e. **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.

- f. 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.
- g. Water: Water shall be clean and free from deleterious substances. Only potable water will be acceptable without testing.

G. Reinforcement steel: Reinforcement steel shall conform with the following minimum requirements.

- a. Design: Reinforcing steel shall conform to one of the following.
 - (1) Welded Wire Fabric – ASTM A 185.
 - (2) Reinforcing Bars – ASTM A 615, Grade 40, or Grade 60.
 - (3) Fabricated Steel Bar and Rod mats – ASTM A 184, Grade 40, or Grade 60.
- b. Fabricating tolerances: Tolerances for concrete reinforcement shall conform to the following requirements.
 - (1) Sheared length = +/- 1 inch.
 - (2) Stirrups, ties, and spiral = +/-2 inches.
 - (3) All other bends = +/- 1 inch.

H. Iron Castings: Casting shall conform to the requirements of ASTM A 48, *Class 35 B, ASUTO M306 and KCMO Standard MH-RC*. 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 *and Kansas City Standard MH-RC*.
 - a. *Cam lock covers shall not be placed in roadway pavement unless shown on the plans or directed by the engineer. All other covers shall be cam lock. All covers shall have provisions for opening, such as concealed pick holes.*
 - b. *Bearing surfaces between the ring and cover shall be machine finished or ground to assure interchangeability and a non-rocking fit in any position.*
 - c. *Bolt-down type manhole rings shall be anchored to the manhole walls with not less than four (4) three-fourths (3/4) inch (M18x2.5) diameter steel bolts embedded a minimum of four (4) inches, (100 mm), plus or minus one half (1/2) inch, (10 mm), into the cone section of the manhole, except where the entire ring is embedded in a concrete top slab.*

- d. *Bolt-down manhole rings and their covers shall be provided with machined surfaces, O-ring or T-ring gaskets and cam locks. Cam lock bolt heads shall fit flush or below the top of the cover. The O-ring or T-ring rubber gasket shall be neoprene or other synthetic material, sixty (60) plush or minus five (5) hardness when measured by ASTM D 2240 type Durometer.*
- e. *All manhole rings and covers placed in paved areas shall be adjustable to meet any slope and grade of the roadway, from 0 to 17%, and shall be able to be raised or lowered in ¼ inch increments, up to 2¼ inches. Ring height must be adjustable after installation without disturbing the surrounding pavement. The ring and lid shall be rated for H20 traffic.*

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.
 - (1) The plastic coating shall be a copolymer polypropylene meeting *ASTM D4101.*
 - (2) The steel core shall be a minimum of ½ inch in diameter and grade 60.
 - (3) The requirements of ASTM C 478 shall be met except minimum pull-out strength shall be 1,000 pounds.

H. Joint sealing systems.

- 1. *Exterior: Heat shrinkable joint wrap shall conform to ANSI/AWWA A C216-89. The wrap system shall consist of a two-part material (backing + adhesive) with a closure system and a G-type primer. It shall consist of an irradiated cross-linked polyolefin sheeting, pre-coated with a layer of anti-corrosion adhesive. The backing shall have a minimum recovery of 22%. The adhesive shall be mastic-type, specially formulated to become fluid at temperatures achieved during installation and maintain flexibility in cold climates with installation temperatures down to -40°F. Upon cooling the adhesive shall form a tough, elastomeric protective layer. The wrap shall employ a closure seal to allow sealing of the overlap area. The overall thickness of an applied sleeve shall nominally measure 0.100 inches (2.5 mm), (Wrapid Seal as manufactures by Canusa has been approved.)*
- 2. *Internal: All internal sealing materials shall be able to withstand hydrogen sulfide and other corrosive gases and shall be approved by the engineer before bidding.*
 - a. *Rubber Seal Systems: Internal flexible rubber sleeve, extensions and wedge strips shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C 923, with a minimum 1500 psi tensile strength, maximum 18% compression set and hardness (Durometer) or 48+ or -5. (Cretex Specialty Products system has*

been approved).

Sleeves shall be either double or triple pleated with a minimum unexpanded vertical height of 8" and 10" respectively, a minimum thickness of 3/16" and shall be capable of a vertical expansion when installed of not less than 2". The top and bottom section of the sleeve shall contain an integrally formed expansion band recess and multiple sealing fins.

