

Section 100

Standard Specifications for Sanitary Sewer Construction

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Section 100

Standard Specifications for Sanitary Sewer Construction

1.0 GENERAL

1.1 SCOPE OF WORK

- 1.1.1 The Contractor shall furnish all the necessary labor, materials, equipment, tools, and supplies that are necessary to install a complete sanitary sewer system, as shown on the plans and/or called for in the specifications or its addenda. It is the intent of the specifications to install a complete system or job.

1.2 QUALITY CONTROL AND SUBMITTALS

- 1.2.1 Shop Drawings: The Contractor shall submit the number of copies as required in the general conditions of the contract. The Contractor shall obtain shop drawing approval before any of the work related to that material is performed. Shop drawings and data shall be submitted for all materials to be installed under the contract. The following is a list of examples:
- a. Manholes, castings, pipe, pipe fittings, bedding material, stabilization material, granular material, and any other pertinent information concerning construction materials that the Engineer deems necessary for the review of the materials used on the project in accordance with the specifications and drawings.
 - b. Manhole shop drawings shall be submitted for each manhole and shall indicate the sections to be used with sizes and heights. A drawing showing the profile of the manhole must be submitted and shall be detailed to scale to show all segments of the manhole in a profile view.
- 1.2.2 O&M Manuals: Manuals of operation and maintenance shall be provided when requested by the engineer.
- 1.2.3 Sanitary Sewer Bypass Plan: A comprehensive Sanitary Sewer Bypass Plan shall be submitted to the engineer prior to the preconstruction meeting.
- 1.2.4 Retesting of work required because of nonconformance to the specified requirements shall be performed by the same independent firm on the instructions of the Engineer. Payment for retesting performed during the contract period and during the warranty period will be charged to and will be the responsibility of the Contractor.

1.3 PAYMENT

1.3.1 Payments to the Contractor shall be made in accordance with the General Conditions.

1.4 ACCEPTANCE

1.4.1 Acceptance of the work shall be in accordance with the General Conditions.

1.5 TERM OF WARRANTY

1.5.1 See Section 500 for warranty for construction activity.

1.6 REFERENCES

1.6.1 ASTM A48-83—Gray Iron Castings (Class 35).

1.6.2 ASTM A53—Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.

1.6.3 ASTM C478—Precast Reinforced Concrete Manhole Sections and Steps.

1.6.4 ASTM F679—Standard Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

1.6.5 ASTM C923—Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

1.6.6 ASTM C-990—Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.6.7 ASTM D1248—Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

1.6.8 ASTM D1784—Standard Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

1.6.9 ASTM D1785—Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.

1.6.10 ASTM D2241—Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series).

1.6.11 ANSI/ASTM D2321—Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.

1.6.12 ASTM D2680—Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.

1.6.13 ANSI/ASTM D3034—Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.

- 1.6.14 ASTM D3212—Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seal.
- 1.6.15 ANSI/AWWA C105—Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
- 1.6.16 ANSI/AWWA C111—Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- 1.6.17 ANSI/AWWA C151—Ductile Iron Pipe, Centrifugally Cast, for Wastewater and Other Liquids.
- 1.6.18 ANSI/AWWA C600—Installation of Ductile Iron Water Mains and Their Appurtenances.
- 1.6.19 ANSI/AWWA C905-97—Standard Specification for Polyvinyl Chloride (PVC) Water Transmission Pipe (Nominal Diameters 14–48 inches).
- 1.6.20 AASHTO M-198.
- 1.6.21 Federal Specifications CRD-D-572.
- 1.6.22 Federal Specifications SS-S-210A.
- 1.6.23 Federal Specifications TT-S-001657.
- 1.6.24 South Dakota Department of Transportation Standard Specifications for Roads and Bridges.
- 1.6.25 City of Sioux Falls Standard Plates

2.0 MATERIALS

2.1 SANITARY SEWER GRAVITY PIPE

2.1.1 POLYVINYL CHLORIDE (PVC) SEWER PIPE AND FITTINGS.

- a. PVC pipe 15 inches in diameter or smaller shall meet the requirements of ASTM D 3034, Type PSM, SDR 35 minimum; PVC pipe 18 inches through 36 inches in diameter shall meet the requirements of ASTM F 679, minimum wall thickness T 1. The pipe shall be made of PVC plastic having a cell classification of 12454 B or 12454 C or 12364 C or 13364 B.
- b. Wyes and service line bends installed at a depth of greater than 14 feet shall be SDR 26. All other wyes shall be SDR 35 minimum.

2.1.2 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- a. PVC pipe, 30 inches in diameter and greater, shall meet the requirements of AWWA C905, dimension ratio (DR) 32.5. All pipes shall have the same outside diameter as ductile iron pipe.

2.1.3 DUCTILE IRON PIPE AND FITTINGS (DIP).

- a. Ductile iron pipe shall be acceptable for use on 54-inch diameter pipe and larger and as specified in the Special Provisions. Ductile iron pipe shall be push on joint type and shall be coated on the outside with bituminous coating (minimum 1 mil thickness). The wall thickness shall be determined based on the laying condition and the depth of cover required. Ductile iron pipe shall meet the requirements of ANSI A21.51AWWA C151 standards. All ductile iron pipe shall be furnished with a fusion bonded polyethylene lining in accordance with ANSI/ASTM D1248. The lining shall have a minimum thickness of 60 mils. All ductile iron pipe shall be installed with polyethylene encasement in accordance with AWWA C105 unless otherwise directed by the City Engineer. Ductile iron pipe thickness class shall be as specified on the drawings and/or in the Special Provisions.

2.2 PIPE JOINT MATERIALS

2.2.1 POLYVINYL CHLORIDE (PVC) SEWER PIPE.

- a. PVC Sewer Pipe shall have a flexible elastomeric seal (O ring or rubber sealing elastomeric gasket joint), and conform to the latest revisions of ASTM D3212. Solvent cement joints will not be allowed for pipe and fittings.

2.2.2 POLYVINYL CHLORIDE (PVC) PIPE

- a. PVC AWWA C905 pipe joints shall conform to the same standards as PVC Sewer Pipe.

2.2.3 DUCTILE IRON PIPE.

- a. Ductile Iron Pipe joints shall be Push On Joints conforming to AWWA C11180 Standards. Installation procedures shall conform to AWWA C600 Standards.

2.3 SANITARY SEWER FORCE MAIN PIPE

2.3.1 POLYVINYL CHLORIDE (PVC) PIPE

- a. All pipe for sanitary sewer pressure piping (force mains) shall conform insofar as appropriate to the city's Standard Specifications for Water Main Construction.

2.3.2 DUCTILE IRON PIPE (DIP)

- a. All pipe for sanitary sewer pressure piping (force mains) shall conform insofar as appropriate to the city's Standard Specifications for Water Main Construction.

2.4 MISCELLANEOUS PIPE MATERIALS

2.4.1 PIPE COUPLINGS

- a. Clamp style couplings shall be "Power Seal Model 3541" as manufactured by Power Seal Pipeline Products Corporation, Adjustable Repair Coupling with 300 series stainless steel shear ring as manufactured by Mission Rubber Company, Inc., "Strong Back RC Series Repair Coupling," as manufactured by Fernco, Inc., or approved equal shall be used on all pipe.
- b. All couplings shall bear the manufacturer's identifying mark and size.
- c. Reducing couplings will not be allowed.

2.4.2 TAPPING SADDLES

- a. Tapping saddles shall be the "Insert a Tee" as manufactured by Inserta Fittings Company or approved equal for use on all pipes.

2.4.3 CAPS / PLUGS

- a. PVC caps and plugs shall be the gasketed or solvent welded sewer fitting type. Caps and plugs for clay pipe shall be made using nonshrink grout placed continuously for a 1-foot distance into the pipe.

2.4.4 INSULATION

- a. Type IV Styrofoam Brand—"Square Edge" as manufactured by Dow Chemical Company or approved equal shall be used for insulating sewer pipes where required. The thickness and dimensions shall be specified on the drawings or in the Special Provisions.

- b. Approved equal products from other manufacturer's shall be Extruded Polystyrene Board Insulation formed from polystyrene base resin by an extrusion process using hydro chlorofluorocarbons as blowing agent to comply with ASTM C578, Type IV, with 1.60 lb./cu. ft. minimum density and a compressive strength of 25 lb./sq. in. as specified in ASTM D1622 and ASTM D1621 respectively. The maximum thermal conductivity of the insulation shall conform with ASTM C518, C177, and C578. The maximum water absorption percentage by volume shall be 1 percent in accordance with ASTM D2842. The range of water vapor permeance shall be 0.4 to 1.0 perm in accordance with ASTM E96.

2.4.5 SANITARY SEWER SERVICE WYES

- a. Refer to Section 2.1 for material type. Wyes with the same main line and branch line diameter will not be allowed (example: 4x4, 6x6, 8x8, etc.).

2.4.6 SANITARY SEWER FORCE MAIN TRACER WIRE AND TERMINAL BOXES

- a. Force main tracer wire shall be in accordance with the water main tracer wire specifications in the Standard Specifications for Water Main Construction. The force main tracer wire shall also conform to the Standard Plate for sanitary sewer force main tracer wire. The tracer wire color shall be green. The tracer wire shall be 10 AWG, solid-strand, soft-drawn copper per ASTM B-3. The tracer wire terminal boxes shall be placed at no more than 1,000 feet apart from one another or as specified on the drawings.

2.5 MANHOLE MATERIALS

2.5.1 PRECAST MANHOLES.

- a. Precast concrete manholes shall conform to ASTM Designation C478 with all current revisions. The inside diameter shall be 48 inches unless otherwise stated in the plans or Special Provisions. The wall thickness shall be a minimum of 5 inches with one cage reinforcing with a minimum of 0.12 square inches of reinforcement per lineal foot of wall. The upper section of the manhole shall be a special precast cone made expressly for this purpose providing a 24-inch diameter opening at the top. The cone section shall be concentric and shall not be eccentric (offset). All manholes shall be constructed without steps or ladders.
- b. O-ring gaskets, "Tylox Super Seal" gasket as manufactured by Hamilton Kent, or continuous butyl rubber rope gasket shall be provided for constructing watertight manhole joints. The butyl rubber rope gasket shall conform to or exceed all requirements of Federal Specification SS-S-210A and AASHTO M-198.
- c. Lift holes shall not extend through the manhole walls on 48-inch diameter manholes. Lift holes shall be filled with nonshrink grout. Nonshrink grout shall conform to the following requirements:

- d. Premixed compound consisting of no-metallic aggregate, cement, water reducing, and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days. Approved manufacturers are:
 - 1. "Supreme Grout" – by Hanson Pipe and Products
 - 2. "Crystex" – by L & M Construction Chemicals
 - 3. "588 Non-Metallic, Nonshrink Grout" – by W.R. Meadows
 - 4. "Master Flow 713" – by Master Builders
 - 5. "Songrout" – by Sonneborn
 - 6. "Five Star Grout" – U.S. Grout Corp.
 - 7. or approved equal.
- e. On manholes where the lift holes extend through the wall sections, a lift hole plug as manufactured by Press Seal Corporation or approved equal and nonshrink grout shall be installed at each lift hole.

2.5.2 CAST-IN-PLACE MANHOLES.

- a. Concrete used for poured manhole bases, pipe cradles, or other monolithically poured structures shall conform to the requirements of Class M6 Section 462 of the "Standard Specifications for Roads and Bridges of the South Dakota Department of Transportation." Water stops for the manhole base and wall sections shall conform to the following requirements:
- b. Polyvinyl Chloride: Federal Specifications CRD-D-572 W.R. Meadows Inc.; B.F. Goodrich Company; Progress Unlimited or approved equal.
 - 1. Construction joints—Use flat profile mechanical ribbed ends 7 inches wide, 5/16 inch minimum thickness.
 - 2. Expansion joints—Use split center bulb with mechanical ribbed ends 9 inches wide, ½ inch minimum thickness.
 - 3. Use on all new pours.

2.5.3 REINFORCEMENT.

- a. Reinforcement bars for manholes shall be structural grade, manufactured by the open hearth process from new billets. All bars shall be deformed and Grade 60.

2.5.4 MANHOLE LINERS

- a. General

1. HDPE manhole liners shall be used on all sanitary sewer manholes with 10-inch diameter or greater pipes. PVC T-Lock liner will be allowed on some structures where it is determined by the Engineer to be acceptable. Specifications for the PVC T-Lock liner shall be supplied for each individual project. The manhole liner specifications shall apply to PVC T-Lock liner where applicable when specified.
2. Manhole liners shall be “GSE Studliner” as manufactured by GSE Lining Technologies, Inc., “AGRU Sure-Grip” as manufactured by AGRU America or approved equal.
3. The manhole liner specified in this section shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacturing of the materials and who has in their employ a full-time field service representative with at least five years field experience. The manhole liner shall be designed, constructed, and installed using techniques recommended by the manufacturer.
4. The manufacturer of the lining shall attest to the successful use of its product as a lining for sewer pipes, manholes or pump stations in sewage conditions, or other chemical environments recognized as corrosive or otherwise detrimental to concrete.

b. Materials and Dimensions

1. The material used in the embedment liner and in all welding strips shall be made from 97–98 percent virgin high-density polyethylene and 2–3 percent carbon black or pigmentation for the purpose of an otherwise specified color. Plasticizers shall not be added to the resin formulation. The material color shall be yellow, white, or off-white. Dark colors will not be acceptable.
2. Embedment sheets for field installation shall be produced in rolls that are a minimum of 6.5 feet (2 m) in width with 2.0 mm thickness for precast concrete pipe and manholes.
3. Locking studs of the same material as that of the liner shall be integrally extruded with the sheet and have a minimum height of 0.40 inches (10 mm). The maximum distance between studs shall be 2.127 inches. A minimum of 39 studs per square foot square shall be installed on the liner.

c. Liner Physical Properties

1. All plastic embedment sheets and welding strips shall have the following physical properties when tested in accordance with the following table.