Extensions shall have a minimum thickness of 3/16". The top section of the extension shall be shaped to fit into the bottom band recess of the sleeve under the bottom chimney seal band. The bottom section of the extension shall contain an integrally formed expansion band recess and multiple sealing fins matching that of the rubber sleeve.

Splices used to fabricate the sleeve and extension shall be hot vulcanized and be strong enough to withstand a 180° degree bend with no visible separation.

- b. Barrier Seal Systems: Barrier seal systems shall be of an impermeable material such as ASTM D 148 polyethylene with a UV inhibitor for above ground applications that will carry an AASHTO M-306 proof load of 25,000 pounds.*
- 3. Flexible Gaskets: Flexible gaskets shall conform to the requirements of ASTM C923 and the type of pipe used. PSX and ALOK gaskets are approved and ALOK X-CEL gaskets are approved for 8, 10 and 12 inch pipes. For fifteen (15) inch pipe and larger, flexible water-stop gaskets conforming to the requirements of ASTM C923 may be used.*
- 4. Mastic Filler: Mastic filler shall be a butyl rubber material meeting ASTM C 990 and AASHTO M-198 and be compatible with all material that it contacts (i.e. Wrapid Seal, PRO-STIK or an approved equal).*
- 5. Manhole Adjustment Rings: Rings shall be constructed of concrete, HDPE or recycled rubber.*

If HDPE adjustment rings are used, they shall be injection molded-recycled HDPE – as manufactured by LADTECH, Inc. or approved equal. They shall be installed as per manufacture's recommendations.

If recycled rubber adjustment rings are used, they shall consist of no less than 80%, by weight, recycled rubber and no less than 10% by volume shredded fiber as manufactured by GNR Technologies or approved equal. They shall be installed per manufacture's recommendations.

The top and bottom of all adjustment rings shall be sealed using a mastic filler meeting the requirements of 2510.3 or an epoxy paste. The epoxy paste shall be a two component, moisture insensitive, containing no solvents, and capable of bonding with all materials it is to be used on, like Epoxytec Micor C.P.P. or approved equal.

2510.4 Manhole Site Preparation: Manhole site preparation shall be governed by Section 2504.

2510.5 Manhole Excavation:

- A. **Excavation:** Excavation for manholes and special structures shall be governed by this Section and Section 2505. 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.

2510.6 Manhole Installation: Manhole installation shall be governed by this Section and Section 2506. 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.

Base thickness may be reduced to six (6) inches when it is poured on solid rock which meets the approval of the Engineer.

4. *Poured-in-place bases shall extend to the first joint from the manhole when reinforced concrete and vitrified clay pipe is used without flexible joints as specified in Sections 2503.*

- 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 ***at the manufacturer prior to delivery to the job site***. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C478.
3. Wall Thickness: Wall thickness shall conform to the requirements of Section 2510.3.
4. Construction: Precast sections shall be cleaned of all dirt, grass, and other deleterious matter. Seal each joint ***of 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 ***and the area between the pipe and the precast sections, when flexible gaskets are not used, shall be patched with non-shrink grout***.
5. ***Waterproofing: A coal-tar coating, in accordance with paragraph 2510.3 shall be applied to the exterior of all precast manhole sections, flat-top sections and adjustment rings. The coating shall be made after the inspection and approved of the manhole sections and adjustment rings by the Public Works Engineering Division materials and testing laboratory. Backfill shall not be made until the coating has cured.***

E. Cast-In-Place:

1. Wall Thickness: Wall thickness shall conform to the dimensions as shown on the drawings.
2. Construction: Reinforcement steel shall be placed as shown on the drawing. Tie-holes shall be patched with non-shrink grout. Wall sleeves, where required, shall be installed as shown on the 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 drawings.
3. Waterproofing: Interior protective coatings, where required, shall conform to the material specifications. 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 drawings.

G. Pipe Stubs: Stubs shall be installed at the locations, angles, elevations and of the materials shown on the 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 ***and joint with the square cut end of the pipes. The outside wall of the pipe at the springline shall extend to the inside wall of the manhole, but shall not project more than 1 inch beyond the wall.*** The invert channel shall be “U” shaped in cross section and extend upward one-half of the inside pipe diameter ***if the pipe diameter is less than 18 inches. If the pipe diameter is 18 inches or greater, the ‘U’ shaped invert shall extend upward for the full inside pipe diameter.***
- 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 no more than six (6) inches above the surrounding ground nor 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 rings(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”. 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 sealer. Bolt-down castings shall be held in place as shown on the Plans.