Nominal Properties for Manhole Liner		
Property	Test Method	Value
Thickness (Min)	ASTM D 751	+/- 10%
Density g/cm ³ (Min)	DIN 53479 / ASTM D 792	0.94
Tensile Properties	DIN 53455 / ASTM D 638	
Tensile Strength at Yield, lb/in ² (Min)		2200
Tensile Elongation at Break, % (Min)		600
Tensile Strength at Break, lb/in ² (Min)		3600
Carbon Black Content % (Max)	ASTM D 1603	2-3
Dimensional Stability, %	DIN 53515	+/-2
Linear Coefficient, in/in/°C	ASTM D 696	1.2x10-4
Service Temperature		-70 to 176 °F
Stud Pull Out Strength (Min)		>4,300 psf

2. Embedment sheets and welding strips shall be free of cracks, cleavages, or other defects adversely affecting the protective characteristics of the material. The Engineer may reject any materials which may be defective.
3. Liner shall have demonstrated good chemical resistance via testing in accordance with EPA 9090.
4. Weld strips shall have good impact resistance, be flexible, and have an elongation sufficient to bridge up to 0.5-inch settling cracks, which may occur in the manhole/pipe or in the joint after installation without damage to the strip. The lining shall be repairable at any time after installation in pipe, manholes, or structures by methods approved and recommended by the manufacturer.

d. Supply Of Material

1. Manhole/pipe embedment sheets shall be supplied as pipe size sheets or tubes fabricated by shop welding the basic size sheets together. For tank containment structures, either roll goods or prefabricated panels shall be supplied. Shop welds shall be made by a butt weld and fusing the sheets together by a thermal process such as an extrusion weld, fusion weld, or equal so as to produce continuous welded seams. Specimens taken from shop welded seams shall show no cracks or separations and shall be tested in tension. Each specimen shall withstand minimum shear strength of 60 percent of parent tensile yield strength.
2. During installation of the embedment sheet onto the forms, there shall be no cuts made within the liner for purposes such as strapping of sheet. If straps are utilized they shall be placed so that the straps are positioned between embedment studs. Sheets may be supplied in prefabricated, pipe sized tubular shaped sheets, ready to install onto the inner form, or roll

goods having specified dimensions listed in the Materials and Dimensions section.

3. Joint strips for pipe seaming shall be approximately 4 inches wide with a minimum width of 3.75 inches. Thickness of joint strips shall be 3.0 mm.
 4. HDPE plastic adjusting rings shall be used on all lined manholes where necessary. Concrete adjusting rings will not be allowed unless otherwise specified.
- e. BENCH AND INVERTS.
1. All manhole bench and inverts shall be preformed at the manufacturer. Hand forming of manhole bench and inverts will not be allowed on new manholes, except as approved by the City Engineer. Bench and inverts shall be polyethylene preformed invert as manufactured by Royal Enterprises America or approved equal. Bench and inverts may also be formed by using a bench and invert forming system as manufactured by Press Seal, A-Lok or approved equal.

2.5.5 MANHOLE CASTINGS.

- a. All frame and covers shall be constructed with gray iron having a tensile strength of not less than 35,000 pounds per square inch. The frame and covers shall conform to ASTM A48, Class 35B. The castings shall be heavy-duty type, designed for H20 loading conditions. The castings shall be free from cracks, blowholes, porosity, shrinkage distortion, or other imperfections. They shall be true to pattern and free from warpage. The frame and covers shall fit together in a satisfactory manner. Machined bearing surfaces shall be provided to prevent rocking and rattling. All covers shall be supplied with concealed pick holes as specified in the standard plates. All covers shall be letter marked "SANITARY SEWER."
- b. All covers shall be supplied with self-sealing type "T" gaskets as manufactured by Neenah Foundry Company or approved equal. The covers shall be delivered from the manufacturer with pre-installed glued-in gaskets. The gasket shall be installed in a machined groove and be continuous around the perimeter. The gasket material shall be oil resistant Nitrile (60 DURO) glued in the groove, and have a maximum swell of 90 percent when tested in accordance with ASTM D471 using ASTM No. 3 oil. The glue shall be Lock-rite Black Max as manufactured by 3M Products.
- c. Manhole frame and covers shall be installed in accordance with the standard plates or as specified. Neenah R1772A manhole frame and covers shall be installed at all manholes unless otherwise specified. Neenah R1713 manhole frame and covers shall be installed where manholes are located into concrete pavement thicker than 6 inches. Neenah R1712 bolt down type manhole frame and covers shall be installed in specified areas outside of the street ROW which are in areas without hard surfacing. Neenah R1916C bolt down type manhole frame and covers shall be installed in specified areas outside of the street ROW which are in areas with hard surfacing.

- d. Covers and frames shall be dimensioned as follows:
 - 1. Neenah R1772A as manufactured by Neenah Foundry Company or approved equal. The cover diameter = 22 3/4 inches, cover height = 1 3/4 inches, frame height = 7 inches.
- e. Other frame and covers that are acceptable, but shall only be installed where specified and in specific conditions are:
 - 1. Neenah R1713 as manufactured by Neenah Foundry or approved equal. The cover and frame shall be dimensioned as follows: 22 3/4 inches, cover height = 1 3/4 inches, frame height = 9 inches.
 - 2. Neenah R1712 (with bolt down cover plate) as manufactured by Neenah Foundry or approved equal. The cover and frame shall be dimensioned as follows: 22 3/4 inches, cover height = 1 3/4 inches, frame height = 9 inches. See Standard Plates for bolt-down cover plate dimensions.
 - 3. Neenah R1916C bolt down type as manufactured by Neenah Foundry or approved equal dimensions shown on Standard Plates.

2.5.6 MANHOLE ADJUSTING RINGS

- a. Materials for Plastic Adjusting Rings
 - 1. Sealant: Butyl Rubber Sealant in trowelable form shall be used. EZ-STIK#3 as manufactured by Pre-seal Gasket Corporation or approved equal. The material must meet or exceed the requirements of Federal Specification TT-S-001657, ASTM C-990 and AASHTO M-198.
 - 2. Plastic Adjusting rings: The adjusting rings shall be injection molded HDPE as manufactured by Ladtech, Inc. or approved equal. The adjusting rings shall be manufactured from polyethylene plastic as identified in ASTM D-1248 (Standard Specification for Polyethylene Plastic Molding and Extrusion Materials). Material properties shall be tested and qualified for usage in accordance with the ASTM Test Methods referenced in ASTM D-1248. The plastic adjusting rings shall be manufactured utilizing the injection molding process as defined by SPE (Society of Plastic Engineers). The adjusting rings shall be tested to assure compliance with impact and loading requirements in accordance with the AASHTO Standard Specification for Highway Bridges. The adjusting rings shall meet and exceed the static load requirements of ASSHTO highway Bridge Specification HS-25 (21,280 lbs). The rings must withstand 1,000,000 plus full load cycles of 10 seconds or less duration. The rings must perform without failure to a minimum of 150 percent of these load values. The

adjusting rings shall be sized to conform to the standard 24-inch manhole opening.

- b. Materials for rubber adjusting rings
 - 1. Sealant: Butyl Rubber Sealant in trowelable form shall be used. EZ-STIK#3 as manufactured by Pre-seal Gasket Corporation or approved equal. The material must meet or exceed the requirements of Federal Specification TT-S-001657, ASTM C-990 and AASHTO M-198.
 - 2. Rubber Adjusting Rings: Rubber adjustment rings shall be a minimum of 80% by weight recycled rubber and a minimum of 10% by volume, recycled RFL coated fiber. Rings shall be of uniform quality, free from cracks, holes, and any other surface defects. Adjustment risers shall be designed for heavy duty street traffic, and shall meet or exceed minimum load capacity requirements of the American Association of State Highway Transportation Officials (AASHTO) and the Canadian Highway Bridge Design Code (CHBDC). The supplier shall provide load test results to that effect, upon request by the engineer.
 - i. Approved manufactures include Infra-Riser as manufactured by East Jordan Iron Works, Inc.

2.5.7 MANHOLE BOOTS

- a. Manhole boots for connecting pipes to the manholes shall be a watertight flexible connection meeting the requirements of ASTM C923. The rubber boots shall be supplied with two stainless steel clamps for attaching the boot to the pipe. A stainless steel “power sleeve” shall be supplied for connecting the boot to the manhole. The boots shall be type PSX as manufactured by Press Seal Corporation or approved equal.

2.5.8 MANHOLE EXTERNAL FRAME SEAL

- a. Manhole external frame seals shall be Infi-Sheild as manufactured by Sealing Systems Inc., Wrapid Seal as manufactured by CANUSA-CPS, Cretex or approved equal. Infi-Sheild manhole external frame seals manufactured by Sealing Systems will only be allowed in street pavement areas. The seal (for the Sealing Systems, Inc. product) shall be a continuous band made of high quality EPDM (Ethylene Propylene Diene Monomer) rubber with a minimum thickness of 60 mils. Each unit shall have a 2-inch-wide mastic strip on the top and bottom of the band. The mastic shall be nonhardening butyl rubber sealant with a minimum thickness of 3/16 inch and shall seal to the cone/top of the manhole section and over the flange of the casting.

2.5.9 DROP MANHOLES

- a. The “Reliner Inside Drop System” as manufactured by Duran, Inc. or approved equal shall be used for all drop manhole connections with an incoming pipe size of 12 inches or less. For all incoming pipes that are greater than 12 inches, which require drop manhole sections, a pipe section shall be used to construct the drop manhole section. See the Standard Plates for details.
- b. Clamping brackets: The clamping brackets shall be stainless steel “Reliner” adjustable clamping brackets with stainless steel fasteners as Manufactured by Duran, Inc. or approved equal as shown in the Standard Plates.
- c. Pipe and fittings: PVC
- d. Couplings: Fernco rubber coupling or approved equal for the drop manhole assembly.

2.5.10 MANHOLE MARKERS

- a. Two types of manholes markers shall be used were indicated. Type 1 Manhole markers shall be a minimum of 3 3/4 inches wide and 78 inches in length. The markers shall be green in color. The markers shall be ultraviolet resistant and stable in all weather conditions. The markers shall be Composite Composition Utility Markers as manufactured by Carsonite International or approved equal. The markers shall be labeled “CAUTION SANITARY SEWER PIPELINE / MANHOLE CALL BEFORE DIGGING.”
- b. Type 2 manhole markers shall be in accordance with the SDDOT standard specifications and the standard plates. Type 2 manhole markers shall be used in all interstate and highway ditch right-of-way areas and where specified. Type 1 manhole markers shall be used in all other installations.

2.5.11 MANHOLE CONSTRUCTION PLATE MARKER

- a. Manhole construction plate markers shall be constructed in accordance with the Standard Plates detail. The manhole construction plate marker shall be constructed using “Flex-Guide 300 Series” delineator post and base as manufactured by Davidson Traffic Control Products or approved equal.

2.6 BEDDING MATERIAL

- 2.6.1 Bedding material shall meet the requirements of the city’s Standard Plates. On-site material may be used if approved by the Engineer.

2.7 TRENCH STABILIZATION MATERIAL

- 2.7.1 The trench stabilization for all sanitary sewer trenches where necessary shall be ¾ inch to 4 inches crushed angular, well graded material. Larger material may be used if necessary and required to stabilize the bottom of the trench.

2.8 GEOTEXTILE FABRIC

- 2.8.1 Geotextile fabric shall be as specified in the Special Provisions.

2.9 GRANULAR MATERIAL

- 2.9.1 Granular material shall be “well graded subbase material” in accordance with the SDDOT Standard Specifications for Roads and Bridges. Sand may be used if approved by the Engineer.

2.10 K-CRETE

- 2.10.1 K-Crete shall be a controlled low strength concrete that is highly flowable without segregation.

2.11 CASING PIPE AND BORING MATERIALS

2.11.1 CASING PIPE:

- a. Steel seamless casing pipe, Grade B ASTM A53. With joints butt welded around the entire pipe. Wall thickness shall be designed and specified with each individual project.

2.11.2 CASING SPACERS:

- a. Shall be as specified on the Standard Plates.

2.11.3 END SEALS:

- a. Shall be as specified on the Standard Plates.

2.11.4 CARRIER PIPE:

- a. Shall be as specified in the Standard Specifications, Special Provisions, or drawings.

2.12 SANITARY SEWER SERVICE LINES

2.12.1 GENERAL

- a. Pipe: Refer to Section 2.1 for material type.
- b. Pipe: Schedule 40 PVC, for cleanouts

2.12.2 SANITARY SEWER SERVICE BENDS

- a. Refer to Section 2.1 for material type. Bends greater than 45 degrees will not be allowed.

2.12.3 SANITARY SEWER SERVICE CLEANOUTS

- a. Pipe
- b. Pipe: Schedule 40 PVC.
- c. Protective Cap And Cover
 - 1. Cover: Neenah R1976 or approved equal. The cover shall be labeled "SEWER."
 - 2. See Standard Plates for details

2.12.4 SANITARY SEWER SERVICE PIPE COUPLINGS

- a. The clamp style coupling shall be "Power Seal Model 3541" as manufactured by Power Seal Pipeline Products Corporation, Adjustable Repair Coupling with 300 series stainless steel shear ring as manufactured by Mission Rubber Company, Inc., "Strong Back RC Series Repair Coupling" as manufactured by Fernco, Inc., or approved equal will be allowed for sewer services.
- b. All couplings shall bear the manufacturer's identifying mark and size.

2.12.5 REDUCERS

- a. Where reducers are necessary and approved for connections to existing service lines, reducers shall be eccentric type manufactured of approved pipe material. Coupling connections shall not be made to the reducers and reducing couplings will not be allowed. Reducers will only be allowed for special situations as determined necessary by the City Engineer.

2.12.6 SANITARY SEWER SERVICE PIPE LINING REPAIRS

- a. Two types of sanitary sewer service pipe lining repairs will be allowed for services, Sliplining and CIPP.
 - 1. Sanitary Sewer Service Sliplining
 - i. Pipe: Refer to Section 2.1 for material type and also HDPE pipe will be allowed with a minimum SDR rating of 17. HDPE pipe shall not be coiled type. HDPE pipe shall have joints at 20 or 40 segments. HDPE pipe shall be PE 3608 sanitary sewer pipe.

- ii. Couplings: Refer to Section 2.12.4
- iii. HDPE fusion connection: Butt welded fusion and electrofusion will be allowed for connections of the HDPE pipe.

2. Cured In-Place Sanitary Sewer Service Pipe Lining

i. Materials:

Tube: The liner tube material shall be designed for use in gravity sanitary sewers and shall be in strict conformance with all applicable sections of ASTM F1216, F2019, or a seamless version or F2019. All materials and procedures used in the cured-in-place pipe rehabilitation process shall be equal to or exceed the manufacturer's standards. The tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and length of the original sewer pipe. Allowance should be made for circumferential stretching during the installation process. The tube shall consist of one or more layers of flexible nonwoven felt, compatible with the resin system used and capable of carrying the resin, withstanding installation pressure and conforming to offset joints, bells, 45- and 90-degree bends, and disfigured pipe sections.

Resin: The resin used shall be compatible with the CIPP system used, and designed for use in gravity sanitary sewers. The resin shall be a two-part epoxy resin system producing a final CIPP product resistant to shrinkage, shall not corrode or oxidize, and shall also be resistant to abrasion for solids, grit, and sand in wastewater. The resin shall have proven resistance to municipal wastewater environment.

ii. Design Calculations and Physical Properties:

The Cured in place pipe (CIPP) material shall meet the following requirements:

Chemical Resistance: The pipe shall be resistant to a variety of chemical effluents as described in ASTM D543.

Flexural modulus: Test method D790, 300,000 psi minimum.

Flexural strength: Test method D790, 4,500 psi minimum.

Design pipe thickness: Shall be a minimum of 6 mm for 4- and 6-inch pipe. The CIPP liner thickness shall be calculated and designed based on the below listed conditions of the existing

pipe to be rehabilitated. All design calculations shall be based on ASTM F1216 Appendix X1, and design calculation documentation shall be submitted to the City Engineer for review prior to installation. All design calculations shall be based on the following:

3. All pipes shall be considered fully deteriorated.
4. Ground water to the ground surface.
5. 2 percent ovality / deviation.
6. Soil load of 120 lbs/cubic foot with applicable live load.
7. Safety factor of 2.0.

2.12.7 SANITARY SEWER SERVICE PIPE BEDDING MATERIAL

- a. The bedding material for all sanitary sewer pipes shall be $\frac{1}{4}$ inch to $\frac{3}{4}$ inch clean angular, crushed rock or pea rock with the following gradation requirements:
- b. 95 percent passing $\frac{3}{4}$ inch sieve
- c. 95 percent retained in the No. 4 sieve.
- d. and well graded.

3.0 CONSTRUCTION REQUIREMENTS

3.1 ALIGNMENT AND GRADE

- 3.1.1 The Engineer will furnish all the necessary line and grade stakes, benchmarks, or other necessary control. It is the responsibility of the Contractor to protect these stakes, and any replacement of stakes shall be at the expense of the Contractor. The Contractor shall carry line and grade into the trench by means of an approved laser beam system and by a surveying level instrument. At no time shall the Contractor change the grade without approval of the Engineer. If underground interference is encountered at the assigned grade, the Contractor shall notify the Engineer and wait until the revised grade for the sewer has been determined, if necessary. As a secondary check to the laser beam device, the Contractor shall check the grade from the grade stake to pipe invert a minimum of every 100 feet using a surveying level instrument.

3.2 UNDERGROUND INTERFERENCE

- 3.2.1 The location of underground public or private utilities may be shown on the plans, as reported by the various utility companies and the City, but this does not relieve the Contractor of the responsibility of determining the accuracy or completeness of said locations. The Contractor shall determine the location of all underground ducts, conduits, pipes, cables, or structures which will be affected by the work, and shall take steps necessary to support and protect said structures by any means suitable to the owners of the structure involved and the Engineer. When necessary, the Contractor shall conduct operations as to permit access to the work site and provide time for utility work to be accomplished during the progress of the work.
- 3.2.2 Portions of utilities which are found to interfere with the line and grade of the sewer will be relocated, altered, or reconstructed by the owners, or the Engineer may order changes in the work to avoid interference. Such changes will be considered to be extra work and will be paid for through a change order. When the plans or specifications provide for the Contractor to alter, relocate, or reconstruct a utility, all costs for such work shall be included in the bid for the items of work necessitating such work unless a separate bid item is provided. Temporary or permanent relocation or alteration of utilities requested by the Contractor for the Contractor's convenience shall be the Contractor's responsibility, and the Contractor shall make all arrangements and bear all costs. In those instances where utility relocation or reconstruction is impractical, the Engineer may order a deviation from line and grade.
- 3.2.3 The Contractor shall be responsible for notifying the various utility companies if the Contractor's work will expose, affect, or endanger any existing utility. All cost of investigation and any necessary protection, support, removal, or relocation of said structures shall be included in the contract bid price for installing pipe or manholes. The Contractor shall not begin construction until all utility companies have been contacted and their respective underground utilities have been located and marked.
- 3.2.4 The bid item "locating utilities" will be used to locate sanitary sewer services only if the service location marked exceeds the actual service location by 4 feet in either direction and additional

excavation is required. The bid item “verify utilities” will be used only when it is necessary to excavate down to the utility to determine if any vertical and/or horizontal conflicts exist between existing utilities and the proposed new sewer to be installed as shown on the plans. All costs of other exploratory investigation/excavation necessary for determining the location and depth of utilities shall be included in the contract bid price for installing pipe.

3.3 EXCAVATION AND TRENCHING

3.3.1 GENERAL

- a. Excavation shall be classed as either earth or rock excavation. Rock excavation shall consist of solid rock lying in its natural bed which requires fracturing for its removal and boulders of 1 yard or more in volume. All other material shall be classed as earth excavation.

3.3.2 EARTH EXCAVATION

- a. All sewers shall be built in open cut, except that where conditions warrant, the Engineer may permit the use of short tunnels.
- b. The Contractor may use any means he desires to excavate to the proper depth and width necessary for the construction of the sewer according to the plans and specifications. The width of the trench at the top of the pipe shall be a minimum of 6 to 9 inches on each side of the pipe. Trenches shall be excavated with vertical sides from pipe flowline to a point 1 foot above top of pipe where possible.

3.3.3 SHEETING AND BRACING

- a. If City, state, or federal regulations dictate the necessity of sheeting, bracing, or pulling a trench box or shield, the cost of such sheeting, unless a special price is called for in the contract proposal form, shall be included in the contract bid price for installing pipe.

3.3.4 EXCAVATION BELOW PIPE GRADE

- a. Trench excavation below pipe grade shall be backfilled with bedding material approved by the Engineer and thoroughly tamped to provide a uniform and continuous bearing and support for the pipe.

3.3.5 EXCAVATION IN UNSTABLE OR UNSUITABLE SOIL

- a. The Contractor shall notify the Engineer when material considered unstable for the pipe foundation is encountered and where additional support, stabilization, and undercutting of the pipe trench are necessary. If the Contractor cannot assure a product in accordance with the specifications, the Contractor may request the use of trench stabilization material and/or geotextile fabric where the trench base is not structurally adequate or otherwise unstable to provide a uniform stable pipe

foundation and requires additional undercutting for placement of trench stabilization material and/or geotextile fabric.

- b. The undercutting and use of trench stabilization material and/or geotextile fabric shall only be approved for use in extreme conditions where it is obviously necessary. Approval for the limits of the payment lines for use of trench stabilization material and geotextile fabric must be obtained from the Engineer, prior to installation. If trench stabilization material and/or geotextile fabric is necessary to stabilize the trench foundation, they shall be installed by the Contractor at the unit bid prices for those respective items.
- c. If geotextile fabric is used, it should be placed on the neutral soils and extended up the trench sidewalls to a level of at least the mid-point of the pipe. Placement of the fabric should then be followed by placement of the stabilization material.
- d. The Contractor will be fully responsible for constructing the sanitary sewer on a stable base and any defects resulting from improperly preparing the pipe foundation shall be the Contractor's responsibility.
- e. The Contractor will be required to furnish weigh tickets for trench stabilization material on a daily basis.
- f. Pipe bedding material will always be required in addition to trench stabilization material where trench stabilization material is used.

3.3.6 ROCK EXCAVATION

- a. All rock excavation shall be under one classification. It shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or blasting for its removal and also boulders that exceed 1 cubic yard in volume.
- b. When rock is encountered in the trench, it shall be stripped of earth and the Engineer shall be notified by the Contractor and given ample time to make a profile before removal operation begins.
- c. Procedures for rock removal operations shall be subject to the approval of the Engineer. The use of explosives shall be limited to the magnitude of the charge that will not cause damage to the adjoining property through shock vibrations or other stress loadings. Also, the Contractor shall provide adequate blanket protection to assure that there will not be fragments of rock or other debris flying through the air when discharging explosives. The Contractor shall employ personnel certified to execute blasting operations.
- d. The entire rock removal operations shall be the responsibility of the Contractor, and the Contractor shall pay for any damages caused by the rock removal operations. Adequate insurance protection, in addition to the standard liability insurance required, shall be purchased by the Contractor for payment of any damages that may be caused by the use of explosives.

- e. The Contractor shall notify the City one week prior to rock removal on any project so the City can televise any sanitary sewer lines in the area that might be disturbed. Once all rock removal is complete, the Contractor shall notify the City so the City can re-televise the line.
- f. Explosive permits must be obtained from the Fire Department as per City ordinance.

3.3.7 DEWATERING

- a. Pipe jointing shall be accomplished in a relatively dry trench condition. Joints shall not be connected under water. If ground water is encountered, the Contractor shall dewater the trench with suitable pumps and equipment. Lowering of the groundwater level shall be by means of wells, well points, or other suitable means.
- b. Water resulting from the dewatering operation shall be disposed of in a manner approved by the Engineer and South Dakota Department of Environment and Natural Resources. It shall not be pumped onto private property without the property owner's approval. Any damage to property, either public or private, shall be rectified to the satisfaction of the owner and the City. All applicable permits must be obtained by the Contractor before the dewatering operation begins.
- c. The water discharged from the dewatering operations shall not be allowed to wash through any excavated material. The Contractor shall be responsible for any damages that might result from this operation.

3.3.8 SANITARY SEWER TEMPORARY BYPASS

- a. The Contractor shall be responsible for continuity of sanitary sewer service to each facility connected to the affected section(s) of sewer main and shall also bypass the main sewer flow around the pipe being replaced, or into adjacent sanitary sewers. No sewage will be allowed outside of the sanitary sewer collection system (sewage will not be allowed to be discharged onto the ground). The Contractor shall be responsible for the design, installation, and operation of the temporary bypass system. The temporary bypasses, automated or otherwise, shall be of adequate capacity and size to handle all flows without sewage backup into property. The Contractor shall be solely responsible for cleanup, repair, property damage costs, and claims resulting from failure of the bypass system.
- b. The Contractor shall (as an incidental part of the project) contact all property residents (that are at the property at the time of construction/service interruption) along any sanitary sewer project where the property residents have the potential to discharge sanitary sewer into the construction area due to an open service line in the trench or other means. The Contractor shall inform the residents not to discharge sanitary sewer during the time(s) when the resident's sewer service is not connected to the city's sanitary sewer system. The Contractor shall inform the resident of the estimated time that the service will not be

functional and inform them immediately (by door hanger if not home) when their service can be used.

- c. The contractor shall coordinate with the city to install door hangers on each affected property residents door. The door hanger shall indicate the time of when the property will not be allowed to discharge sewage to the sanitary sewer system and a phone number for answering questions.
- d. The Contractor shall submit a detailed temporary bypass plan in writing to the Engineer for approval before or at the preconstruction meeting. The Contractor shall also provide the Engineer a detailed drawing showing the location of temporary bypasses for each line segment(s) around which flows are being bypassed.
- e. The Contractor shall submit the specifications for all pumping equipment to the Engineer for approval when requested. The submittal shall include the following information:
 - 1. The size (pumps and piping), quantity, capacity, and location of all pumping equipment.
 - 2. The pump manufacturer's pump performance curves.
 - 3. A list of all backup pumping equipment to be held in reserve on the job site shall also be submitted.
- f. The pumps and bypass lines shall be of adequate capacity and size to handle all flows. The Contractor shall demonstrate that the pumping system is in good working order and is sufficiently sized to successfully handle flows by performing a test run prior to beginning the work. The Contractor shall cease temporary bypassing operations and return flows to the new and/or existing sewer when directed by the Engineer. All temporary bypass pumping operations shall be manned continuously during operation.
- g. All pumps used for bypassing shall be fully automatic self-priming units that do not require the use of foot valves in the priming system. All pumps used must be constructed to allow dry running for extended periods of time to accommodate the cyclical discharge of wastewater flows.
- h. Manholes that are used for the pump suction and discharge points shall be adequately protected to prevent storm water from entering the manholes.

3.3.9 INSTALLATION OF PIPE

- a. Sewer pipe shall not be installed in frozen ground or in water, and no water will be allowed to run into or through the pipe.

- b. Pipe shall be carefully installed to line and grade in accordance with line and grade stakes set by the Engineer so that the finished sewer will present a uniform bore. Any noticeable variations from true alignment or grade will be cause for rejection of the work.
- c. All pipe shall be installed upgrade with spigot ends pointing in the direction of flow. The bottom of the trench shall be freed of all rocks and stones and shall be hand shaped and bedded with bedding material as hereafter specified, and the pipe shall be in firm contact with the bedding material for its entire length. At each joint of bell and spigot pipe, a hole shall be dug of sufficient size so that the weight of the pipe will rest on the barrel of the pipe and not on the bells, and the bell hole shall not be compacted. All pipe must be properly fitted together. A suitable stopper shall be kept in the end of the pipe so as to prevent any dirt or water from entering during the progress of the work at all times. Any dirt, loose material, or cement mortar which may accumulate in the pipe shall be removed as the work progresses. The backfilling around and to a depth of 1 foot over the pipe shall be completed and thoroughly hand tamped as the pipe installation progresses as hereafter specified in bedding and backfill requirements. Whenever pipe is installed in rock trenches it shall be bedded to at least a 4-inch depth, and then shall be covered to a depth of at least 1 foot with bedding material or granular material.
- d. Standard length pipe shall be utilized for all installations. Shorter lengths will only be allowed for use at manhole terminations and service line tie-ins to service connections. A full standard length pipe shall be used upstream of all manholes.

3.3.10 SANITARY SEWER SPOT REPAIR

- a. Sanitary sewer spot repair shall be done in accordance with the specifications and details for each individual repair.

3.4 SANITARY SEWER PIPE JOINTS

3.4.1 JOINTS IN PVC SANITARY SEWER PIPE

- a. All PVC Sewer Pipe shall be jointed utilizing elastomeric gaskets as referenced in ASTM D3034 and ASTM F679 and meeting the requirements of ASTM D3212. All pipe, fittings, and joints shall be installed in full compliance with the recommended practices of the pipe manufacturer and as specified in the latest revision of ASTM D2321. The joint surfaces (external and internal) shall be wiped free of all foreign materials, and the spigot end shall be centered on grade into the bell end and the joint shall be properly seated in accordance with the manufacturer's recommendations. Any pipe that is field cut shall have a square end with beveled edge equal to a factory cut and all field repairs shall be performed per manufacturer's recommendations.

3.4.2 JOINTS IN DUCTILE IRON PIPE (DIP)

- a. All Ductile Iron pipe shall be jointed utilizing a push-on type joint in accordance with the requirements of AWWA C111. All pipe, fittings, and joints shall be installed in full compliance with the recommended practices of the pipe manufacturer and the latest revision of the ANSI/AWWA C600 standard.
- b. When making joints, the gasket and gasket seal inside the socket shall be wiped clean before the gasket is inserted. A film or lubricant shall be applied to the gasket and the outside of the spigot end of the pipe. The spigot shall then be positioned inside the socket and pushed home to the manufacturer's specified distance. Lubricant other than that furnished with the pipe shall not be acceptable.

3.5 WYE BRANCHES

- 3.5.1 "Wye" branches for house connections, multiple dwellings, and commercial connections shall be built into the sewers at such points as shown on the drawings, as the Engineer shall designate and be approved by the City Engineer. It will be the Contractor's responsibility to keep accurate records of the location of each wye and stubout measurement and give the information to the Engineer or Inspector at the end of each day for City projects and at the end of each phase for subdivision projects or as requested by the Engineer or Inspector. All wye locations shall be recorded on the grade sheets by the Engineer where necessary, and all grade sheets shall be turned in to the City Engineer for subdivision projects. Stubout locations shall be recorded on a permit drawing for all CIP projects.
- 3.5.2 All measurements shall be: (1) Provided on a plat drawing in new subdivision work areas; (2) legible; (3) measured from the property line for stubouts (ex: 20' SNPL); (4) measured from the downstream manhole for wye locations (ex: y-79'); (5) given to the inspector within 30 days of the installation of the pipe (deflection test will not be accepted by the City until after the wye and stubout measurements have been submitted in proper format). Measurements not properly submitted will be rejected.
- 3.5.3 All wyes which are not to be immediately connected shall be closed with a watertight cap or plug. All wyes and stubouts shall be marked with a marker (see detail in Standard Plates) to help relocate it and prevent breakage when excavating. All stubouts shall be capped and sealed, and the Contractor shall be responsible for the measurement(s) recorded on the permits.

3.6 MANHOLES

3.6.1 GENERAL

- a. All manholes shall be constructed to meet the requirements of the latest revision of ASTM C478, "Precast Reinforced Concrete Manhole Sections," and all related ASTM Specifications. All manholes shall be waterproof.

- b. All manholes are to be built to the dimensions shown in the plans, special information, detail plates, or cut sheets furnished by the Engineer. All manhole sections shall be numbered and/or measured by the Contractor prior to installation to assure that the finished manhole will be to the grade specified on the grade sheet as there may be variations between plan sheet depths and the final depths shown on the grade sheet.
- c. Construction of all cast-in-place manholes shall conform to the South Dakota Department of Transportation “Standard Specifications for Roads and Bridges” and Standard Plates, unless otherwise indicated.

3.6.2 BASE AND SECTIONS

- a. Where precast concrete sections are used, the base section shall be cast with proper cutouts to accommodate the required sewer pipes. Precast sections shall be connected together using a specified gasket material and shall be in place on all manhole joints to assure watertight joints. All lift holes on the interior and exterior of the manhole sections shall be filled with nonshrink grout. Where installation of lift hole plugs is required, they shall be installed into the center of the manhole wall. The area on either side of the lift hole plug shall be filled with nonshrink grout.
- b. All manholes shall be constructed of precast base, barrel, and cone sections. The joints between sections shall be of watertight construction utilizing a specified gasket material.
- c. All manholes that are constructed, unless otherwise specified, shall be built with the base and bottom barrel section being precast together in one integral concrete pour. Such will provide for no joint between the base and barrel section ensuring a watertight seal. This section shall be constructed to meet the Specifications of the latest revision of ASTM C478 and the manhole details in the Standard Plates.
- d. Manholes shall not be constructed at the manufacturer or in the field with piping installed in the manhole boots prior to setting the manhole in the trench. This type of installation will be cause for rejection of the work.

3.6.3 BENCH AND INVERT

- a. All inverts shall be formed to the diameter of the incoming and outgoing pipe diameter up to the pipe centerline and vertical beyond that point. The invert shall be formed to a depth of one-half to two-thirds the pipe diameter. The forming of the bench and invert shall allow for a sewer television camera with skids to be installed in the invert and into any pipe connection into the manhole. Where lateral connections are required into the manhole, a gradual change in the direction of the manhole invert for each lateral shall be formed. Sharp angles without gradual changes in direction will not be allowed. Flat bottomed manholes will not be allowed. Such work will be cause for rejection of the work. The City

Standard Plates for the manhole bench and invert construction illustrates the construction for a typical manhole.

- b. Where hand formed and reconstructed manhole bench and inverts are determined necessary by the Engineer, they shall be constructed with concrete. The manhole invert shall be shaped and finished in a glass smooth-like finish (a steel trowel will give this finish). The bench shall have a broomed finish.

3.6.4 ADJUST MANHOLE

- a. There shall be at least one 2-inch adjusting ring, and a maximum of 14 inches of adjustment used on each manhole. Unless otherwise specified, the manhole cover shall be set approximately 6 inches below the finished street elevation by the sewer contractor to be raised to finished grade elevation by the contractor prior to paving.
- b. Plastic adjusting rings shall be installed as recommended by the manufacturer. No shims or other leveling devices, other than leveling rings provided by the manufacturer, will be permitted with use of the plastic adjusting rings. The annular space between the adjusting rings shall be sealed using an approved butyl rubber sealant. The first plastic adjusting ring on existing manholes may require leveling with concrete mortar, and therefore the first plastic ring may be set in mortar.
- c. Concrete adjusting rings shall not be allowed.

3.6.5 MANHOLE EXTERNAL FRAME SEAL

- a. Manhole external frame seals shall be used on all new concrete surfacing street projects and on existing concrete surfacing street projects where the manholes are adjusted to the corbel section. Manhole external frame seals shall also be required for all manholes located outside of the street ROW area, in unpaved areas, and where specified. The manhole external frame seal shall extend onto the casting and the cone section a minimum of 2 inches. Manhole external frame seals shall be installed in accordance with the manufacturer's recommendations.

3.6.6 FRAME AND COVER

- a. Manhole frame and covers shall be installed in accordance with the Standard Plates or as specified.
- b. Manhole frames that are installed onto plastic adjusting rings shall be installed using the manufacturer's recommended sealant between the frame and adjusting rings to form a watertight seal.
- c. Manhole frames shall be set on a butyl rubber sealant where the manhole is located in an unpaved area.

- d. Bolt-down type manhole frames and covers shall be installed on the corbel section without adjusting rings and bolted to the corbel section as shown in the Standard Plates to form a watertight seal, unless otherwise indicated.
- e. Manhole frames offset by more than 2 inches from the adjusting rings or corbel section will be rejected.
- f. Manhole frames and covers shall be set to the grade specified on the grade sheet and plans.
- g. Manhole frame and covers in permanent gravel surfaced streets shall be vertically installed so that the manhole rim is set 6 to 8 inches below the finished street grade.

3.6.7 MANHOLE BOOTS

- a. The precast base-barrel section shall also contain watertight gaskets, adaptors, or sealers to assure a leak-proof connection between the manhole and the sewer pipes entering the manhole. Such connections shall be flexible and/or pliable enough to allow for deflection from shifting or settling of the manholes and to accommodate the pipe on grade. The connections shall also be capable of adapting to the various sizes and types of sewer pipe that may be used. The manhole boot shall be a PSX gasket, as manufactured by the Press Seal Gasket Corporation, or approved equal. When future connections are specified, a short pipe length with a cap shall be installed and sealed. This section of pipe will need to be removed and replaced when the pipe is extended from the manhole.

3.6.8 DROP MANHOLES

- a. Drop manholes will be permitted only when approved or specified by the Engineer. Where changes in elevation within the manhole are not sufficient for a drop section, the manhole invert shall be filleted so that a smooth channel is formed from the end of the drop pipe throughout the length of the drop. Connections to a drop manhole will require ASTM D2241 Class 200 psi pipe to be laid through the excavation area.
- b. The drop manhole shall be constructed in accordance with the manufacturer recommendations and as shown on the Standard Plates. A V-notch shall be cut into the flow line of the incoming pipe end. The V-notch is to provide improved flow control.

3.6.9 MANHOLE MARKERS

- a. Manhole markers shall be installed for all manholes outside of the street ROW that are not in paved areas unless otherwise indicated. Manhole markers shall be installed as detailed on the Standard Plates.

3.6.10 MANHOLE RECONSTRUCTION

- a. Any manhole that cannot be adjusted within the 14-inch height limit of the bid item for adjusting manholes shall be reconstructed. When an existing manhole is lower than the proposed finished grade elevation, the manhole shall be required to be reconstructed by:
 1. Removal of the cone section and adding the appropriate height of barrel section(s) to increase the manhole height to a level that the manhole can be adjusted using the appropriate height of adjusting rings.
- b. When an existing manhole is higher than the proposed finished grade elevation, the manhole shall be required to be reconstructed by:
 1. Removal of the cone and barrel section(s) and installing the appropriate height of barrel section to decrease the manhole height to a level that the manhole can be adjusted using the appropriate height of adjusting rings.

3.6.11 MANHOLE LINERS

- a. General
 1. The work shall include furnishing all labor, materials, equipment, and incidentals required to install manhole sheet liner with studded backside in concrete manholes, concrete structures, and appurtenances to effectively protect the exposed concrete surfaces from corrosion in those areas shown on the drawings or specified. The liner shall be continuous and free of pinholes at the joints and in the liner itself.
 2. All work for and in connection with the installation of the lining, field seaming, and welding of joints shall be done in strict conformity with all applicable instructions and recommendations of the liner manufacturer unless otherwise specified.
 3. Installation of the lining and the welding of all joints shall be done in strict accordance with the manufacturer's instructions and recommendations and the details and methods indicated on approved shop drawings by an experienced and qualified installer acceptable to the manufacturer and the Engineer. Lining welders shall be trained and certified by the lining manufacturer prior to the start of welding. All pipe joints and other lined areas where welding is performed shall be numbered and initialed by the welder. The Contractor shall record on a daily basis at the end of each working day the identification of the joint areas and the welder who performed the work.
 4. Coverage of the lining shall not be less than the minimum specified or as shown on the Plans. Manholes and concrete structures shall be fully lined

on the interior, including man-way openings, unless otherwise shown or specified.

5. When needed, the lining shall be held snugly in place against inner forms by means of steel banding straps or other means recommended by the manufacturer. Banding straps must be located in the interstitial space between studs to prevent crushing or tilting of the embedment studs.
6. If liner is extended for the purpose of joint overlap, embedment studs shall terminate not more than 1/2 inch from the end of the inside surface of the pipe section. Joint flaps shall extend approximately 4 inches beyond the end of the inside surface.
7. Concrete poured against lining shall be vibrated in a careful manner so as to protect the lining and produce a dense, homogenous concrete, securely anchoring the locking studs into the concrete.
8. Forms shall be properly cleaned and prepared to remove any abrasive areas that may damage the liner when removing forms. In removing forms, care should be taken to protect the lining from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the lining shall be pulled, without tearing the lining, and the resulting holes clearly marked. Form tie holes shall be marked before ties are broken off and all areas of abrasion or damage shall be marked.
9. Hot joint compounds, such as coal tar, shall not be poured or applied to the lining. Solvents or adhesives shall not be used in fusion of material in any manner.
10. The Contractor shall take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the work area and shall immediately repair any damage.
11. All welding shall be performed in accordance with the published directives and procedures of the manufacturer and by welders certified by the manufacturer. Completion of welding shall provide a one-piece monolithic concrete protective liner system that will provide excellent resistance to hydrogen sulfide attack and will not pull off the wall in the event that infiltration occurs.

b. Submittals

1. Submit to the Engineer for review, as provided in the General Conditions, complete shop drawings showing liner materials and typical installation details of all liner work and details of materials of construction and installation. The shop drawings shall include manufacturer's detailed

drawings, directions, and specifications for construction and all special and typical installations.

2. Included with shipment of liner, submit certified test reports that the liner and material were manufactured in accordance with standards specified herein.

c. Joints in Lining for Concrete Structures

1. No lining of joints shall be made until after the trench has been backfilled and the joints pressure tested. Lining at joints shall be free of all mortar and other foreign material and shall be clean and dry before joint are made.
2. Field joints in the lining shall be of the following types used as prescribed:
 - i. Strip Type: The joint shall be made with a separate 4-inch-wide joint strip and two welding strips. The 4-inch joint strip shall be centered over the joint, and then extrusion welded to the liner. The width of the space between adjacent sheets shall not exceed 1 inch. The 4-inch joint strip shall lap over each sheet a minimum of 1.5 inch. It may be used at any transverse or longitudinal joint.
 - ii. Lap Type: The joint shall be made by lapping sheets not less than 1 inch. The upstream sheet shall overlap the one downstream. The lap shall be tack-welded into place, and then welded with an extrusion bead over the adjoined materials.
 - iii. Butt Type: Butt type welds will not be allowed for field welding of joints.
3. All welding is to be in strict conformance with the instruction of the liner manufacturer. Welding shall fuse both sheets together to provide a continuous joint equal in corrosion resistance and permeability to the liner plate.

d. Installation

1. General
 - i. Field seaming involves bonding of adjacent panels using approved thermal methods such as extrusion welding. Testing and verification of the resulting welds will be required.
2. Trial Seams
 - i. General: Prior to any field welding of lined surface, trial seams shall be performed to ensure that the technician and method is adequate.

Trial seams shall be performed on materials from the current project, a minimum of 3 feet in length. Trial weld seams shall then be tested to ensure equipment settings are sufficient to produce quality welds. Testing shall consist of both nondestructive and destructive methods.

- ii. Nondestructive Seam Testing: Nondestructive testing shall consist of spark testing. Spark testing of the finished seams is required; a copper wire may be set into the weld joint prior to welding. This will allow for spark testing for the welded seam for determination of the presence of possible leaks in the weld. This process is not necessary but may provide an alternative method for nondestructive testing of the welds. Spark testing can be performed with approved instrumentation when set at approximately 20,000 to 35,000 volts depending upon apparatus. Any defects found should be marked and repaired according to approved repair methods.

Repairs of pinholes and defective areas shall be performed by extruding a bead of molten plastic over the surface, or if too large, a patch shall be utilized. Once complete, retest using the spark tester when applicable.

- iii. Destructive Seam Testing: When job requirements mandate destructive seam testing of trial seams, an appropriate number of samples should be determined by the Engineer. Weld seams should then be tested for shear strength according to standard industry guidelines. When proper welding techniques are followed, the weld shall exhibit approximately 80 percent of the parent tensile yield strength in shear when tested in accordance to ASTM D 4437.

3. Field Seams

- i. Nondestructive Seam Testing: Nondestructive testing shall consist of spark testing. Spark testing allows for the welded seam to be tested for determination of the presence of possible leaks in the weld. Spark testing may be performed over the entire surface of the weld and liner sheet. Spark testing shall be performed with approved instrumentation set at approximately 20,000 to 35,000 volts depending upon apparatus. Any defects found shall be marked and repaired according to approved repair methods. The spark testing device shall be equipped with an audible alarm indicator for signaling any defects.

Repairs of pinholes and defective areas shall be performed by extruding a bead of molten plastic over the surface, or if too large, a patch shall be utilized. Once complete, retest using the spark tester when applicable.

3.6.12 MANHOLE CONSTRUCTION PLATE MARKER

- a. The manhole construction plate markers shall be used on all projects or where designated. Manhole construction plate markers will be required on development projects where designated by the City. Manhole construction plate markers shall be installed on existing manholes immediately after construction surfacing removals have been completed and on new manholes immediately after installation. The markers, on asphalt streets, shall remain on the manhole until after the first lift of asphalt is installed (with exception to when any internal manhole construction work may need to be performed). The markers on concrete streets shall remain on the manhole until concrete paving occurs. The Contractor shall ensure that all manholes are secured, protected, and watertight at the end of each work day. Under no circumstances shall an uncompleted or completed manhole be left uncovered, unprotected, or not watertight overnight.

3.6.13 MANHOLE BENCH AND INVERT RECONSTRUCT

- a. Manhole bench and invert reconstruct shall be done in accordance with the specifications and details for each individual repair.

3.7 CONNECTIONS TO EXISTING MANHOLES

- a. Wherever new sewers connect with existing sewer manholes or structures, the Contractor shall cut the necessary openings into the existing manholes and make the connections thereto in a neat and workmanlike manner. The connections shall be made so as to make the joints around the entering sewers watertight and an approved smooth channeled flow line shall be constructed. All existing cast in place, precast, and block-type manholes shall be core drilled, and manhole boots shall be installed for the pipe connection.
- b. Where existing manholes are constructed of brick, cobblestone, or other materials determined by the Engineer that cannot be core drilled, pipes shall be grouted into the manhole wall with nonshrink grout and a water seal. The water seal shall be placed continuously around the pipe to form a seal. The water seal shall be a butyl rubber rope type material.
- c. All manhole bench and inverts shall be reconstructed as a part of the connection to the existing manhole. The manhole bench and invert reconstruct shall be paid for under the bid item for Manhole Bench and Invert Reconstruct.

3.8 CONNECTIONS TO EXISTING SANITARY SEWER PIPES

- 3.8.1 Pipe couplings shall be used where it is necessary to connect two spigot ends of the same diameter pipe together and where bell and spigot connections are not possible.

3.9 STUBS AND FUTURES FROM MANHOLES FOR FUTURE EXTENSIONS

- a. Futures from manholes shall be defined as piping and plugs that extend longer than one standard 13-foot section of pipe. Stubs from manholes shall be defined as piping and plugs/caps that extend less than a 5-foot section of pipe. Stubs and futures from a manhole shall be installed to the grade staked and/or specified. Futures shall be plugged with a suitable watertight plug at a bell end section of pipe.
- b. Stubs can be plugged at the bell end section of pipe or capped on a plain end section of pipe. Connecting onto stubs will not be allowed. Stubs must be removed from the existing manhole when connections to the manhole are installed and a full section of pipe must be installed. Stubs shall not extend more than 5 feet and no less than 3 feet in length from the manhole unless otherwise specified.

3.10 SERVICE CONNECTIONS

- 3.10.1 In all new sanitary sewer mains, prefabricated wyes shall be installed at all service stubout locations and sealed with an approved watertight cap or plug. Wyes with the same branch pipe diameter as the main line sewer will not be permitted.
- 3.10.2 Any future taps on the existing main shall be coordinated with the City. Taps on existing pipes shall be made by removing a section of main line and installing a prefabricated wye. Non-shear couplings shall be installed as necessary to reconstruct the main line. Taps or saddles such as inserta-tees will not be allowed.

3.11 BEDDING, BACKFILL, AND COMPACTION

3.11.1 GENERAL

- a. Installation of PVC pipe, including bedding and backfill of the pipe, shall conform to the latest revision of ASTM D2321 "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe," and the specifications and Standard Plates of the City.
- b. All bedding and backfill areas shall be subject to compaction testing by nuclear or standard methods according to the latest applicable ASTM Specifications. In addition to the construction and testing procedures outlined in other sections of the specifications, the Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed 5 percent (see pipe testing section) and the materials surrounding the pipe shall be compacted to the required Standard Proctor Densities outlined in D2321. The areas requiring compaction shall include the bedding, initial backfill, and final backfill areas, as defined in the following sections. The Engineer may take random compaction tests of the material. If any of these tests indicate that the material has not been compacted to the required density, the Contractor shall recompact said material at no additional cost to the Owner, and the Engineer shall then have the right to

take additional compaction tests to assure that this or other material is compacted to the proper density without any additional cost to the Owner.

- c. The contractor shall notify the City's Engineer to coordinate density tests as needed. The city will contract testing with a certified testing agency. Tests that pass will be paid for by the city. Any failing tests will be paid by the contractor. In the case of a failed test, the contractor shall recompact the area to be retested.
- d. Material for all areas of backfilling is to be free of rock, frozen materials, and hard clay. Care shall be taken in placing backfill over the crown of the pipe to avoid damage to the pipe.

3.11.2 BEDDING OF PIPE

- a. The trench base shall be undercut a minimum of 4 inches or one-fourth of the outside diameter of the pipe barrel (whichever is larger) below the grade line of the pipe and uniformly backfilled with bedding material to the grade-line of pipe. After the pipe has been installed on top of the first layer of bedding material, the haunching area shall be backfilled with bedding material up to the "spring-line" (halfway) on the pipe (bedding material shall be used to the top of the pipe for all pipes with a diameter of 12 inches or less). The bedding material shall be "shovel-sliced" or hand tamped around and under the haunches of the pipe to assure adequate and uniform support along the bottom of the pipe. Care shall be taken to prevent dislodging and misalignment of the pipe and to provide adequate bell hole for the pipe.
- b. All sewer service lines shall be installed with bedding material from 2 inches below the pipe to the top of the pipe.
- c. When the foundation material is not suitable to provide a uniform base for the pipe, the trench shall be undercut to sufficient depth to build an acceptable base. Such areas shall be backfilled with trench stabilization and/or geotextile fabric material to build a uniform foundation. The trench stabilization material shall be brought up to the bottom of the bedding material specified for the pipe and the bedding material shall be used up to the spring line (bedding material shall be used to the top of the pipe for all pipes with a diameter of 12 inches or less).

3.11.3 INITIAL BACKFILLING OF PIPE TRENCH

- a. All sewer pipe installed in an open trench shall be initial backfilled to at least 12 inches above the top of the pipe. The initial backfill shall be placed evenly so as not to disturb the grade or line of the pipe. Above the bedding area the pipe shall be backfilled with acceptable native material (Class I, II, and III as described in ASTM D2321), approved by the Engineer, or with granular material to a minimum of 90 percent Standard Proctor Density to 12 inches above the top of the pipe.
- b. Where no suitable backfill material is available, the initial backfilling shall be constructed with granular material.

3.11.4 FINAL BACKFILLING OF TRENCH TO GRADE

- a. All final backfill material shall consist of approved excavation material, granular material, or as otherwise specified. Sand may be used if approved by the Engineer. The final backfill shall be placed in layers and compacted by suitable and approved compaction methods in a manner approved by the Engineer to at least 95 percent Standard Proctor Density, or as otherwise specified.
- b. Excess material not required for final backfilling shall be removed by the Contractor or otherwise disposed of as ordered by the Engineer.
- c. If the material encountered in the trench excavations is unsuitable to be used as final backfill material, it shall be replaced with other suitable material available at the project site or with granular material, as approved by the Engineer. In final backfill areas below pavement, the Engineer may direct the Contractor to use native material a specified distance below the pavement elevation to ensure a consistent material is utilized under the pavement section.
- d. At least 36 inches of cover shall be placed over the top of the pipe before the trench is wheel-loaded, and 48 inches of cover shall be placed over the top of the pipe before the trench is hydro-hammered for compaction.

3.12 SURFACE RESTORATION

3.12.1 GENERAL

- a. Unless stated specifically to the contrary in the Special Provisions, the Contractor shall replace all surface material and shall restore paving, curbing, sidewalks, gutters fences, trees, sod, topsoil, and other items disturbed to a condition equal to that before the work began, furnishing all labor, materials, and equipment necessary to do this work. Traveled streets shall be kept open and maintained by the Contractor after backfilling and before surfacing or final inspection. The cost of all such work shall be absorbed in the unit price bid for pipe installation unless otherwise specified in the Special Provisions or Bid Proposal.

3.12.2 USE AND REPAIR OF STREET

- a. The Contractor shall carry on the work in such a manner as to interfere as little as possible with the use of the street for public travel and as specified in the Special Provisions.
- b. Wherever any paved gutters, pavements, graveled highways or street crossings, or other improvements are interfered with or removed, they must be replaced by the Contractor and left in as good condition as previously. The Contractor shall also remove all surplus material leaving the streets clean and in good order.

- c. No more than 300 feet of trench will be opened at any one time in advance of the complete construction of the sewers and the backfilling shall follow up the installation of the sewers.
- d. All street repairs and cleaning shall be promptly done as the work progresses. The Contractor shall not obstruct any street gutters, but shall provide for the passage of surface water along the same at all times.
- e. It shall be the Contractor's responsibility to protect all sanitary sewer pipes, manholes, and trenches from extraneous water and storm water entering the sanitary sewer system at all times during construction.

3.12.3 CONCRETE PAVEMENT REMOVAL AND REPLACEMENT

- a. The surface of all concrete pavements shall be sawed with a concrete saw to the full pavement depth. The width of pavement removed shall be 12 inches wider than the trench excavation to provide a shoulder on all sides. Where within 2 feet of existing joint, concrete shall be removed to the joint.
- b. The Contractor shall place a 6-inch gravel cushion unless otherwise specified and replace the concrete pavement to the same thickness as the original pavement, with a minimum thickness of 6 inches. The concrete shall be Class M6 as specified by SDDOT and shall be finished the same as the existing pavement.
- c. The cost of pavement removal, replacement, and sawing of the concrete shall be included in the unit price bid for pipe unless otherwise provided for in the Bid Proposal or specified in the Special Provisions.
- d. All concrete pavement shall be removed and replaced in accordance with the Standard Specifications and Standard Plates.

3.12.4 ASPHALT PAVEMENT REMOVAL AND REPLACEMENT

- a. Where streets are asphalt surfaced, the Contractor shall cut the asphalt surfacing to a minimum depth of 4 inches by an approved method to a width of 12 inches wider than the trench excavation.
- b. When asphalt surfacing has a concrete base, the asphalt shall be cut in the previously described manner and the concrete base removed with a pneumatic or mechanical type hammer or by similar means.
- c. Unless otherwise specified, the Contractor shall place a 6-inch gravel cushion under the concrete base; replace the concrete base with a minimum of 6 inches of Class M6 concrete; and then place a minimum of 2 inches of asphalt surfacing meeting SDDOT Standard Specifications for Roads and Bridges on top of the concrete base, or as otherwise specified in the Special Provisions.

- d. On all excavations in asphalt surfaces without concrete base, there shall be a minimum of 6 inches aggregate base course and a minimum of 4 inch asphalt mat or the thickness of the existing mat whichever is the greater.
- e. All asphalt surfacing shall be replaced and rolled in accordance with the SDDOT Standard Specifications for Roads and Bridges.
- f. All street surfacing cuts, asphalt or concrete, shall be in a straight line parallel to the existing curb and gutter or perpendicular to the centerline of the street. No jagged, skewed, or irregular cuts will be allowed. All asphalt cuts shall be in an approved manner and not ripped out with the bucket. Such work lifts the remaining mat away from the base material and shall be cause for widening the street cut and increasing the amount of surfacing replaced at the Contractor's expense.

3.13 REMOVAL AND ABANDONING SEWER PIPE AND MANHOLES

3.13.1 REMOVAL OF PIPE AND MANHOLES

- a. This work shall consist of removal and disposal of pipe and manholes which are not designated or permitted to remain and which are not removed and disposed of under other items in the contract. Removals shall be in accordance with the Standard Specifications. Manholes that are to be removed shall be entirely removed and disposed of unless otherwise indicated.

3.13.2 ABANDONING OF PIPE AND MANHOLES

- a. Abandon sanitary sewer pipe that is to remain in-place shall be entirely filled with K-crete unless otherwise indicated. Manholes that are to be abandon in-place shall be abandoned by removing the top 3 feet below finish grade elevation, seal off any incoming piping with K-crete, install a 2-inch minimum diameter hole in the base section of the manhole, and fill the manhole with sand.

3.14 PIPE INSULATION

- 3.14.1 Pipe insulation shall be required on all sanitary sewer pipe installations where the cover depth to finished grade elevation is 5 feet or less above the pipe. The insulation work shall be in accordance with the Special Provisions, drawings, and manufacturer's recommendations.

3.15 JACKING, BORING, AND TUNNELING

- 3.15.1 It shall be the responsibility of the Contractor to maintain the alignment and grade specified. The jacking, boring, and tunneling specifications shall be in accordance with the standard plates, drawings, and Special Provisions. Grouting of the annular space in the pipe shall not be allowed.

3.16 SANITARY SEWER SERVICES

3.16.1 GENERAL

- a. Glued connections will only be allowed at the connection between the SDR 35 and the Schedule 40 PVC pipe at the building. 45-degree bends shall not be located closer than 3 feet from each other.

3.16.2 CLEANOUTS

- a. Cleanouts shall be used only on service lines in approved locations. Cleanouts used for service lines shall be covered at finished grade with a Neenah R1976 frame and cover except for cleanouts located adjacent (within 5 feet) to the structure it services. The cleanout shall be constructed as shown on the Standard Plates.
- b. Cleanouts must be located within 5 feet of all commercial buildings. At least one cleanout shall be provided for all commercial buildings. The size of the cleanout piping shall be in accordance with the South Dakota Utility Contractor Handbook.

3.16.3 COUPLINGS

- a. Couplings on new construction will not be allowed unless the building sewer stubout exists before the service from the property line to the building is installed. If couplings are determined to be necessary, only one coupling for each service line will be allowed on new construction.

3.16.4 COMMON TRENCH FOR SERVICE LINES

- a. All sewer service lines within public street right of way shall be installed at least 10 feet horizontally from any existing or proposed water service line. Any variation to this requirement is subject to the approval of the City Engineer. On private property, a sewer service line may be laid in the same trench with a water service line. In such a case, the elevation of the crown of the sewer service line shall be at least 18 inches below the invert of the water service line. The water service will be allowed to be benched or additional pipe bedding material may be used to create the separation between water and sanitary sewer services. The sewer service line and water service line shall not have less than 1-foot horizontal distance between the piping.
- b. Whenever sewer service lines must cross under water service lines, the sewer service line shall be laid at such an elevation that the crown of the sewer service line is at least 18 inches below the invert of the water service line.

3.16.5 RECONNECT SEWER SERVICE

- a. Connections to existing sewer services shall be completed by installing a non-shear coupling at the point of connection.

3.16.6 CAPS AND PLUGS

- a. Existing clay service lines that are to be abandoned shall be capped with nonshrink grout placed continuously for a 1-foot distance into the pipe.
- b. New PVC service lines that are to be plugged shall be plugged at a bell end section of pipe.

3.16.7 SANITARY SEWER SERVICE PIPE LINING REPAIRS.

a. General

1. Bypass Pumping: The Contractor shall furnish, install, and operate pumps, plugs, conduits, and other equipment to divert the flow of sewage around the lined pipe line for which work is to be performed. The bypass system shall be of sufficient capacity to handle existing flow plus additional flow that may occur during a wet weather event. If pumping is required on a 24-hour basis, engines shall be equipped in a manner to keep noise to a minimum and within the city's noise ordinance.
2. Cleaning: The Contractor shall thoroughly clean the sewer pipe that is to be relined prior to installation of the repair liner pipe. The cleaning shall constitute removal of all debris, solids, roots, and other deposits in the sewer line that could prevent installation of the liner pipe. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, the Contractor shall make a point repair excavation to remove the repair or obstruction.
3. Pre-inspection and Measuring of Service Connections, bends, etc.: The Contractor shall inspect the sewer pipe immediately before the installation of the liner to assure that the pipe is clean and existing pipe conditions are acceptable for the liner installation. The Contractor shall also create a log as well as video tape documentation with exact measurements of each service connection in the sewer pipe, in order to reopen the service connections after the installation by means of a robotic cutter for CIPP lining or excavation and a wye connection for sliplining repair projects. The service connection log shall at a minimum state the exact distance from a designated point to the middle of each service connection and where the connection is located along the service line (i.e., 9 o'clock, etc.).
4. Post inspection: The Contractor shall coordinate with the city to videotape the service line repairs for CIP projects. A copy of the report shall be submitted to the property owner and the City Engineer for review. All measurements for the repairs shall be provided to the Inspector at the time of inspection.

b. Sanitary Sewer Service Sliplining

1. Sliplining of sanitary sewer service lines shall be performed by pulling or pushing liner pipe into existing sewers by use of mechanical or hydraulic equipment. Once in place, the liner pipe shall be connected at one or more ends with a coupling to the existing pipe. Annular spaces between the liner pipe and existing pipe shall be sealed at the ends with a chemical seal or nonshrink grout. The liner pipe shall not obstruct the City main line sanitary sewer. Pipes protruding into the City main line sewer will be required to be cut off flush or back from the main line sewer.

c. Cured In-Place Sanitary Sewer Service Pipe Lining

1. The following documents (latest additions) shall be a part of this specification.
 - i. ASTM F1216. Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
 - ii. ASTM F2019. Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pull-in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).
 - iii. ASTM F1743. Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pull in and inflate and Curing of a Resin-Impregnated Tube.
 - iv. ASTM D638. Standard Test Method for Tensile Properties of Plastics.
 - v. ASTM D790. Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - vi. ASTM D792. Standard Test Methods for Density and Specific Gravity of Plastics by displacement.
 - vii. ASTM D5813. Standard Specification for Cured-in Place Thermosetting Resin Sewer Pipe.
 - viii. NASSCO. Specification Guidelines.
 - ix. The installation of the CIPP shall be in accordance with the manufacturer's recommendations and ASTM F1216, ASTM F2019, or ASTM F1743. The resin shall be distributed into the tube in strict conformance with the ASTM and NASSCO standards. After installation of the liner is completed, the Contractor shall cure, cool

down, and finish the liner in accordance with the ASTM standards. When required, the Contractor shall reinstate all connections to their original diameter. The CIPP shall provide a smooth bore interior throughout the length and a uniform wall thickness. The CIPP shall be wrinkle-free. The CIPP shall not obstruct the City main line sanitary sewer.

3.17 INSPECTION AND TESTING

3.17.1 GENERAL

- a. The Engineer shall have access at all times to all parts of the job, and the Contractor must furnish such personnel, facilities, equipment, tools, and materials as are necessary to make whatever tests and inspection that are deemed necessary.

3.17.2 VISUAL INSPECTIONS BY OWNER

- a. The Owner shall inspect all mainline and service fittings once constructed in place and prior to backfilling operations. Fittings shall remain exposed for the engineer to visually inspect and record data for as-built plans. The Contractor shall notify the engineer at least 48 hours in advance of being ready for an inspection.

3.17.3 PIPE MATERIAL TESTING

- a. The Engineer may require a test of specimens not to exceed 5 percent of the quantity of pipe to be furnished in order to prove the acceptability of the pipe. The manufacturer shall provide an approved testing stand near the site of the plant.

3.17.4 PIPE INSPECTION

- a. Prior to being lowered into the trench, each pipe shall be carefully inspected by the Contractor and those not meeting the specified requirements shall be removed from the site immediately. Rejections may be made for any of the reasons as stated in the specifications for each specific type of pipe. Pipe having minor flaws not serious enough to cause rejection shall be installed so as to bring such flaws in the top half of the sewer. Pipe shall be protected during handling against impact, shocks, and free fall.

3.17.5 TELEVISION INSPECTION

- a. The City will perform an inspection of the completed sewer line within the two-year warranty period through the use of a television camera. The expense of the initial television will be borne entirely by the City. If defective workmanship of material or construction is noted, the deficiency shall be corrected by the Contractor at no expense to the City. The City will perform additional television inspections to review if the repairs were made properly and in accordance with

the specifications. The expense of any additional television inspections beyond the initial inspection will be borne entirely by the Contractor.

- b. The Contractor shall be responsible for all related costs, including concrete or asphalt resurfacing, if the street has been surfaced. The Contractor shall be required to repair all areas of infiltration and other deficiencies.

3.17.6 CLEANING

- a. The Contractor shall be responsible for all work necessary to make the sewer acceptable for usage including removal of all mud, silt, rocks, or blockages that might hinder the flow and make said sewer unacceptable for final acceptance and usage. Also included is all work necessary in the manholes and all cleanup work required prior to final acceptance.
- b. The City will not be responsible for cleaning lines prior to televising the sewer. In the event that the line is not acceptable for televising, due to the Contractor's operations, the Contractor will be notified. It will be the Contractor's responsibility to make arrangements to clean the sewer and make it acceptable for the television work.

3.17.7 BACKFILL DENSITY TEST

- a. The Contractor shall expose the compacted soil layers, as required by the Engineer, to enable the Engineer to perform density tests. The cost of exposing the soil layers for testing shall be incidental to the pipe and/or manhole installation.
- b. A minimum of one density test and moisture content shall be made for every 500 lineal feet of trench per four (4) feet of depth. A minimum of one (1) standard density and optimum moisture determination shall be made for the project and one (1) additional test for each change in backfill.

3.17.8 PIPE AND MANHOLE LEAKAGE FIELD TESTING—GENERAL

- a. All manholes and piping shall be tested and inspected for leakage by the Contractor. Exfiltration testing with water will only be allowed where specifically specified.
- b. Piping shall be tested using one of two methods: infiltration test or pipe exfiltration test (low pressure air test). The pipe infiltration test shall be used when the ground water table elevation is greater than 2 feet above the top of the pipe as determined by the Engineer. The pipe exfiltration test (water test or low pressure air test) shall be used when the ground water table elevation is less than 2 feet above the top of the pipe as determined by the Engineer. Exfiltration testing of the pipe with water will only be allowed where specifically specified.
- c. After each section of sanitary sewer between manholes has been completely installed and backfilled, the line and manholes shall be inspected by the

Contractor for leakage. All visual leakage at individual joints or other parts of the sewer and/or leakage in excess of that specified shall be repaired by the Contractor at the Contractor's expense before the sewer is accepted. The repair of leaks may require the removal and replacement of manhole sections and pipe sections. The gasket shall be the sole element depended upon to make the joint leak proof. The use of grout to repair leaks will not be allowed. The actual method of correction shall be approved by the Engineer prior to performing the repair.

- d. When existing sanitary sewers which have service connections are being reconstructed or replaced (example: street reconstruction projects), the leakage test requirements may be waived or other testing methods substituted, subject to the approval of the City Engineer.
- e. The Contractor shall notify the Engineer 48 hours prior to performing the test to enable the Engineer to be present during the testing operations. All data will be recorded and evaluated by the Engineer. All lined manholes and pipe shall be tested prior to welding the joints.

3.17.9 INFILTRATION TEST

- a. This test shall be performed by the Contractor using a V-notched weir in the downstream manhole of a line segment to measure the upstream sewer leakage. The test shall be maintained for not less than 24 hours before the measurement is performed. The test shall be performed one line segment at a time (a line segment shall be defined as the line from one manhole to the next adjacent manhole). The V-notched weir shall have volumetric calibrations (gallons/24 hours) and shall be easy to read.
- b. The Engineer may waive the use of the V-notched weir if the Engineer determines that the leakage flow is obvious or nonexistent through visual inspection. The maximum allowable infiltration or exfiltration for any new sanitary sewer section, including all manholes, shall be 50 gallons per inch of diameter per mile of pipe per day. All visible leakage at individual locations (including the amounts less than the 50 gallons per inch of diameter per mile of pipe per day) as determined by the Engineer shall still be the Contractors responsibility to repair. Payment for the infiltration test will be incidental to the pipe and manhole installation.

3.17.10 PIPE EXFILTRATION (WATER) TEST

- a. The low pressure air test shall be used for the exfiltration test unless otherwise specified. The pipe exfiltration (water) test shall only be allowed where specified.
- b. The pipe exfiltration (water) test shall be performed by sectionalizing the test so that interior pressure in pipe does not exceed 5 feet of water pressure. The test will be performed by the Contractor as follows:
 - 1. Place watertight bulkhead in inlet of the upstream and downstream manholes of sewer to be tested.

2. Fill section of sewer and upstream manhole with water until the elevation of water in the upstream manhole is 2 feet higher than the top of the pipe in the line being tested or 2 feet above the existing ground water in the trench—whichever is the higher.
3. Allow the water to stabilize for one-half hour, then fill the manhole with water to the original level and begin the test.
4. The amount of water lost in the manhole during one hour will be measured and used to determine the exfiltration. The maximum allowable drop in vertical water height in the manhole shall be 1/4 inch for all diameter manholes. If the water level in the manhole drops below the allowable drop amount, the Contractor shall repair the leak and retest.

3.17.11 PIPE EXFILTRATION (LOW PRESSURE AIR) TEST

- a. The pipe exfiltration (low pressure air) test shall be performed in accordance with ASTM F1417 standards. The following procedure is summarized from ASTM F1417 and shall be followed in conjunction with ASTM F1417 unless modified by the Engineer. Repair of leaks may require the removal and replacement of manhole sections. The use of grout to repair leaks will not be allowed.
- b. Procedure
 1. Clean the section of sewer line to be tested by flushing or other means prior to conducting the low-pressure air test. This cleaning serves to eliminate debris and produce the most consistent results.
 2. Isolate the section of sewer line to be tested by inflatable stoppers or other suitable test plugs.
 3. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. All plugs and caps shall be securely braced to prevent blow-out. One of the plugs or caps should have an inlet tap, or other provision for connecting a hose to a portable air control source.
 4. Connect the air hose to the inlet tap and portable air control source. The air equipment shall consist of necessary valves and pressure gauges to control an oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section.
 5. Add air slowly to the test section until the pressure inside the pipe reaches 4.0 psig.
 6. After the pressure of 4.0 psig is obtained, regulate the air supply so that the pressure is maintained between 3.5 to 4.0 psig for at least 2 minutes depending on air/ground temperature conditions. The air temperature

should stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until equilibrium is obtained; however, a minimum of 3.5 psig is required.

7. Determine the rate of air loss by the time-pressure drop method.
8. Time-Pressure Drop Method—Air is slowly introduced into the section of pipe to be tested, until the air pressure is raised to approximately 4.0 psi and the test pipe section is stabilized as in 8.1. Disconnect the air supply and decrease the pressure to 3.5 psi before starting the test. Determine the time required for the pressure to drop from 3.5 psi to 2.5 psi, and compare this interval to the required time to decide if the rate of air loss is within the allowable. Minimum holding times required by pipe diameter are shown in Table 3.17.10 and are also listed in ASTM 1417.
9. Upon completion of the test, open the bleeder valve and allow all air to escape. Plugs should not be removed until all air pressure in the test section has been reduced to atmospheric pressure.
 - i. Table No. 3.17.10 below indicates the minimum test period durations, length of test section for minimum test durations, and the formula to calculate the testing time when the test section length exceeds the length for minimum test time (in accordance with ASTM F1417). Repair of leaks may require the removal and replacement of pipe sections. The use of grout to repair leaks will not be allowed.
 - ii. The Engineer may reduce the testing time to one-half the testing time if the pressure drop is less than 0.5 psi for the first one-half the test period listed in Table 3.17.10.

Table No. 3.17.10

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

3.17.12 MANHOLE EXFILTRATION TEST

- a. The manhole vacuum test shall be used for testing manholes for leakage defects. The manhole water exfiltration test shall only be allowed where specified.
- b. To perform this test, the inlet and outlet of the manhole shall be plugged and the manhole filled with water to a depth equal to that used for the sanitary line water test, or in the case when the air test was run on the line, a minimum depth of 2 feet above the top of the sewer line or 2 feet above the existing ground water— whichever is the higher. Allow the water to stabilize for one-half hour and refill the manhole to the original elevation. Mark the initial depth of the water and after one hour, record the drop in the water level in the manhole. The maximum allowable drop in vertical water height in the manhole shall be 1/4 inch for all diameter sizes of manholes. If the water level in the manhole drops below the allowable drop amount, the Contractor shall repair the leak and retest.

3.17.13 MANHOLE VACUUM TEST

- a. The manhole vacuum test shall be performed in accordance with ASTM C1244. The following procedure is summarized from ASTM C1244 and shall be followed in conjunction with ASTM C1244 unless modified by the Engineer. The vacuum test shall include testing the top of the manhole, excluding the adjusting rings and manhole frame and cover. Testing will be allowed after backfilling has occurred or as specified in the Special Provisions. Manhole vacuum tester assembly and vacuum pumps shall be as manufactured by Cherne Industries, Inc. or approved equal. Repair of leaks may require the removal and replacement of manhole sections. The use of grout to repair leaks will not be allowed.

b. Procedure

1. All lift holes shall be plugged.
2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
3. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
4. A vacuum of 10 in. of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. of mercury.
5. The manhole shall pass if the time for the vacuum reading to drop from 10 in. of mercury to 9 in. of mercury meets or exceeds the values indicated in Table 3.17.12.
6. If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.

Table 3.17.12

Minimum Test Times for Various Manhole Diameters in Seconds

Depth (ft)	Diameter of Manhole		
	48 Inch	60 Inch	72 Inch
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

3.17.14 PIPE DEFLECTION TEST

- a. Deflection tests shall be performed by the Contractor on all PVC sewers. Deflection tests shall be conducted after the final backfill has been in place at least 30 days. Deflection tests shall be conducted no more than 45 days after the final backfill

has been in place. Deflection tests shall be made using a deflection gauge (mandrel) device or other approved method. The diameter of the deflection gauge device shall be 95 percent of the undeflected inside diameter of the flexible pipe. The Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed 5 percent. All pipes exceeding the 5 percent deflection within the two-year warranty period shall be re-laid or replaced by the Contractor at no additional cost to the Owner.

4.0 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.1 REMOVAL OF SEWER PIPE

- 4.1.1 The removal of sewer pipe shall be measured as lineal foot of pipe removed. The removal footage shall be rounded up to the nearest 1-foot increment.
- 4.1.2 The removal of a sewer pipe shall be paid for at the contract unit price for each foot of sewer removed. Payment for removal of sewer pipe shall be full compensation for excavation, removal and disposal of the pipe, and all appurtenances necessary for the proper removal of the pipe.

4.2 REMOVAL OF SEWER MANHOLE

- 4.2.1 The removal of sewer manhole shall be measured as a unit for each manhole removed.
- 4.2.2 The removal of a sewer manhole shall be paid for at the contract unit price for each sewer manhole removed. Payment for removal of sewer manhole shall be full compensation for removal and disposal of the manhole, frame and covers, boots, and all appurtenances necessary for the proper removal of the manhole.

4.3 ABANDONING OF SEWER PIPE

- 4.3.1 The abandoning of sewer pipe shall be measured as cubic yards of K-Crete fill in the pipe. K-Crete shall be measured to the nearest 0.1 cubic yard.
- 4.3.2 The abandoning of sewer pipe shall be paid for at the contract unit price per cubic yard for K-Crete. Payment for K-Crete shall be full compensation for abandoning the pipe, filling the pipe with K-Crete, excavation for allowing insertion holes for filling the K-Crete into the pipe, backfilling to finished grade elevation, and all appurtenances necessary for properly abandoning the sewer pipe.

4.4 ROCK EXCAVATION

- 4.4.1 The removal of rock shall be measured as cubic yards of rock removed. The cubic yards removed shall be rounded to the nearest 0.1 increment. All rock excavation shall be under one classification. The classification shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or blasting for its removal and also boulders that exceed 1 cubic yard in volume.

4.4.2 Pay lines for computing rock excavation shall be described as follows for trench widths:

Pipe Size	Trench Width Pay Limits
Pipe equal to or less than 24 inches in diameter	4 feet
Pipe greater than 24 inches in diameter	The outside pipe diameter plus 24 inches

4.4.3 Pay lines for computing depth of the rock excavation shall be described as the distance from top of rock to 12 inches below the pipe invert elevation. The top of the rock profile will be measured and determined by the Engineer and used to determine the rock quantities.

4.4.4 The accepted quantities of rock excavation shall be paid for at the contract unit price per cubic yard. Payment for rock excavation shall be full compensation for permits, excavation, blasting, removal and proper disposal of the rock offsite, and all appurtenances necessary for the proper removal of the rock. Furnishing and installing suitable fill material to replace the rock removed (except in locations where bedding material is required) will be paid for with the Granular Material bid item.

4.5 GRANULAR MATERIAL

4.5.1 The furnishing and installing of granular material shall be measured as tons of granular material to the nearest 0.1 ton.

4.5.2 The accepted quantities of furnished and installed granular material will be paid for at the contract unit price per ton. Payment for granular material will be full compensation for furnishing and installing of granular material and all appurtenances necessary for the proper installation of it.

4.6 TRENCH STABILIZATION MATERIAL

4.6.1 The furnishing and installing of trench stabilization material shall be measured as cubic yards of trench stabilization material to the nearest 0.1 cubic yard.

4.6.2 The accepted quantities of furnished and installed trench stabilization material will be paid for at the contract unit price per ton. Payment for trench stabilization material will be full compensation for furnishing and installing of trench stabilization material, excavation, removal and disposal of unstable soils, and all appurtenances necessary for the proper installation of it.

4.7 GEOTEXTILE FABRIC

4.7.1 The furnishing and installing of geotextile fabric material shall be measured as square yards of geotextile fabric material to the nearest 1 square yard.

4.7.2 The accepted quantities of furnished and installed geotextile fabric will be paid for at the contract unit price per square yard. Payment for geotextile fabric will be full compensation for furnishing and installing of geotextile fabric and all appurtenances necessary for the proper installation of it.

4.8 K-CRETE

4.8.1 The furnishing and installing of K-Crete shall be measured as cubic yards of K-Crete to the nearest 0.1 cubic yard.

4.8.2 The furnishing and installing of K-Crete will be paid for at the contract unit price for K-Crete. Payment for K-Crete will be full compensation for furnishing and installing of K-Crete and all appurtenances necessary for the proper installation of it.

4.9 ADJUST MANHOLE

4.9.1 The furnishing and installing of manhole adjustments shall be measured as a unit for the manhole adjustment at each manhole.

4.9.2 The furnishing and installing of adjusting rings shall be paid for at the contract unit price for each manhole adjustment. Payment for adjust manhole will be full compensation for furnishing and installing of the manhole adjusting rings, sealant, mortar, and all appurtenances necessary for the proper installation of the manhole adjusting rings. Payment for adjust manhole will also be full compensation for replacement of all or a portion of the existing adjusting rings if necessary or required. Manhole adjustments will be paid for at new and existing manholes where necessary.

4.10 MANHOLE RECONSTRUCTION

4.10.1 The work of reconstructing manholes shall be measured by each respective manhole reconstruction unless otherwise indicated.

4.10.2 The work of reconstructing manholes shall be paid for at the contract unit price for each manhole reconstruction unless otherwise noted. Payment for reconstructing manholes will be full compensation for furnishing and installing of the manhole sections, gaskets, manhole sealant, and all appurtenances necessary for the proper installation of the manhole reconstruction.

4.11 MANHOLE FRAME AND COVER

4.11.1 The furnishing and installing of manhole frame and covers shall be measured as a unit for each type of manhole frame and cover installation.

4.11.2 The furnishing and installing of frame and covers shall be paid for at the contract unit price for each type of manhole frame and cover. Payment for manhole frame and covers will be full

compensation for furnishing and installing of the manhole frame and covers, sealant, mortar, and all appurtenances necessary for the proper installation of the manhole frame and cover.

4.12 MANHOLE EXTERNAL FRAME SEAL

4.12.1 The furnishing and installing of manhole frame seal shall be measured as a unit for each manhole frame seal installation at a manhole.

4.12.2 The furnishing and installing of the manhole frame seal shall be paid for at the contract unit price for each manhole frame seal. Payment for manhole frame seal will be full compensation for furnishing and installing of the complete manhole frame seal and all appurtenances necessary for the proper installation of the manhole frame seal for the manhole. Payment will be made for a complete frame seal system and not be made for individual extensions unless otherwise specified.

4.13 MANHOLE RESTORATION

4.13.1 The work of manhole restoration shall be measured by each respective manhole restoration unless otherwise indicated.

4.13.2 The work of manhole restoration shall be paid for at the contract unit price for each manhole restoration unless otherwise noted. Payment for manhole restoration shall be full compensation for restoring the manhole with the specified methods and materials and all appurtenances necessary for the proper restoration of the manhole.

4.14 STYROFOAM INSULATION

4.14.1 Styrofoam insulation shall be measured by the lineal foot of the pipe length that is insulated and for different sizes of insulation. The measured length shall be rounded up to the nearest 1-foot increment.

4.14.2 The furnishing and installing of Styrofoam insulation shall be paid for at the contract unit price per lineal foot for the sizes furnished and accepted of Styrofoam insulation. Payment for Styrofoam insulation will be full compensation for furnishing and installing of the Styrofoam insulation and all appurtenances necessary for the proper installation of it.

4.15 SANITARY SEWER PIPE

4.15.1 Sanitary sewer pipe shall be measured by the lineal foot of the respective type, classes, and sizes of pipe at 2-foot depth increments. Sanitary sewer pipe depths will be measured from the plan finished grade elevation to the pipe invert unless the constructed grade elevation differs. Piping shall be measured from end to end with no deduction for length through manholes. Where two or more pipes of different size enter a manhole, each pipe will be measured to the center of the manhole. The measured length shall be rounded up to the nearest 1-foot increment.

- 4.15.2 The furnishing and installing of sanitary sewer pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for sanitary sewer pipe will be full compensation for furnishing and installing of the sanitary sewer pipe, gaskets, trench dewatering (unless otherwise specified), excavation, backfilling, and all appurtenances necessary for the proper installation of the sanitary sewer pipe.

4.16 BEDDING MATERIAL

- 4.16.1 Pipe bedding material shall be measured by the lineal foot of the respective type and sizes of pipe. Bedding material shall be measured from pipe end to end with no deduction for length through manholes. Where two or more pipes of different size enter a manhole, bedding material for each pipe will be measured to the center of the manhole. The measured length shall be rounded up to the nearest 1-foot increment.
- 4.16.2 The furnishing and installing of pipe bedding material shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for pipe bedding material will be full compensation for furnishing and installing of the pipe bedding material and all appurtenances necessary for the proper installation of it.

4.17 SANITARY SEWER SERVICE PIPE

- 4.17.1 Sanitary sewer service pipe shall be measured by the lineal foot of the respective type, classes, and sizes of pipe. The measured length shall be rounded up to the nearest 1-foot increment. Unless otherwise shown on the plans, couplings, bends, or other fittings will be included in the length of measurement.
- 4.17.2 The furnishing and installing of sanitary sewer service pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for sanitary sewer service pipe will be full compensation for furnishing and installing of the sanitary sewer service pipe, gaskets, bedding material, trench dewatering (unless otherwise specified), and all appurtenances necessary for the proper installation of the sanitary sewer service pipe.

4.18 SEWER WYE/TAP

- 4.18.1 Sanitary sewer wyes and taps shall be measured by each unit of the respective type and size of pipe.
- 4.18.2 The furnishing and installing of sanitary sewer wyes and taps shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for sanitary sewer wyes and taps will be full compensation for furnishing and installing of the sanitary sewer wyes and taps, gaskets, bands, cutting of pipe openings, and all appurtenances necessary for the proper installation of the sanitary sewer wyes and taps.

4.19 SEWER COUPLINGS

- 4.19.1 Sanitary sewer couplings shall be measured by each unit of the respective type and size of pipe.
- 4.19.2 The furnishing and installing of sanitary sewer couplings shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for sanitary sewer couplings will be full compensation for furnishing and installing of the sanitary sewer couplings, bands, pipe, and all appurtenances necessary for the proper installation of the sanitary sewer couplings.

4.20 SEWER CAPS/PLUGS

- 4.20.1 Sanitary sewer caps/plugs shall be measured by each unit of the respective type and size of pipe.
- 4.20.2 The furnishing and installing of sanitary sewer caps/plugs shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for sanitary sewer caps/plugs will be full compensation for furnishing and installing of the sanitary sewer caps/plugs and all appurtenances necessary for the proper installation of the sanitary sewer caps/plugs.

4.21 SEWER SERVICE CLEANOUT ASSEMBLY

- 4.21.1 The furnishing and installing of clean-outs shall be measured as a unit for each clean-out assembly for the designated pipe size.
- 4.21.2 The furnishing and installing of clean-outs shall be paid for at the contract unit price for each sewer clean-out assembly unless otherwise noted. Payment for the sewer clean-out assembly will be full compensation for furnishing and installing of the piping, fittings, protective covers, manhole covers, and all appurtenances necessary for the proper installation of the cleanout.

4.22 MANHOLE

- 4.22.1 Manholes shall be measured as each unit, by inside nominal diameter, and at 2-foot depth increments. Manhole depths will be measured from the top of the rim to the lowest pipe invert.
- 4.22.2 The furnishing and installing of manholes shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for manholes will be full compensation for furnishing and installing of the manhole sections, gaskets or butyl rubber rope sealant, futures (pipe, plugs and/or caps), and all appurtenances necessary for the proper installation of the manhole.

4.23 LINED MANHOLE

4.23.1 Lined manholes shall be measured as each unit, by inside nominal diameter, and at 2-foot depth increments. Lined manhole depths will be measured from the rim to the lowest pipe invert.

4.23.2 The furnishing and installing of lined manholes shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for lined manholes will be full compensation for furnishing and installing of the lined manhole sections, gaskets or butyl rubber rope sealant, lining, welding lining, testing lining, and all appurtenances necessary for the proper installation of the lined manhole.

4.24 DROP MANHOLE

4.24.1 The furnishing and installing of drop manhole sections shall be measured as a unit for each separate drop manhole installation. Each manhole drop section will be described in the bid item description by the location and by the footage difference between the vertical drop length as measured from the incoming pipe invert to the lowest outgoing pipe invert elevation in the manhole.

4.24.2 The furnishing and installing of each manhole drop section shall be paid for at the contract unit price for each drop section. Payment will be full compensation for furnishing of the pipe and fittings, drop manhole assembly, clamping brackets, stainless steel, setting of the drop section in concrete in the bottom of the manhole, and all appurtenances necessary for the proper installation of the drop manhole section.

4.25 MANHOLE BOOTS

4.25.1 Manhole boots shall be measured by each unit of the respective size of pipe.

4.25.2 The furnishing and installing of manhole boots shall be paid for at the contract unit price per each for the sizes furnished and accepted. Payment for manhole boots will be full compensation for furnishing and installing of the manhole boots onto the manhole and pipe, bands, and all appurtenances necessary for the proper installation of the sanitary sewer couplings.

4.26 SEWER SERVICE RISER PIPE

4.26.1 Sewer service riser pipe shall be measured by the lineal foot of the respective type, classes, and sizes of pipe. The measured length shall be rounded up to the nearest 1-foot increment.

4.26.2 The furnishing and installing of sewer service riser pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for sewer service riser pipe will be full compensation for furnishing and installing of the sanitary sewer service pipe, gaskets, bedding material, bends, caps/plugs, trench dewatering (unless otherwise specified), and all appurtenances necessary for the proper installation of the sewer service riser pipe.

4.27 RECONNECT SEWER SERVICE

- 4.27.1 (Reconnecting Sewer Service lines where new main line sewer pipe is installed to replace existing main line sewer.)
- 4.27.2 Bid item, "Sewer Wye/Tap" (for each specified size), shall be used for payment for the furnishing and installing of the wye or tap and tapping saddle. The wye or tap and tapping saddle size shall be indicated on the drawings and in the bid form. Bid item, "Reconnect Sewer Service," shall be used for payment for furnishing and installing pipe, fittings, couplings necessary for performing the service reconnection. All services shall be installed to the curb line along the street and connected to the existing service line unless otherwise noted. The pipe for extending services from the main line sewer to the curb line shall be furnished and installed and paid for under bid item "4-inch Sanitary Sewer Service," bid item "6-inch Sanitary Sewer Service," or as specified.

4.28 CONNECTION INTO EXISTING MANHOLE

- 4.28.1 Connections into existing manholes shall be measured by each unit connection.
- 4.28.2 The furnishing and installing of connections into existing manholes shall be paid for at the contract unit price per each furnished and accepted. Payment for connections into existing manholes will be full compensation for furnishing and installing of the pipe into the manhole, core drilling of the manhole, manhole boot(s), grout, water seal, and all appurtenances necessary for the proper installation of the connection into existing manhole.

4.29 MANHOLE EXFILTRATION/VACUUM TEST

- 4.29.1 Manhole exfiltration/vacuum test shall be measured by each acceptable unit test.
- 4.29.2 The manhole exfiltration/vacuum test shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole exfiltration/vacuum test will be full compensation for testing of the manhole and all appurtenances necessary for the proper manhole exfiltration/vacuum testing.

4.30 SANITARY SEWER EXFILTRATION TEST

- 4.30.1 Sanitary sewer exfiltration test shall be measured by lineal foot of pipe tested that is acceptable and shall be measured from end to end with no deduction for length through manholes. Service line testing shall be measured as incidental to the main line testing. The lineal footage shall not include the length of connected sanitary sewer service pipes. The measured length shall be rounded up to the nearest 1-foot increment.
- 4.30.2 The sanitary sewer exfiltration test shall be paid for at the contract unit price per lineal foot furnished and accepted. Payment for sanitary sewer exfiltration test will be full compensation for testing of the pipe and all appurtenances necessary for the proper sanitary sewer exfiltration testing.

4.31 PVC SEWER PIPE DEFLECTION TEST

- 4.31.1 PVC sewer pipe deflection test shall be measured by lineal foot of pipe tested that is acceptable. The lineal footage shall not include the length of connected sanitary sewer service pipes. The measured length shall be rounded up to the nearest 1-foot increment.
- 4.31.2 The PVC sewer deflection test shall be paid for at the contract unit price per lineal foot furnished and accepted. Payment for PVC sewer deflection test will be full compensation for testing of the pipe and all appurtenances necessary for the proper PVC sewer deflection test.

4.32 TRENCH DEWATERING

- 4.32.1 Trench dewatering shall be measured lump sum where trench dewatering is necessary and as indicated on the Bid Proposal. If trench dewatering is not indicated on the bid form and is necessary, payment shall be incidental to the pipe and manhole installation. Service line dewatering shall be measured as incidental to the main line dewatering where main line sewer is installed in conjunction with service lines.
- 4.32.2 Payment for trench dewatering will be for lump sum price unless otherwise noted on the drawings or Special Provisions and/or Bid Proposal. If trench dewatering is not indicated on the bid form and is necessary, payment for trench dewatering shall be incidental to the pipe and manhole installation unless otherwise noted. Payment for trench dewatering will be full compensation for furnishing, installing, maintaining of the trench dewatering, and all appurtenances necessary for the proper operation of trench dewatering.

4.33 SANITARY SEWER TEMPORARY BYPASS

- 4.33.1 Sanitary sewer temporary bypass shall be measured by lump sum for the work.
- 4.33.2 The furnishing, installing, operating, and maintaining of sanitary sewer temporary bypass shall be paid for at the contract lump sum price for the sanitary sewer temporary bypass furnished and accepted. Payment for sanitary sewer temporary bypass will be full compensation for furnishing, installing, operating, and maintaining of the sanitary sewer temporary bypass system and all appurtenances necessary for the proper operation of sanitary sewer temporary bypass. Payment for sanitary sewer temporary bypass will be included with the payment for the price per lineal foot of pipe or manholes unless otherwise noted on the drawings or Special Provisions.

4.34 MANHOLE MARKERS

- 4.34.1 Manhole markers shall be measured by each unit furnished and installed.
- 4.34.2 The furnishing and installing of manhole markers shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole markers will be full compensation for furnishing and installing of the manhole markers, concrete, and all appurtenances necessary for the proper installation of the manhole markers.

4.35 JACKING, BORING, AND TUNNELING

- 4.35.1 The basis of measurement shall be by the lineal foot for casing pipe, linear foot for carrier pipe, each for end seals, each for casing spacers, and each for boring obstructions. The measured length of carrier and casing pipe shall be rounded up to the nearest 1-foot increment.
- 4.35.2 The furnishing and installing of casing pipe and carrier pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. The furnishing and installing of end seals and casing spacers shall be paid for at the contract unit price per each for the types and sizes furnished and accepted.
- 4.35.3 Payment for casing pipe will be full compensation for furnishing and installing of the casing pipe by boring, jacking or tunneling, excavation and backfilling of bore pits, welding, trench dewatering (unless otherwise specified), and all appurtenances necessary for the proper installation of the casing pipe.
- 4.35.4 Payment for carrier pipe will be full compensation for furnishing and installing of the carrier pipe, gaskets, and all appurtenances necessary for the proper installation of the carrier pipe.
- 4.35.5 Payment for the end seals and casing spacers will be full compensation for furnishing and installing of the end seals and all appurtenances necessary for the proper installation of the end seals and casing spacers.
- 4.35.6 Payment for boring obstruction will be full compensation for the labor, equipment, and materials needed for removal of the obstruction. Payment for boring obstructions will be paid only for boring operations with mechanical equipment. If the project work is performed by a hand-mining operation, all such obstructions will be considered part of the normal operation and will not be paid for as a boring obstruction.
- 4.35.7 A boring obstruction shall be defined as any rock, boulder, etc., or similar material, which is encountered during the excavation that cannot be removed by the boring machine and requires shutdown of the equipment for removal. The Contractor shall be aware that all quantities are estimates and that there may be no obstructions or could be a large number of obstructions on the project. The Contractor will only be paid for obstructions encountered and reported to and verified by the Engineer. The bid item quantities are not guaranteed items.

4.36 MANHOLE CONSTRUCTION PLATE MARKER

- 4.36.1 Manhole construction plate markers shall be measured by each unit furnished and installed. The project quantity for manhole construction plate markers shall be measured for each location the manhole construction plate markers are used. Measurement will be made twice at locations where new manholes are installed at existing manhole locations. Only one measurement will be made at existing manhole reconstruction locations.
- 4.36.2 The furnishing and installing of manhole construction plate markers shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole construction plate markers will be full compensation for furnishing, installing, and removal of the manhole

construction plate marker and all appurtenances necessary for the proper installation of the manhole construction plate marker.

4.37 MANHOLE BENCH AND INVERT RECONSTRUCT

- 4.37.1 Manhole bench and invert reconstruct shall be measured by each unit furnished and installed.
- 4.37.2 The furnishing and installing of manhole bench and invert reconstruct shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole bench and invert reconstruct will be full compensation for furnishing, installing, and removal of the manhole bench and invert, and all appurtenances necessary for the proper installation of the manhole bench and invert.

4.38 SANITARY SEWER SPOT REPAIR

- 4.38.1 Sanitary sewer spot repair shall be measured by each unit furnished and installed.
- 4.38.2 The furnishing and installing of the sanitary sewer spot repair shall be paid for at the contract unit price per each furnished and accepted. Payment for sanitary sewer spot repair will be full compensation for furnishing, installing, and removal of the defective pipe section, and all appurtenances necessary for the proper installation of the sanitary sewer spot repair.

4.39 SANITARY SEWER PIPE LINING REPAIRS

- 4.39.1 Sanitary sewer pipe lining repairs shall be measured by each unit furnished and installed.
- 4.39.2 The furnishing and installing of the sanitary sewer pipe lining repairs shall be paid for at the contract unit price per each furnished and accepted. Payment for sanitary sewer pipe lining repairs will be full compensation for furnishing and installing the liner pipe, pipe cleaning, pre- and post-inspections, and all appurtenances necessary for the proper installation of the sanitary sewer pipe lining repair.

4.40 SANITARY SEWER FORCE MAIN TRACER WIRE

- 4.40.1 Sanitary sewer force main tracer wire shall be measured by lineal foot of wire furnished and installed. The measured length shall be rounded up to the nearest 1-foot increment.
- 4.40.2 The sanitary sewer force main tracer wire shall be paid for at the contract unit price per lineal foot furnished and installed. Payment for sanitary sewer force main tracer wire will be full compensation for furnishing, installing, and all appurtenances necessary for the proper installation of the sanitary sewer force main tracer wire.

4.41 SANITARY SEWER FORCE MAIN TRACER WIRE TERMINAL BOX

- 4.41.1 Sanitary sewer force main tracer wire terminal boxes shall be measured by each unit furnished and installed.

4.41.2 The furnishing and installing of the sanitary sewer force main tracer wire terminal box shall be paid for at the contract unit price per each furnished and accepted. Payment for sanitary sewer force main tracer wire terminal box will be full compensation for furnishing, installing, and all appurtenances necessary for the proper installation of the sanitary sewer force main tracer wire terminal box.