M. Joint Sealing Systems:

1. External Joint Sealing Systems:

- a. ***Adjustment rings and manhole joints below the surface of the ground shall be covered with heat shrinkable joint wrap and shall be installed in accordance with AWWA C-206. Manhole surface to be covered shall be free of dirt, sharp points and preheated to remove moisture. Primer shall be applied over the entire area to be covered and let dry (5-15 minutes).***

Wrap shall be cut twelve (12) inches longer than the exterior circumference of the manhole, or as recommended by manufacturer. The wrap shall extend six (6) inches above and below each joint and

the wrap at the cone section and casting shall be a minimum of eighteen (18) inches wide.

Place wrap around the manhole and position the self-adhering closure seal at the overlap. Heat the overlap area and pat down with a gloved hand to ensure bonding. Then continue heating until the entire wrap has recovered. Smooth out the wrinkles and allow the adhesive to set by quenching with water or allowing to air cool prior to backfilling.

- b. Adjustment rings and manhole joints above the surface of the ground shall be covered with an adhesive wrap of elastomeric and/or rubber materials (minimum thickness 0.065 inches) as approved by the engineer. The wrap shall overlap the joint between the bottom of the casting and the upper adjustment ring and be continuous to the joint between the lower ring and manhole. The minimum overlap of a manhole joint shall be six (6) inches. The minimum overlap at each casting shall be one (1) inch. The surface of the adjustment rings and all manhole joints shall be primed in accordance with the manufacturer's recommendations*

2. Internal Joint Sealing Systems:

Adjustment rings may be sealed with a barrier seal similar to I/I Barrier manufactured by Strike Products (31785 64th Ave, Cannon Falls, MN 55009). Installation shall be in accordance with the manufacturer's recommendation, including the omission on sealant between the I/I Barrier and the bottom adjustment ring.

- O. Connections to Manhole: All pipe connections to manholes shall be made with flexible gaskets in compliance with paragraph 2510.3.10. and installed as required by the manufacturer.*

2510.7 Manhole Backfilling: Manhole backfilling shall be governed by Section 2507.

2510.8 Restoration: Restoration shall be governed by Section 2508.

2510.9 Manhole Testing:

- A. **Scope:** This section governs the required testing of manholes and structures not otherwise set forth.
- 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 ten and one-half inches of mercury shall be drawn on the manhole. Shute the valve on the vacuum line to the manhole and disconnect the vacuum line. Open the vacuum line valve and adjust the vacuum to ten 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. The test equipment shall be capable of having two gages connected. The gage supplied with the test equipment shall match the reading of a gage furnished by the Public Works Department. The gage reading is to be verified on each project.*
7. *The time for the vacuum reading to drop from ten inches of mercury to nine inches of mercury must be equal to or greater than the following values for the manhole to be considered as passing the vacuum test:*

<i>Manhole Depth</i>	<i>Time (minutes)</i>
<i>10 feet or less</i>	<i>2</i>
<i>10.1 to 15 feet</i>	<i>2.5</i>
<i>15.1 to 25 feet</i>	<i>3</i>

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 2511 MEASUREMENT AND PAYMENT

2511.1 Measurement: The quantities of completed work will be measured in the following units. *All quantities shall be field measured unless otherwise specified.*

A. Pipe:

1. Open Trenched: Measurement of various size, type of 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 plan.
3. Embedment or Encasement :Concrete embedment or encasement will be measured by the lineal foot of each size and type.
4. Manhole: Measurement will be made for the applicable type, size and depth of manhole as listed in the proposal 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.
5. Seeding: Measurement will be made in accordance with Section 2403.
6. Sodding: Measurement will be made in accordance with Section 2403.
7. Pavement and Curbing: Measurement will be made in accordance with Section 2210.
8. Driveways and Sidewalks: Measurement will be made in accordance with Section 2310.

2511.2 Payment: Payment will be made at the respective unit or lump-sum price listed in the proposal 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 proposal, 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 proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule