

Brookings Municipal Utilities (BMU)
Standard Specifications
For
Sanitary Sewer Main Construction
(City of Brookings)

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PART 1.0 - GENERAL

1.1 SCOPE OF WORK

- A. 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, standard plates and/or called for in the specifications or its addenda.

1.2 CONTRACTOR LICENSE AND PERMITS

- A. Any Contractor involved with “sewer and water installation”, shall have a valid “Sewer and Water Contractor” or “Sewer and Water Installer” license obtained from the South Dakota Plumbing Commission as defined by [SD Administrative Rule Chapter 20:53:01:01](#), Definitions.
- B. Any Contractor installing or repairing private water services, shall obtain a City of Brookings PLUMBING CONTRACTOR LICENSE as specified in [Section 22-161-“Required”](#) as found in Article III-PLUMBING of the City of Brookings Code of Ordinances.
 - 1. Contractor shall provide all required documentation needed to secure the City of Brookings PLUMBING CONTRACTOR LICENSE, including, but not limited to, a copy of the “Sewer and Water Contractor” and/or “Sewer and Water Installer” license, current insurance certificate, and performance bond.
- C. When required by [Section 74-141-“Permit Required”](#) per Article IV-EXCAVATIONS of the City of Brookings Code of Ordinances, the Contractor shall obtain an “EXCAVATIONS PERMIT” issued at no charge from the Brookings City Engineering Office before any installation or repair of water/sewer commences.
- D. The Contractor shall obtain any “DEWATERING PERMITS” required from local, state or federal agencies. The discharge area must be prior approved by the Engineer before initiating the dewatering.
- E. The Contractor shall be required to obtain any other permits or license required by the project manual. It shall be the Contractor sole responsibility to determine which license and permits are needed for the completion of the project.

1.3 WARRANTY PERIOD

- A. The Contractor shall be held responsible for workmanship, materials, settling trenches or any other deficiencies in the sanitary sewer system during the corrective period. The Contractor shall repair and/or replace all deficiencies in the sanitary sewer system during the corrective period at no cost to the Owner. Any surface restoration costs incurred because of the repairing and/or replacing of deficiencies in the water system shall be borne by the Contractor. The duration of the warranty period is dependent on the method in which the Contract and/or work is completed:
 - 1. When these Standard Specifications for Water Main Construction are included in technical specifications of a project manual, the warranty period for the water

system improvements shall be consistent with the warranty period identified in the Agreement, General Conditions, Supplemental Conditions and/or any other project document that defining the corrective period duration.

2. When these Standard Specifications for Water Main Construction are used in conjunction with a project covered by [Section 51-64-Street Standards](#) as found in Article VI-SUBDIVISION IMPROVEMENTS AND DESIGN STANDARDS of the City of Brookings Code of Ordinances, the warranty period for water system improvements shall be the same one (1) year period of time as required by the Ordinance.
3. If the work is being completed within an established right-of-way, including excavation in or upon any street, sidewalk, alley or public ground in the city, the Contractor shall be required to obtain a "EXCAVATIONS PERMIT" from the City of Brookings. The corrective period for work covered by the executed Excavation Permit shall be a period of five (5) years as specified in [Section 74-148-Warranty](#) as found in Article IV-EXCAVATIONS of the City of Brookings Code of Ordinances.

1.4 BMU SANITARY SEWER SERVICE TAPPING FEES

- A. Contractor shall be responsible for payment to BMU for all sewer tapping fees. Sewer tapping fees shall be charged to the Contractor at the cost identified on the BMU annually published "SERVICE CHARGES – WATER/SEWER" rate sheet.
 1. Upon completion of work, BMU will generate an invoice and bill accordingly for any BMU furnished & installed tapping tee (inserta tee) or saddles for making sanitary sewer taps.
 2. If the Contractor installs an in-line wye (preferred), or tapping tee (inserta tee), then a tapping fee will not be required.

1.5 QUALITY CONTROL

- A. Testing and/or retesting of materials because of nonconformance to the specified requirements shall be performed by an independent firm as per the instructions of the Engineer of Record.
- B. Payment for retesting performed during the Contract period and during the warranty period will be the responsibility of the Contractor.

1.6 SUBMITTALS

- A. The Contractor shall submit the number of copies that the contract requires plus one copy that the Engineer of Record will retain. The Contractor shall obtain shop drawing approval before any of the work related to that material is performed.
- B. Shop drawings and data shall be submitted for, but not be limited to, the following items:
 1. Sanitary sewer manholes, pipe, pipe fittings, bedding material, stabilization material, road topping 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.

2. Sanitary sewer manhole shop drawings shall be submitted for each sanitary sewer manhole and shall indicate the sections to be used with sizes and heights. A drawing showing the profile of the sanitary sewer manhole must be submitted and shall be detailed to scale to show all segments of the sanitary sewer manhole in a profile view.
- C. The Contractor shall submit appropriate documentation to the Engineer of Record for any materials not listed in these specifications. The Engineer of Record may forward any shop drawing to the BMU Engineer for consideration. Correspondence shall indicate any discrepancies between the BMU specification requirements and the Contractor provided submittal.
 1. BMU Engineer reserves the right to reject any and all materials that do not meet the requirements for sanitary sewer pipe and appurtenances as indicated in these standard specifications.
 - D. If a Temporary Sanitary Sewer Bypass System is deemed necessary by the Engineer of Record, the Contractor shall submit a comprehensive Temporary Sanitary Sewer Bypass Plan to the BMU Engineer for approval.

1.7 TRAFFIC CONTROL

- A. The Contractor shall furnish, install and maintain any and all traffic control devices as required by the project plans. All traffic control devices shall be provided and installed according to the manual on "Uniform Traffic Control Devices" for streets & highways whenever applicable. The Federal Highway Administrator approves this manual as the National Standard.

1.8 GEOTECHNICAL REPORT

- A. In the event that a geotechnical report, prepared by a licensed South Dakota Professional Engineer, exists for the proposed project, the requirements of that report shall be strictly adhered to.
- B. Any requirements for, but not limited to compaction requirements, dewatering, testing frequency, the need for imported materials or trench stabilization included in the geotechnical report shall be followed regardless of the specific requirements in the following subsections.

PART 2.0 - PRODUCTS

2.1 TRENCH STABILIZATION MATERIAL

- A. In poor trench conditions, or if directed by the BMU Engineer’s Representative, the Contractor shall be required to use trench stabilization consisting of 3/4-inch to 4-inch crushed angular, well-graded material.
- B. Larger crushed angular material may be required if deemed necessary by the BMU Engineer’s Representative to stabilize the bottom of the trench.
- C. The use of trench stabilization material will not eliminate the need for pipe bedding material.

2.2 PIPE BEDDING MATERIAL

- A. Contractor shall use 1/4” x 3/4” clean angular crushed rock for pipe bedding, with the following minimum percentage gradation requirements:

Table 1- Pipe Bedding Gradation

Sieve Size	Percentage Passing
1-inch	100%
3/4-inch	85% to 100%
1/2-inch	15% to 85%
#4	0% to 15%

2.3 IMPORTED ENGINEERED FILL MATERIAL

- A. When native materials are less than ideal for subgrade, or if directed by the Engineer of Record, the Contractor shall use imported engineered fill material for backfilling the sanitary sewer trench.
- B. Imported engineered fill material shall be a granular material conforming to requirements for “PIT RUN” as indicated in the South Dakota Department of Transportation Specifications, Section 882 “AGGREGATES FOR GRANULAR BASES AND SURFACING”, processed sand or gravel having a maximum particle size of 1-inch.

2.4 IMPORTED CLAY MATERIAL

- A. When native materials are less than ideal for subgrade, or if directed by the Engineer of Record, the Contractor shall use imported clay backfill material for backfilling the sanitary sewer trench.
- B. Clay material is available from the Brookings Regional Landfill (605-693-3667). Contractor shall be responsible for contacting the landfill to determine the availability and cost of the material. Contractor shall be responsible for loading, hauling and placing the clay material.
- C. The moisture content of the imported clay material shall be 1 to 4% below the optimum moisture content at time of placing and compacting the material. The

Contractor shall be responsible for drying material to obtain the optimum moisture conditions.

2.5 AGGREGATE BASE MATERIAL

- A. Aggregate base material shall be provided at any location where a hard road surface (concrete or asphalt) will be placed over the sanitary sewer trench.
- B. The aggregate base material shall conform to requirements for “AGGREGATE BASE COURSE” as indicated in the South Dakota Department of Transportation Specifications, Section 882 “AGGREGATES FOR GRANULAR BASES AND SURFACING”.
- C. The 3/4-inch granular material, unless otherwise directed, shall conform to the following sieve analysis:

Table 2- Imported Granular Material Gradation

Sieve Size	Percentage Passing
1-inch	100%
3/4-inch	80% to 100%
1/2-inch	68% to 91%
#4	46% to 70%
#8	34% to 58%
#40	13% to 35%
#200	3% to 12%

2.6 GRAVEL SURFACING MATERIAL

- A. The gravel surfacing or road topping material shall conform to requirements for “GRAVEL SURFACING” as indicated in the South Dakota Department of Transportation Specifications, Section 882 “AGGREGATES FOR GRANULAR BASES AND SURFACING”.
- B. The 3/4-inch gravel surfacing material with a soil mortar or binder, unless otherwise directed, shall conform to the following sieve analysis:

Table 3- Crushed Gravel Gradation

Sieve Size	Percentage Passing
3/4-inch	100%
#4	50% to 78%
#8	37% to 67%
#40	13% to 35%
#200	4.0% to 15%

2.7 FLOWABLE FILL MATERIAL (K-CRETE)

- A. Flowable fill (K-Crete) shall be a controlled low strength concrete that is highly flowable without segregation. The concrete mix shall meet the following requirements:

Table 4- Flowable Fill Mix Design

Materials	Mix Design Parameters
Cementitious Materials	100 to 300 lbs
Sand	2000 to 3000 lbs
Water	Water to cement ratio = 1.0 to 1.5
Air	10 to 30 %
Unit Weight	110 to 125 lbs/ft ³
Slump	8" Min
Compressive Strength	200 psi Max

2.8 POLY VINYL CHLORIDE (PVC) SANITARY SEWER MAIN PIPE

- A. Sanitary sewer pipe 4-inches in diameter and greater shall be poly Vinyl Chloride (PVC) with a gasket material. The pipe shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, 12364-C or 13364-B.
- B. PVC sewer service and main pipe 12-inch and smaller shall be manufacturer in accordance with ASTM D3034, latest revision and be available with standard dimension ratio (SDR) of 35 and 26.
- C. PVC sewer main pipe 15-inch and larger shall be manufacturer in accordance with ASTM F679, latest revision and be available with pipe stiffness of PS46 and PS115.
- D. 4-inch and 6-inch PVC sewer service pipe shall be PVC Schedule 40 solid pipe when installed in same trench as water service. Pipe shall be iron pipe size (IPS) conforming to ASTM D1725 and ASTM D2665.
- E. All PVC pipe joints shall be gasketed, bell and spigot, push on type conforming to ASTM D3212. The bell shall consist of an integral wall section with a solid cross section elastomeric ring, factory assembled, securely locked in place to prevent displacement. Solvent cement joints will not be allowed for sanitary sewer pipe and fittings.
- F. Acceptable Manufacturers for sanitary sewer pipe shall be JM Eagle, Diamond or prebid BMU Engineer approved equal.

2.9 SANITARY SEWER FORCE MAIN PIPE

- A. All pipe for sanitary sewer pressure piping (force mains) shall meet the requirements of "POLYVINYL CHLORIDE (PVC) WATER MAIN PIPE" in the BMU Standard Specifications for Water Main.

2.10 TRACER WIRE FOR SANITARY SEWER FORCE MAIN

- A. All components of the tracer wire system shall meet the requirements of "TRACER WIRE FOR WATER MAINS" in the BMU Standard Specifications for Water Main. The only exceptions shall be that the tracer wire color shall be green.
- B. Tracer wire access point for sanitary sewer shall include a terminal block, cast iron collar and lockable lid. Terminal box shall be manufactured from high grade ABS rigid plastic (ASTM D1788) and have a magnet securely attached to be easily detected by magnetic locators. Locking mechanism shall secure the lid to the base

and be locked/unlocked with a pentagon wrench. Access point shall be designed so that when installed, the collar will be flush with the surface and contain the lid. Access point terminations shall be Snakehead Roadway access point as manufactured by Copperhead Industries or prebid BMU Engineer approved equal.

- C. The tracer wire terminal boxes shall be placed at no more than 1,000-feet apart from one another or as specified on the plan notes or drawings.

2.11 PIPE COUPLING – PVC TO PVC

- A. Pipe coupling used to mate PVC to PVC pipe materials shall be a rigid, PVC molded SDR 35 gasket joint repair sleeve. Repair sleeve shall be constructed to the meet ASTM D3034 requirements.
- B. Coupling shall be a gasketed, hub by hub style fitting with no center stop. Coupling shall be manufactured to slide over PVC sewer pipe ASTM D3034 SDR 35 or SDR 26 for pipe 12-inch and smaller. Coupling shall be manufactured to slide over PVC sewer pipe ASTM F679 PS46 or PS115 for pipe 15-inch and larger.
- C. Manufacture shall provide a wide range of coupling size to accommodate different pipe materials and associated sizes.
- D. All couplings shall bear the Manufacturer's identifying mark and size.
- E. Acceptable Manufacturers for couplings shall be Strong Back RC Series Repair Coupling as manufactured by GPK Products, Harrington Corporation, Multi Fitting or prebid BMU Engineer approved equal.

2.12 PIPE COUPLING – DISSIMILIAR MATERIAL

- A. Pipe coupling shall be designed for resistance to heavy earth loads and shear forces. Coupling shall be designed to a maximum test pressure of 4.3 psi and a maximum operating temperature of 140 degrees (F).
- B. Coupling shall utilize a gasket, clamps, shear ring and coupling. Pipe coupling shall be manufactured to conform to the performance requirements of ASTM C1173, latest revision. Clamps and bands shall be 316 stainless steel and available in two nut and bolt take-up points per band in 6-inch and larger sizes.
- C. Manufacture shall provide a wide range of coupling size to accommodate different pipe materials and associated sizes.
- D. All couplings shall bear the Manufacturer's identifying mark and size.
- E. Reducing couplings shall not be allowed. Reducer couplings will only be allowed for special situations as determined necessary by the BMU Engineer. Pipe coupling shall not be installed on reducers.
- F. Acceptable Manufacturers for couplings shall be Strong Back RC Series Repair Coupling as manufactured by Fernco Inc., Indiana Seal or prebid BMU Engineer approved equal.

2.13 POLY VINYL CHLORIDE (PVC) FITTINGS

- A. Provide fittings, including but not limited to cleanouts, wyes, caps, covers, bends, reducers and plugs, fabricated from PVC materials and having gasketed joints conforming to ASTM D3034 and ASTM F949.
- B. PVC fittings shall be provided to match the standard dimension ratio (SDR 35 and 26) of the pipe that the fitting is being installed on.
- C. Sanitary Sewer Service Cleanouts:
 - 1. Pipe for cleanouts shall be Schedule 40 PVC.
 - 2. Cleanout Cap and Cover shall be Neenah R1976 or prebid BMU Engineer approved equal. The cover shall be labeled "SEWER".
- D. All PVC caps and plugs shall be gasketed or solvent weld.
- E. Where reducers are necessary and approved for connections to existing service lines, reducers shall be eccentric type manufactured of approved pipe material.
- F. Bends greater than 45 degrees will not be allowed.
- G. Wyes with the same main line and branch line diameter will not be allowed (example: 4x4, 6x6, 8x8, etc.).

2.14 PRECAST SANITARY SEWER MANHOLE

- A. Precast concrete sanitary sewer manholes shall conform to ASTM Designation C478 with all current revisions. 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. Sanitary sewer manholes shall be constructed without steps or ladders.
 - 1. Acceptable manufacturers for Precast Sanitary Sewer Manholes shall be CemCast, Hancock or prebid BMU Engineer approved equal.
- B. Provide size and number of sanitary sewer manholes as indicated on project plans and bid form.
- C. The upper section of the sanitary sewer manhole shall be a concentric precast cone made expressly for this purpose providing a minimum diameter of 24-inch opening at the top. The offset or eccentric cone section shall not be allowed.
- D. Provide O-ring gaskets or continuous butyl rubber rope gasket for constructing watertight sanitary sewer manhole joints. The butyl rubber rope gasket shall conform to or exceed all requirements of Federal Specification SS-S-210A and AASHTO M-198. O-ring gaskets shall be manufactured by Hamilton Kent, Tylox Super Seal gasket, Press-Seal Gasket Corporation, RFS Seal or BMU Engineer approved Equal.
- E. Lift holes shall not extend through the sanitary sewer manhole walls on 48-inch diameter sanitary sewer manholes. Lift holes shall be filled with non-shrink grout.
- F. Non-shrink grout shall be a premixed compound consisting of no-metallic aggregate, cement, water reducing, and plasticizing agents. Grout shall have a minimum compressive strength of 2,400-psi in 48-hours and 7,000-psi in 28-days.
 - 1. Approved Manufacturers for the non-shrink grout shall be:
 - a. "Supreme Grout" – by Hanson Pipe and Products

- b. "Crystex" – by L & M Construction Chemicals
 - c. "588 Non-Metallic, Nonshrink Grout" – by W.R. Meadows
 - d. "Master Flow 713" – by Master Builders
 - e. "Songrout" – by Sonneborn
 - f. "Five Star Grout" – U.S. Grout Corp.
 - g. or prebid BMU Engineer approved equal.
- G. On sanitary sewer manholes where the lift holes extend through the wall sections, a lift hole plug as manufactured by Press Seal Corporation or prebid BMU Engineer approved equal shall be installed at each lift hole and non-shrink grouted over the plug.
- H. All sanitary sewer manhole bench and inverts shall be manufacture pre-formed. Hand forming of sanitary sewer manhole bench and inverts will not be allowed on new sanitary sewer manholes, unless prior approved by the BMU Engineer.
- 1. Bench and inverts may also be formed by using a bench and invert forming system as manufactured by Royal Environmental Systems, Press Seal, A-Lok or prebid BMU Engineer approved equal.
- I. Upon request from BMU, the Contractor and/or supplier shall supply BMU with a test report from an independent testing laboratory showing compliance with this specification.

2.15 CAST-IN-PLACE SANITARY SEWER MANHOLE (DOGHOUSE)

- A. Cast-in-place concrete sanitary sewers are not allowed unless specifically called out for on project plans.
- B. Concrete used for poured sanitary sewer 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".
- C. Reinforcement bars for sanitary sewer manholes shall be structural grade, manufactured by the open hearth process from new billets. All bars shall be deformed and Grade 60.
- D. PVC Water stops for cast-in-place concrete sanitary sewer manhole base and wall sections shall be used on all joints associated with new pours. Provide a flat profile mechanical ribbed ends 7-inches wide, 5/16-inch minimum thickness for construction joints and use a split center bulb with mechanical ribbed ends measuring 9-inches wide by 1/2-inch minimum thickness for all expansion joints.
 - 1. Acceptable manufacturers for PVC water stops shall be Meadows Inc.; B.F. Goodrich Company; Progress Unlimited or prebid BMU Engineer approved equal.

2.16 SANITARY SEWER 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. Frames shall be 7-inch in height.

- B. 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.
- C. All covers shall be supplied with concealed pick holes and shall have casted letter indicating "SANITARY SEWER."
- D. All covers shall be supplied from manufacture with pre-installed, glue-in, self-sealing type "T" 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.
- E. Acceptable manufacturers for the manhole castings, including frame and lids shall be Deeter 1260, East Jordan Ironworks 1205, Municipal Castings 301-7, or a Neenah Foundry R-1733.

2.17 HDPE ADJUSTMENT RINGS

- A. Adjusting rings shall be manufactured from high density polyethylene (HDPE) 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.
- B. The adjusting rings shall be sized to conform to a standard 24-inch sanitary sewer manhole opening.
- C. The HDPE 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.
- D. 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.
 - 1. Acceptable manufacturers for the HDPE adjustment rings shall be manufactured by Ladtech, Inc. or prebid BMU Engineer approved equal.
- E. HDPE adjustment rings shall be adhered to manhole section and adjoining adjustment rings using a trowelable form of Butyl Rubber Sealant. The material must meet or exceed the requirements of Federal Specification TT-S-001657, ASTM C-990 and AASHTO M-198.
 - 1. Acceptable manufacturers for the trowelable sealant shall be manufactured Pre-seal Gasket Corporation, EZ-STIK #3 or prebid BMU Engineer approved equal.

2.18 SANITARY SEWER MANHOLE BOOTS

- A. Sanitary sewer manhole boots for connecting pipes to the sanitary sewer 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 sanitary sewer manhole.
- B. Acceptable manufacturers for the sanitary sewer manhole boots shall be C-lok by A-Lok, Type PSX by Press Seal Corporation, Tylox Cobra Boot by Hamilton Kent or prebid BMU Engineer approved equal.

2.19 SANITARY SEWER MANHOLE EXTERNAL FRAME SEAL

- A. 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.
- B. Each unit shall have a 2-inch wide mastic strip on the top and bottom of the band. The mastic shall be non-hardening butyl rubber sealant with a minimum thickness of 3/16-inch and shall seal to the cone/top of the sanitary sewer manhole section and over the flange of the casting.
- C. Acceptable manufacturers for the external frame seal shall be Wrapid Seal as manufactured by CANUSA-CPS, Infi-shield Uni-Band as manufactured by Sealing Systems Inc., I/I Barrier by Strike Products, Internal/External Frame Seal as manufactured by Adaptor Inc., or prebid BMU Engineer approved equal.
 - 1. Infi-shield Uni-Band as manufactured by Sealing Systems Inc. shall be the only product allowed in street pavement areas.

2.20 SANITARY SEWER MANHOLE EXTERNAL JOINT SEAL

- A. The seal shall be made of a 6-inch wide, stretchable, self-shrinking, intra-curing based rubber with a minimum thickness of 30 mils.
- B. The adhesive side of the tape shall be coated with a cross-linked re-enforced butyl adhesive. The butyl adhesive shall be non-hardening sealant, with a minimum thickness of 30 mils.
- C. The butyl adhesive and the inward pressure exerted on the substrate shall prevent the intrusion of water and soil through the joint section of the manhole.
- D. Acceptable manufacturers for the external joint seal shall be Gator Wrap as manufactured by infi-Shield or prebid BMU Engineer approved equal.

2.21 SANITARY SEWER MANHOLE DROP ASSEMBLY

- A. The drop system shall include a plastic composite collection device that facilitates the controlled drop of effluent into the main stream flow of a sanitary manhole. The drop system permits easy inspection and cleaning without the need to enter the structure.
- B. The “A” size drop bowl has a 12-inch wide receptor bowl with a 4-inch or 6-inch outlet. The 4-inch bowl outlet will service a 6-inch sanitary sewer main and the 6-inch bowl outlet will service an 8-inch sanitary sewer main. The “B” size drop bowl has an 18-inch wide receptor bowl with an 8-inch or 10-inch outlet. The 8-inch

bowl outlet will service a 10-inch sanitary sewer main and the 10-inch bowl outlet will service a 12-inch sanitary sewer main.

- C. Vertical pipe used in the drop assembly shall be the same material and pipe class as piping exterior to the manhole. Heavy wall pipe, SDR 26, shall be used if heavy wall pipe is used outside of the manhole.
- D. The clamping brackets and fasteners shall be adjustable and be manufactured from 316 stainless steel.
- E. Acceptable manufacturers for the drop system shall be the “Reliner Inside Drop System” as manufactured by Duran, Inc. or prebid BMU Engineer approved equal.

2.22 SANITARY SEWER MANHOLE CONSTRUCTION PLATE MARKER

- A. Sanitary sewer manhole construction plate shall be fabricated from ½-inch plate steel. Plate shall be fabricated with 4-inch by 4-inch, 1/4-inch box tubing to provide stiffing capacity to plate. Provide a plate with a minimum diameter of 32-inches to provide adequate overlap with the manhole cover.
- B. Sealant shall be installed between the manhole plate and the top of the manhole to form a water tight seal.
- C. The sanitary sewer manhole construction plate marker shall be fluorescent orange in color and have three (3) bands of reflective tape installed on the top third of the marker. Acceptable manufactures for the construction plate marker shall be “Flex-Guide 300 Series” delineator post and base as manufactured by Davidson Traffic Control Products or prebid BMU Engineer approved equal.

2.23 SANITARY SEWER MANHOLE LINERS

- A. HDPE sanitary sewer manhole liners shall be used on sanitary sewer manholes which are required to be lined.
- B. The material used in the embedment liner and in all welding strips shall be a 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.
- C. 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 sanitary sewer manholes.
- D. 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 shall be installed on the liner.
- E. Liner Physical Properties: All plastic embedment sheets and welding strips shall have the following physical properties when tested in accordance with the following table.

Table 5- Sanitary Sewer Manhole Liner Properties

Property	Test Method	Value
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Thickness (min)	ASTM D 751	+/- 10%
Density g/cm³ (min)	DIN53479 / ASTM D 792	0.94
Tensile Properties	DIN53455 / ASTM D 638	
Tensile Strength at Yield, lb/in² (min)		2,200
Tensile Elongation at Break, % (min)		600
Tensile Strength at Break, lb/in² (min)		3,600
Carbon Black Content, % (max)	ASTM D 1603	2-3
Dimensional Stability, %	DIN 53515	+/- 2
Linear Coefficient, in/in/oC	ASTM D 696	1.2x10 ⁻⁴
Service Temperature		-70 to 1760F
Stud Pull Out Strength (min)		>4,300 psf

- F. 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.
- G. Liner shall have demonstrated good chemical resistance via testing in accordance with EPA 9090.
- H. 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 sanitary sewer 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, sanitary sewer manholes, or structures by methods approved and recommended by the Manufacturer.
- I. Supply of Material:
 1. Sanitary sewer 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 a 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.
- J. The sanitary sewer 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 employment a full-time field service representative with at least five years field experience. The sanitary sewer manhole liner shall be designed, constructed, and installed using techniques recommended by the Manufacturer.

- K. The Manufacturer of the lining shall attest to the successful use of its product as a lining for sanitary sewer pipes, sanitary sewer manholes or pump stations in sewage conditions, or other chemical environments recognized as corrosive or otherwise detrimental to concrete.
- L. Acceptable manufacturers for the sanitary sewer manhole liner Manufacturers shall be GSE Studliner as manufactured by GSE Lining Technologies, Inc., AGRU Sure-Grip as manufactured by AGRU America or prebid BMU Engineer approved equal.
- M. PVC T-Lock liner will be allowed on some structures where it is determined by the BMU Engineer to be acceptable. Specifications for the PVC T-Lock liner shall be supplied for each individual project. The sanitary sewer manhole liner specifications shall apply to PVC T-Lock liner where applicable when specified.

2.24 BACKFLOW PREVENTERS

- A. Backflow preventer or backwater valve shall be designed as sewage check valve to prevent water from flowing back from the wastewater collection system into a residence.
- B. Valve assembly shall include threaded cover to allow for access and valve flapper which seals closed while not in use. Flapper shall be installed into valve body via removable carrier and allow unrestricted, unidirectional flow.
- C. Valve body shall be adaptable to either shallow or deep bury installations and be designed in accordance with South Dakota Plumbing Code and ASME A112.14.1. Valve shall be made of PVC or ABS plastic and shall be solvent welded to sewer service piping.
- D. Acceptable manufacturers of backflow preventer shall be Oatley model 439XX, Sioux Chief 869 Series, IPS Corporation Model No. BWV4A, NDS Model 475P/R or engineer approved equal.

2.25 SANITARY SEWER SERVICE TAPPING TEE

- A. Provide a three-piece service connection that consists of a PVC hub, rubber sleeve and stainless-steel band. Connection shall be a compression fit into the cored wall of the mainline sewer pipe. Hub shall be made from heavy duty PVC material. Stainless steel clamping assembly shall be made from a minimum 301 grade stainless steel. Rubber sleeve and gasket shall meet the requirements of ASTM F477. Gasket shall be factory installed by the manufacturer.
- B. Service connections shall be available from the manufacture for a wide variety of pipe materials, including, PVC C900, C905, SDR 26 HWS, SDR 35, IPS/Sch 40 PVC and concrete pipe.
- C. Acceptable manufacturers for the sanitary sewer service connection for PVC sewer pipe shall be "Inserta Tee" as manufactured by Inserta Fittings Company or prebid BMU Engineer approved.

2.26 PIPE INSULATION

- A. Sanitary sewer main insulation shall be an extruded polystyrene board and meet the requirements of ASTM C578, Type IV. The minimum R-value shall be 5.0 as determined by ASTM C518. The minimum compressive strength shall be 25-psi as determined by ASTM D1621. The maximum water absorption shall be 0.1-percent by volume as determined by ASTM C272. The maximum water vapor permeability shall be 1.1-perm as determined by ASTM E96.
- B. Water main insulation shall be STYROFOAM™ Square Edge by the Dow Chemical Company, STYROFOAM™ Brand Scoreboard by the Dow Chemical Company, or prebid BMU Engineer approved equal.

2.27 ENCASEMENT PIPE - PVC

- A. Encasement pipe for sanitary sewer mains shall use restraint joint PVC pressure pipe. Restraint Joint PVC Pressure pipe shall be manufactured in accordance with the dimensions, materials, quality control and markings specifications found in AWWA C900/C905.
- B. PVC Material shall conform to a minimum cell classification of 12454 as defined by ASRM D1784. The pipe compound is listed as standard grade material with a Hydrostatic Design Basis (HDB) of 4000 psi.
- C. Pipe system shall utilize a restrained joint utilizing a precision-machined groove on the pipe spigot and inside the pipe bell or coupling. A spline shall be inserted through an entry hole in the pipe bell, resulting in a continuous circumferential restrained joint that locks the pipe segments together.
- D. Pipe classes shall be as follows:

Table 6- PVC Encasement Pipe Material

Casing Pipe Size	PVC Pipe Type
4" – 12"	C900 DR 18
14" – 48"	C905 DR 18

- E. All PVC pipe and gasket materials shall meet NSF/ANSI Standard 61 - Drinking Water System Components, Health Effects and NSF/ANSI 61 Annex G, NSF/ANSI 372.
- F. Standard pipe laying length on 20 feet shall be provided unless otherwise specified on project plans.
- G. Acceptable Manufacturers are NAPCO Certa Lok , Certainteed Yelomine or prebid BMU Engineer approved equal.

2.28 ENCASEMENT PIPE - STEEL

- A. Steel casing pipe shall be ASTM A53 or ASTM A139 welded pipe with a minimum yield strength of 35,000 psi.
- B. Pipe shall be full circumference welded joint in accordance with AWS D1.1 to withstand excavation forces.
- C. Minimum wall thickness and diameter shall be provided as shown in the following table:

Table 7- Steel Encasement Pipe Material

Carrier Pipe Size	Carrier Pipe Type	Casing Pipe Size	Wall Thickness
4"	ASTM D3034, DR 35	10"	0.188"
6"	ASTM D3034, DR 35	12"	0.188"
8"	ASTM D3034, DR 35	16"	0.281"
10"	ASTM D3034, DR 35	18"	0.312"
12"	ASTM D3034, DR 35	20"	0.344"
15"	ASTM F679, PS46	24"	0.375"
21"	ASTM F679, PS46	30"	0.469"
24"	ASTM F679, PS46	36"	0.531"
27"	ASTM F679, PS46	40"	0.594"
30"	ASTM F679, PS46	42"	0.625"
36"	ASTM F679, PS46	48"	0.688"

2.29 CASING SPACERS

- A. Casing spacers shall be constructed of circular T-304 stainless steel segments, which bolt together forming a shell around the carrier pipe. T-304 stainless steel bolts and nuts shall be supplied with the spacers.
- B. The spacers shall be designed with risers (when needed) and runners to support and center the carrier pipe within the casing pipe and maintain a clearance of 1/2-inch to 1-inch maximum between the casing pipe inside diameter (ID) and the spacer outside diameter (OD).
- F. The band shall be manufactured of 8-inch (SSI-8) or 12-inch (SSI-12-2) wide, 14-gauge T-304 stainless steel. The risers shall be constructed of T-304 stainless steel having a minimum length of 6-inches (SSI-8) or 10-inches (SSI-12-2).
- G. Abrasion-resistant runners, having a minimum length of 7-inches (SSI-8) or 11-inches (SSI-12-2), and a minimum width of 2-inches, shall be attached to each riser to minimize friction between the casing pipe and the carrier pipe as it is installed. Runner material shall be of glass reinforced plastic with the following minimum properties:
 1. compression strength of 25,000-psi,
 2. flexural strength of 32,000-psi, and
 3. tensile strength of 22,000-psi.
- H. The ends of all runners shall be beveled to facilitate installation over rough weld beads or the welded ends of misaligned or deformed casing pipe.
- I. On carrier pipes with an OD of 16-inches or less, each spacer shall have four riser/runner combinations-two on each half. On carrier pipes with an OD of 20-inches and greater, the number of riser/runner combinations shall be as recommended by the Manufacturer, with four being the minimum.
- J. Interior surfaces of the stainless steel shell shall be lined with EPDM having a minimum thickness of 0.090-inches with a hardness of durometer "A" 85-90. Placement of the spacers shall be a maximum of 1-foot on each side of the bell joint and one every 6 to 8-feet thereafter.

- K. Casing spacers shall be Model SSI-8 for carrier pipes 24-inches in diameter and smaller and Model SSI-12-2 for carrier pipes 30-inches in diameter and greater as manufactured by Advance Products & Systems, Inc., Lafayette, LA, or prebid BMU Engineer approved equal.

2.30 CASING END SEALS

- A. Full conical-shaped wraparound seals made of 1/8-inch-thick neoprene rubber shall be provided for each end of the casing pipe. T-304 stainless steel banding straps with a 100-percent nonmagnetic worm gear mechanism and pressure sensitive butyl mastic strips shall be provided to seal edges.
- B. End seals shall be Model AW Wraparound casing end seals as manufactured by Advance Products & Systems, Inc., Lafayette, LA, or prebid BMU Engineer approved equal.

2.31 TEMPORARY SANITARY SEWER MAIN BYPASS PIPE

- A. Temporary sewer/sewer main bypass pipe and fittings shall be High Density Polyethylene (HDPE) Pipe, unless otherwise prebid BMU Engineer approved, and shall adhere to the following:
 - 1. HDPE piping shall conform to the latest revision of the AWWA C906 standard.
 - 2. Pipe ends shall be fused together utilizing Thermal Butt Fusion or Electrofusion.
 - 3. PVC Gravity Sanitary Sewer Pipe conforming to these specifications may be used for bypass pumping on short distance low flow sewage projects if prebid BMU Engineer approved.

2.32 GREASE TRAP

- A. Grease trap shall be a hydromechanical grease trap suitable of being installed below grade, outside of the structure.
- B. Grease trap shall be made of seamless, rotationally-molded polyethylene. Interceptor shall be furnished for below grade installation. Interceptor shall be certified to ASME A112.14.3 (Type D) and CSA B481.1, with adjustable cover adapter, access restrictor built into cover adapter, and three outlet options.
- C. Provide inlet diffuser that reduces turbulence, creates laminar flow and allows the entire tank volume to be utilized for efficient grease separation and minimal disturbance of existing grease and sediment layers. Inlet diffuser shall be attached to any of the three inlets provided to ease job site piping arrangements.
- D. Grease trap shall have integral air release/anti-siphon at the outlet diffuser to allow pressure stabilization within the unit during operation. The outlet diffuser shall be attached to any of the three outlets provided for ease of job site piping layouts.
- E. Interceptor flow rate and capacity shall be designed based on the facility being services.
- F. Grease Trap shall be Great Basin hydromechanical grease interceptor as manufactured by Schier, or prebid BMU Engineer approved equal.

PART 3.0 - EXECUTION

3.1 OWNER OPERATE

- A. No pumps, valves, or other appurtenances of the existing sanitary sewer collection shall be operated for any purpose by the Contractor. BMU staff shall be the only authorized operator of existing collection system.

3.2 INTERRUPTION OF SERVICE

- A. The Contractor shall coordinate with BMU staff of any interruption of sanitary sewer service at least 24-hours before the interruption of service. BMU Staff shall notify all customers affected by any the interruption of service.
- B. BMU is providing a courtesy to the Contractor by notifying the customers of a schedule interruption of service. It is the Contractor sole responsibility to develop, communicate and adhere to the schedule that is communicated to the BMU staff. Under no condition does BMU contacting and communicating directly with the customers relieve the Contractor of the requirements of the General Conditions of any other requirements identified in the Contract Documents.
- C. Customers shall be verbally notified and provided an interruption of service notice. In the event a consumer cannot be notified, the Contractor may need to reschedule their work until the customers are notified.
- D. The Contractor shall communicate the temporary operation of permanent lift station pumps, plugging of manholes and/or any other action that disrupts service to existing customers, directly with BMU staff.

3.3 ALIGNMENT AND GRADE

- A. The Engineer of Record shall furnish all the necessary line and grade stakes, benchmarks, or other necessary control.
- B. It is the responsibility of the Contractor to protect these stakes, and any replacement of stakes shall be at the expense of the Contractor.
- C. The Contractor shall carry alignment 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 Engineer of Record approval.
- D. If underground interference is encountered at the assigned grade, the Contractor shall notify the Engineer of Record and wait until the revised grade for the sanitary sewer system 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.

3.4 SEWER PIPE MATERIAL HANDLING & STORAGE

- A. All pipe, fittings, manholes and accessories shall be loaded and unloaded by a means to prevent shock or damage. Under no circumstances shall such material be dropped.

- B. Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times.
- C. Piping shall not be stacked higher than Manufacturers' recommendations according to size. The bottom tier of piping shall be kept off the ground on timbers, rails, or concrete. Pipe in tiers shall be alternated: bell, plain end; plain end, bell. At least two rows of timbers shall be placed between tiers, and chocks shall be affixed to each timber in order to prevent movement. The timbers shall be large enough to prevent contact between the pipes in adjacent tiers.
- D. Gaskets for push-on joints shall be stored in a cool location, out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

3.5 MATERIAL INSPECTION

- A. All pipe and appurtenances are subject to inspection by the Engineer of Record and/or BMU staff. Material found to be defective due to manufacture or damage in shipment shall be rejected and removed from the job site.
- B. 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 sanitary sewer. Pipe shall be protected during handling against impact, shocks, and free fall.
- C. The Engineer of Record and/or BMU staff may perform tests as specified in the applicable AWWA standard to ensure conformance with the standard. In case of failure of the pipe or appurtenance to comply with such specifications, responsibility for replacement of the defective materials becomes that of the Contractor or Manufacturer, even if piping and appurtenance has already been installed.
- D. The Engineer of Record and/or BMU staff 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.

3.6 BMU ACCESS TO PROJECT SITE

- A. The BMU Engineer or Engineers' Representative shall have access to all parts of the job at all times. The Contractor shall furnish personnel, facilities, equipment, tools, and materials as are necessary to make whatever tests and inspection that are required by the Contract Documents.
- B. The BMU Engineer reserves the right to inspect and/or reject any part of, or all unsatisfactory work performed by the Contractor. Rejected or unapproved work shall be promptly replaced or modified to comply with these specifications.

3.7 REMOVAL AND ABANDONING OF SANITARY SEWER PIPE AND MANHOLES

- A. Sanitary sewer main and sanitary sewer manholes shall be removed at the locations shown on the plans or as directed by the BMU Engineer. Sanitary sewer manholes shall be entirely removed and disposed of unless otherwise directed by the BMU Engineer.
- B. Sanitary sewer pipe, 10-inch diameter and larger shall be abandoned in place by filling entire pipe with flowable fill, unless otherwise indicated.
- C. Sanitary sewer manholes that are to be abandoned in-place shall be abandoned by removing the top 4-feet (min) below finished grade elevation, seal off any incoming piping with flowable fill, install a 2-inch minimum diameter hole in the base section of the sanitary sewer manhole, and fill the sanitary sewer manhole with granular material as directed by the BMU Engineer.

3.8 TRENCH EXCAVATION

- A. All sanitary sewer systems shall be built in open cut trenches, except where conditions warrant, the Engineer may permit the use of short tunnels.
- B. The Contractor shall excavate to the proper depth and width necessary for the construction of the pipe according to the plans and specifications. The width of the trench at the top of the pipe shall be a minimum of 12-inches on each side of the pipe.
- C. Trenches shall be excavated with vertical sides from pipe flow line to a point 1-foot above top of pipe where possible.
- D. Trench excavation below pipe grade shall be backfilled with bedding material to provide a uniform and continuous bearing and support for the pipe.
- E. Wherever, in the opinion of the Engineer of Record, the bottom of the trench does not afford a reliable or suitable foundation, the trench shall be excavated to such additional depth as is required and replaced with trench stabilization material. Pipe bedding material will be required in addition to trench stabilization material where trench stabilization material is used.
- F. The Contractor will be fully responsible for constructing the sanitary sewer system on a stable base and any defects resulting from improperly preparing the pipe foundation shall be the Contractor's responsibility.

3.9 DEWATERING

- A. Water resulting from the dewatering operation shall be disposed of in a manner approved by the Engineer of Record and South Dakota Department of Agriculture and Natural Resources (SD DANR). 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 BMU. All applicable permits must be obtained by the Contractor before the dewatering operation begins.
- B. Unless otherwise designated on project plans, it is the Contractor's responsibility to investigate soil conditions and/or review included geotechnical reports to determine what dewatering methods shall be required.

- C. Sanitary sewer main installation shall be constructed in a relatively dry trench. 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.
- D. 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.

3.10 SEWER PIPE INSTALLATION

- A. Installation of PVC 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 of Brookings.
- B. Sanitary sewer main shall be installed in the locations shown on the plans or as directed by the Engineer. Before installing the sanitary sewer main, it shall be cleaned of all foreign matter and kept clean thereafter. Open ends shall be protected at all times to prevent the entrance of dirt, trench water, animals, or foreign matter into the pipe. The bell and spigot shall be wiped clean and sufficient lubrication placed on the gasket and spigot before the pipe is pushed fully into the bell.
- C. Sanitary sewer main pipe which is stubbed for future extension shall end with a bell end with a short pipe with cap installed in the bell end which can be removed for future pipe extension.
- D. Every pipe shall be bedded uniformly throughout its length with sanitary sewer main bedding material. Care shall be taken to not have any part of the pipe bearing on rocks or stones.
- E. Sanitary 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.
- F. Pipe shall be carefully installed to line and grade in accordance with line and grade stakes set by the Engineer so that the finished sanitary sewer system will present a uniform bore. Any noticeable variations from true alignment or grade will be cause for rejection of the work.
- G. Pipe shall be installed up-grade with spigot ends pointing in the direction of flow.
- H. 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. Pipe must be properly fitted together.
- I. 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.

- J. Standard length pipe shall be utilized for all installations. Shorter lengths will only be allowed for use at sanitary sewer manhole terminations or sanitary sewer service wye locations. A full standard-length pipe shall be used upstream of all sanitary sewer manholes.

3.11 SANITARY SEWER PIPE JOINTS

- A. All PVC Sanitary Sewer Pipe shall be jointed utilizing elastomeric gaskets as referenced in ASTM D3034 and ASTM F679 and meeting the requirements of ASTM D3212.
- B. 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.
- C. 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.
- D. 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.

3.12 TRACER WIRE SYSTEM FOR SANITARY SEWER FORCE MAINS

- A. Tracer wire system, including terminal boxes, ground rods and all appurtenances, shall be installed with PVC sanitary sewer force main and shall be considered incidental to the sanitary sewer force main installation. The wire shall be installed along the lower quadrant of the pipe, but the pipe shall not be laid directly on the wire.
- B. Ground rods shall be installed adjacent to connections and at locations specified on the plans. The tracer wire shall be brought to each terminal box and connected to a 60-inch ground rod. Terminal boxes shall be placed at locations designated by the Engineer and no more than 1,000-feet apart from one another or as specified on the plan notes or drawings.
- C. All underground splices shall be inspected by the Engineer of Record and/or BMU representative prior to backfilling.
- D. Prior to the road surfacing be placed, BMU shall be responsible for testing and verifying that the tracer wire has been installed and operates correctly. If the tracer wire system does not function as intended, the Contractor shall repair the system to the satisfaction of the Engineer of Record or BMU representative. Any costs associated with making the repairs to the tracer wire shall be at the Contractor's expense.

3.13 SANITARY SEWER MANHOLES

- A. All sanitary sewer manholes shall be constructed to meet the requirements of the latest revision of ASTM C478, "PRECAST REINFORCED CONCRETE SANITARY SEWER MANHOLE SECTIONS," and all related ASTM Specifications. Engineer of Record shall determine if manhole liners are required and indicate on Bid Form.

- B. All sanitary sewer manholes are to be built to the dimensions shown in the plan sheets, special information, detail plates, or cut sheets furnished by the Engineer of Record. All sanitary sewer manhole sections shall be numbered and/or measured by the Contractor prior to installation to assure that the finished sanitary sewer manhole will be installed to grade as specified on the plan sheet or grade sheet.
- C. Base and Sections
1. Where precast concrete sections are used, the base section shall be cast with proper cutouts to accommodate the required sanitary sewer pipes. Precast sections shall be connected together using a specified gasket material and shall be in place on all sanitary sewer manhole joints to assure watertight joints. All lift holes on the interior and exterior of the sanitary sewer manhole sections shall be filled with non-shrink grout. Where installation of lift-hole plugs are required, they shall be installed into the center of the sanitary sewer manhole wall. The area on either side of the lift-hole plug shall be filled with non-shrink grout.
 2. All sanitary sewer 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.
 3. All sanitary sewer manholes that are constructed shall be built with the base and bottom barrel section being precast together in one integral concrete pour to form a monolithic base section. 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 sanitary sewer manhole details in the Standard Plates.
 4. Sanitary sewer manholes shall not be constructed at the Manufacturer or in the field with piping installed in the sanitary sewer manhole boots prior to setting the sanitary sewer manhole in the trench. This type of installation will be cause for rejection of the work.
 5. Doghouse base section is typically not allowed, unless the BMU Engineer determines there is no other feasible method of installation. If allowed, the Contractor shall submit detailed drawings and specifications including, but not limited to, waterstop pipe connectors, non-shrink grout compounds, etc. for review and prebid BMU Engineer approval.
- D. Bench and Invert
1. 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 the BMU sanitary sewer television camera to be installed into the invert and into any pipe connection into the sanitary sewer manhole. Where lateral connections are required into the sanitary sewer manhole, a gradual change in the direction of the sanitary sewer manhole invert for each lateral shall be formed. Sharp angles without gradual changes in direction will not be allowed. Flat bottomed sanitary sewer manholes will not be allowed. Such work will be cause for rejection of the work.

2. Where hand formed and reconstructed sanitary sewer manhole bench and inverts are determined necessary by the Engineer, they shall be constructed with concrete. The sanitary sewer 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.

E. Adjustment Rings

1. The preferred adjustment ring height shall be 4-inches, with a 12-inch maximum of adjustment on each sanitary sewer manhole. Unless otherwise specified, the sanitary sewer manhole cover shall be set approximately 6-inches below the finished street elevation by the sanitary sewer Contractor to be raised to finished grade elevation by the Contractor prior to paving.
2. The HDPE adjustment 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 HDPE adjusting rings. The annular space between the adjusting rings shall be sealed using an approved butyl rubber sealant.

F. Sanitary Sewer Manhole External Frame Seal

1. Sanitary sewer manhole external frame seals shall be used on all manholes. The sanitary sewer manhole external frame seal shall extend onto the casting and the cone section a minimum of 2-inches. Sanitary sewer manhole external frame seals shall be installed in accordance with the Manufacturer's recommendations.

G. Frame and Cover

1. Sanitary sewer manhole frame and covers shall be installed in accordance with the Standard Plates or as specified.
2. Sanitary sewer manhole frames installed onto HDPE adjusting rings shall be installed using the Manufacturer's recommended sealant between the frames and adjusting rings to form a watertight seal.
3. Sanitary sewer manhole frames offset by more than 2-inches from the adjusting rings or corbel section will be rejected.
4. Sanitary sewer manhole frames and covers shall be set to the grade specified on the grade sheet and plans. Refer to the Standard Plates for setting the frame and covers to grade, either by the circular cutout method or setting the frame and lid to grade (including side slope) prior to any asphalt lifts.
5. Sanitary sewer manhole frame and covers in permanent gravel surfaced streets shall be vertically installed so that the sanitary sewer manhole rim is set 12 to 18-inches below the finished street grade.
6. Sanitary sewer manhole frame and covers placed on the sanitary sewer manhole riser prior to final surfacing shall be bolted to the corbel section with a continuous band of butyl rubber rope gasket between the frame and the corbel section.

H. Sanitary Sewer Manhole Boots

1. The precast base section shall also contain watertight gaskets, adaptors, or sealers to ensure a leak-proof connection between the sanitary sewer manhole and the sanitary sewer pipes entering the sanitary sewer manhole.
2. Connections shall be flexible and/or pliable enough to allow for deflection from shifting or settling of the sanitary sewer manholes and to accommodate the pipe on grade. The connections shall also be capable of adapting to the various sizes and types of sanitary sewer pipe that may be used.
3. When futures 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 sanitary sewer manhole.

I. Drop Sanitary Sewer Manholes

1. Drop sanitary sewer manholes shall be constructed in accordance with the Manufacturer's recommendations and as shown on the Standard Plates. The drop bowl shall be fastened securely to the wall of the manhole with stainless steel fasteners.
2. The sanitary sewer main inlet shall protrude through the sanitary sewer manhole to the edge of the drop in the bowl, where the Contractor shall make a 1 1/4-inch long 60-90 degree v-notch in the bottom of the sanitary sewer main inlet to provide improved flow control.
3. The PVC drop section shall be secured to the barrel section with stainless steel adjustable clamping. Clamps shall be required 6-inches maximum from the bottom 45 degree solvent weld elbow and 6-inches maximum from the drop bowl, with 4-foot" maximum spacing between clamps. A 45-degree bend shall be installed on the bottom of the drop to direct the flow towards the channel.
4. The stainless steel fasteners shall not be allowed to penetrate the precast sanitary sewer manhole section.

3.14 SANITARY SEWER MANHOLE LINERS

- A. The work shall include furnishing all labor, materials, equipment, and incidentals required to install sanitary sewer manhole sheet liner with studded backside in concrete sanitary sewer 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.
- B. 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.
- C. 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.

- D. Coverage of the lining shall not be less than the minimum specified or as shown on the plans. Sanitary sewer manholes and concrete structures shall be fully lined on the interior, including man-way openings, unless otherwise shown or specified.
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. Liner Submittals
 - 1. Submit to the Engineer of Record 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.
- M. 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:
 - a. 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.
 - b. 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.
 - c. 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.

N. Installation

1. 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
 - a. 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.
 - b. Non-Destructive 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.

- c. 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

a. Non-Destructive 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.

3.15 SANITARY SEWER MANHOLE VERTICAL ADJUSTMENT RECONSTRUCTION

- A. Any sanitary sewer manhole that cannot be adjusted within the 12-inch height limit for adjusting sanitary sewer manholes shall be reconstructed.
- B. When an existing sanitary sewer manhole is lower than the proposed finished grade elevation, the sanitary sewer 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 sanitary sewer manhole height to a level that the sanitary sewer manhole can be adjusted using the appropriate height of adjusting rings.
- C. When an existing sanitary sewer manhole is higher than the proposed finished grade elevation, the sanitary sewer 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 sanitary sewer manhole height to a level that the sanitary sewer manhole can be adjusted using the appropriate height of adjusting rings.

3.16 MANHOLE CONSTRUCTION PLATE MARKER

- A. The sanitary sewer manhole construction plate markers shall be used on all BMU, City of Brookings projects or development projects.

- B. Sanitary sewer manhole construction plate markers shall be installed on existing sanitary sewer manholes immediately after construction surfacing removals have been completed and on new sanitary sewer manholes immediately after installation.
- C. The markers, on asphalt streets, shall remain on the sanitary sewer manhole until after the first lift of asphalt is installed (with exception to when any internal sanitary sewer manhole construction work may need to be performed).
- D. The markers on concrete streets shall remain on the sanitary sewer manhole until concrete paving occurs.
- E. The Contractor shall ensure that all sanitary sewer manholes are secured, protected, and watertight at the end of each work day. Under no circumstances shall an uncompleted or completed sanitary sewer manhole be left uncovered, unprotected, or not watertight overnight.

3.17 CONNECTIONS TO EXISTING SANITARY SEWER MANHOLES

- A. The Contractor shall cut the necessary openings into the existing sanitary sewer manholes and make the connections thereto in a neat and workmanlike manner. If the Contractor is unable to make the necessary penetration(s), BMU will make the opening and invoice the Contractor for the work completed.
- B. The connections shall be made so as to make the joints around the entering sanitary sewers watertight and an approved smooth channeled flow line shall be constructed. All existing cast-in-place, precast, and block-type sanitary sewer manholes shall be core drilled, and sanitary sewer manhole boots shall be installed for the pipe connection.
- C. Where existing sanitary sewer manholes are constructed of brick, cobblestone, or other materials determined by the BMU Engineer that cannot be core drilled, pipes shall be grouted into the sanitary sewer manhole wall with non-shrink 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.
- D. All sanitary sewer manhole bench and inverts shall be reconstructed as a part of the connection to the existing sanitary sewer manhole.

3.18 EXTENSIONS FROM SANITARY SEWER MANHOLES

- A. Futures from sanitary sewer manholes shall be defined as piping and plugs that extend longer than one standard 13-foot section of pipe. Futures shall be plugged with a watertight plug at a bell end section of pipe.
- B. Stubs from sanitary sewer manholes shall be defined as a 5-feet or less section of pipe with a plug at the bell end or capped on a plain end section of pipe.
- C. Stubs and futures from a sanitary sewer manhole shall be installed to grade.
- D. Connecting onto stubs will not be allowed. Stubs must be removed from the existing sanitary sewer manhole when connections to the sanitary sewer 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 sanitary sewer manhole unless otherwise specified.

3.19 PIPE COUPLINGS

- A. Pipe couplings are typically not allowed, but if deemed necessary by the Engineer of Record, connect two spigot ends of the same diameter pipe together if the bell and spigot connections are not possible. Reducing couplings shall not be allowed.

3.20 SERVICE CONNECTIONS

- A. For all new sanitary sewer mains, prefabricated wyes shall be installed for all sanitary sewer service stub-out locations and sealed with an approved watertight cap or plug. Wyes with the same branch pipe diameter as the main line sanitary sewer will not be permitted.
- B. All taps of the existing sanitary sewer main shall be made by BMU where the sanitary sewer main is clay pipe material. BMU will provide the saddle and all equipment necessary to make the tap into the clay pipe. Taps on existing clay pipe shall be made by tapping the line and using a saddle to connect the service pipe to the main line. Cutting out a section of main line pipe and installing a wye and couplings will not be permitted.
- C. All wyes or taps which are not to be immediately connected shall be closed with a watertight cap or plug. All wyes and stub-outs shall be marked with a marker to help relocate them and prevent breakage when excavating. All stub-outs shall be capped and sealed.

3.21 BEDDING, BACKFILL, COMPACTION AND COMPACTION TESTING

A. Bedding of Pipe

1. The trench base shall be undercut a minimum of 6-inches below the bottom of the pipe and uniformly backfilled with bedding material to 6-inches above the pipe.
2. Pipe shall be installed on top of the first layer of bedding material and the pipe shall be backfilled with bedding material up to the "spring-line" (halfway) on the pipe. 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.
3. Care shall be taken in placing backfill over the crown of the pipe to avoid damage to the pipe. Care shall be taken to prevent dislodging and misalignment of the pipe and to provide adequate bell hole for the pipe.
4. All sanitary sewer service lines shall be installed with bedding material from 2-inches below the pipe to 2-inches above the top of the pipe.

B. Initial Backfilling of Pipe Trench

1. Above the bedding area the pipe shall be backfilled with acceptable native material (Class I, II, and III as described in C605), approved by the Engineer of Record and compacted to 95-percent Standard Proctor Density to 12-inches above the top of the pipe bedding.
2. If unacceptable initial backfill material is not found onsite, Contractor shall furnish and install import engineered fill or clay material in the initial backfilling

area. Imported material shall be placed in a minimum of two (2) lifts and compacted to a minimum of 95-percent Standard Proctor Density to 12-inches above the top of the pipe bedding.

3. The initial backfill shall be placed evenly so as not to disturb the grade or line of the pipe.
4. Stones larger than 3 inches in diameter shall not be placed within initial backfill of the pipe trench. Care shall be taken in placing backfill over the pipe to avoid damage to the pipe.
5. Native material for all initial backfilling of the pipe trench shall be free of debris, frozen material, large clods or stone, organic matter or other unstable material. Stones larger than 3-inch in diameter shall not be placed within the initial backfill area.

C. Final Backfilling of Trench to Grade

1. All final backfill material shall consist of acceptable native excavation material, approved by the Engineer of Record, and shall be placed in maximum 12-inch lifts and compacted by suitable and approved compaction methods in a manner to achieve at least 95-percent Standard Proctor Density, or as otherwise specified.
2. If unacceptable final backfill material is encountered in the trench excavations, it shall be replaced with other suitable material available at the project site, imported engineered fill, imported clay material or with other suitable imported material, as approved by the Engineer of Record.
3. At least 12-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.
4. Material for all areas of backfilling is to be free of debris, frozen material, large clods or stone, organic matter or other unstable material.
5. 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.
6. Excess material not required for final backfilling shall be removed by the Contractor or otherwise disposed of as directed by the Engineer.

D. Moisture Control and Stability

1. The moisture content of backfill material should be adjusted to a moisture level that is within plus or minus two (2) percent of optimum moisture content as determined by a standard proctor (ASTM: D698).
2. The moisture content of granular backfill material should be maintained at a level that will be conducive for vibratory compaction.

E. Road Surfacing Base Material

1. Material used under concrete and asphalt surfacing shall meet the requirements as indicated in the Products section of these specifications for "AGGREGATE BASE MATERIAL".

2. Base material shall be placed in maximum 6-inch lifts and compacted by suitable and approved compaction methods in a manner to achieve at least 97-percent Standard Proctor Density, or as otherwise specified.

F. Compaction Testing Requirements

1. All bedding and backfill areas shall be subject to compaction testing by nuclear or standard methods according to the latest applicable ASTM Specifications.
2. Frequency of compaction tests shall be completed in accordance with South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridges, current edition.
3. The areas requiring compaction testing shall include the bedding, initial backfill, final backfill, road surface base and gravel surfacing, as defined in the previous sections.
4. The Engineer of Record may require 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 re-compact said material at no additional cost to the Owner, and the Engineer of Record shall then have the right to take additional compaction tests to assure that this material is compacted to the proper density without any additional cost to the Owner.

3.22 UNDERGROUND INTERFERENCE

- A. The location of underground public or private utilities may be shown on the plans, as reported by the various utility companies and BMU, but this does not relieve the Contractor of the responsibility of contacting SD ONE CALL and 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 of Record.
- B. 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.
- C. Portions of utilities which are found to interfere with the alignment and grade of the sanitary sewer main will be relocated, altered, or reconstructed by the Owners, or the Engineer may order changes in the work to avoid interference.
- D. 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 alignment and grade.
- E. Unless otherwise noted, all costs of exploratory investigation or excavations necessary for determining the location and depth of utilities shall be included in the contract bid price for installing pipe.

3.23 SANITARY SEWER AND WATER MAIN SEPARATION

A. Horizontal Pipe Separation

1. Sanitary sewer shall be laid at least 10-feet horizontally from any existing or proposed water mains. The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10-foot pipe separation, BMU may allow deviation on a case-by-case basis, if supported by data from the Engineer of Record. Such deviation may allow installation of the sanitary sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sanitary sewer main with the bottom of the water main 18-inch above the top of the sanitary sewer.

B. Vertical Pipe Separation for Water Main Crossings

1. The vertical separation between the water main and sanitary sewer main shall be constructed to provide a minimum of 18-inches of vertical separation from the outside of the sanitary sewer main to the outside of the water main. This shall be the case where the water is either above or below the sanitary sewer with preference to the water main located above the sanitary sewer.
2. The crossing shall be constructed so that a full length water main pipe be used and the pipe joints will be equidistant and as far as possible from the water main.
3. In the event 18-inches of vertical pipe separation cannot be maintained, adhere to one of the following:
 - a. Use vertical bends to lower the water main under the sanitary sewer main.
 - b. Install an encasement pipe around the water main. The encasement pipe shall be 20-foot minimum in length, centered where the pipes intersect, and sealed at both ends with end seals.

3.24 SANITARY SEWER AND STORM SEWER SEPARATION

A. Horizontal Pipe Separation

1. Sanitary sewer shall be laid at least 10-feet horizontally from any existing or proposed storm sewer mains. The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10-foot pipe separation, BMU may allow deviation on a case-by-case basis, if supported by data from the Engineer of Record. Such deviation may allow installation of the sanitary sewer closer to a storm sewer main, provided reinforced concrete pipe (RCP) storm sewer pipe be assembled with either:
 - a. A gasket that conforms to ASTM C443 specifications (generally available for round RCP pipe up to 72-inches), OR:
 - b. A watertight sealant meeting ASTM C990, AASHTO M 198, and Federal Specification #SS-S-210-A.

B. Vertical Pipe Separation for Storm Sewer Crossings

1. The vertical separation between the sanitary sewer and storm sewer main shall be constructed to provide a minimum of 18-inches of vertical separation from the outside of the storm sewer main to the outside of the sanitary sewer. The minimum vertical separation of the sanitary sewer and the storm sewer is dependent on the size of the storm sewer pipe. Larger diameter storm sewer

pipes have a greater minimum clearance to prevent sanitary sewer pipes from freezing.

2. In the event that vertical pipe separation cannot be maintained, adhere to one of the following:
 - a. Install an encasement pipe around the sanitary sewer. The encasement pipe shall be 20-foot minimum in length, centered where the pipes intersect, and sealed at both ends with end seals AND install rigid insulation between the storm sewer and sanitary sewer.

3.25 SANITARY SEWER SERVICES

- A. The sanitary sewer service is the pipe that conveys raw wastewater to the public sewer from the private structure, including but not limited to residential, commercial, industrial, institutional and other such connections. All sanitary sewer service installation methods and procedures shall conform to the Local, State or National Plumbing Code.
- B. Sanitary sewer service pipe shall be bedded in accordance with the requirements of "BEDDING, BACKFILL, COMPACTION AND COMPACTION TESTING".
 1. The BMU Inspector shall observe the backfill and compaction of the sanitary sewer service. If the BMU Inspector questions the licensed Plumbing Contractor's means and methods for backfill and compaction, BMU will coordinate and hire a SD licensed Geotechnical Engineer to perform a compaction test to determine if the backfilled trench meets the compaction testing requirements.
 - a. If the compaction test meets the compaction requirements of these specifications, BMU will pay the Geotechnical Engineer for all the associated costs.
 - b. If the compaction test fails, the licensed Plumbing Contractor shall be responsible for reimbursing BMU for the Geotechnical Costs. BMU will pay the Geotechnical Engineer and bill the licensed Plumbing Contractor directly for the costs of a failed tests.
 - Upon a failed test, the Geotechnical Engineer shall provide a recommendation to the Contractor as to how the trench shall be backfilled and compacted to meet the requirements set forth in these standard specifications.
 - The Contractor shall be responsible for all costs associated with backfilling the trench, including but not limited to, removing the failing material, drying, importing and installing dry material, removing failing material from site, compaction and re-testing by the Geotechnical Engineer.
- C. All sanitary sewer services shall have a nominal inside diameter of not less than four (4) inches. Sanitary sewer services shall be laid at a minimum slope of 2.0% (1/4-inch per foot) and a maximum slope of 4.0% (1/2-inch per foot) to the right of way or property line.
 1. From the right of way line to the structure, sanitary sewer service pipe may laid at a minimum slope as defined in the South Dakota Department of Agriculture

and Natural Resources (SD DANR) "RECOMMENDED DESIGN CRITERIA MANUAL FOR WASTEWATER COLLECTION AND TREATMENT FACILITIES"

- D. 4-inch and 6-inch diameter sanitary sewer services shall not be directly connected to manholes.
- E. Cleanouts are required for sanitary sewer service lines greater than 75-feet in length or change in horizontal direction, and shall be used only in approved locations.
 - 1. Cleanouts shall be required to be brought to grade every 75-feet (maximum) for 4-inch sanitary sewer services and every 100-feet (maximum) for 6-inch sanitary sewer services.
 - 2. Cleanouts shall be covered at finished grade with a frame and cover.
 - 3. 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".
- F. Glued connections will only be allowed at the connection between the SDR 35 or SDR 26 and the Schedule 40 PVC pipe at the building.
- G. PVC service lines shall be plugged at a bell end section of pipe. If a cap is to be used, the cap shall be glued to the service stub to accommodate an air pressure test, infiltration test or exfiltration test.
- H. 22 1/2-degree bends shall not be located closer than 3-feet from each other.
- I. Couplings, on new construction, will not be allowed unless the building's sanitary sewer stub-out exists before the sanitary sewer 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.
- J. All sanitary sewer service lines shall be installed with a marker to help locate them and prevent breakage when excavating the service.
 - 1. Sewer service shall be marked by a vertical 4-inch PVC pipe or an approved marker. The top 1-foot portion of the marker should be painted green.
 - 2. The marker should be placed near the termination point of the sanitary sewer service.
 - 3. The sanitary sewer service marker shall remain in place and be maintained by the Developer or Property Owner until the sanitary sewer service is extended into the property to serve a house, building, or other structure.
- K. Sanitary sewer service risers shall be installed when the depth is 20-feet or more from the sanitary sewer main invert to the proposed road grade.
 - 1. Elevations for an approved sanitary sewer service riser shall be determined by the Engineer of Record or Property Owner.
 - 2. The in-line wye, pipe and fittings (bends) shall be PVC SDR 26 until the sanitary sewer service is 5-foot (min) onto virgin ground. After the sanitary sewer service is installed 5-foot (min) onto virgin ground, the sanitary sewer

service may revert to ASTM D3034 with a SDR 35 rating, unless otherwise specified.

3. Pipe bedding material shall be required from the center of the carrier sanitary sewer main up to where the sanitary sewer service riser is anchored to the virgin soil to ensure the sanitary sewer service shall be stable when backfilling.
- L. Sanitary sewer services installed via directional boring or hole-hogging are to be installed as indicated on the project plans with prior approved by the BMU Engineer.
1. 4-inch to 6-inch sanitary sewer service piping and fittings installed via directional boring or hole hogging shall conform to the latest revision of ASTM D3034, SDR 26. SDR 26 PVC pipe and fittings shall be used from one end of the directional bore or hole-hog to the other end of the directional bore or hole-hog.
 2. On either side of the directional bore or hole-hog the sanitary sewer service may be reverted to ASTM D3034 with a SDR 35 rating, if depth allows.
 3. Prior to inspection, the Contractor shall be required to clean the sanitary sewer service line which has been directional bored or hole hogged with a bean machine or etc., and get all excess debris and water out of the sanitary sewer service line.
 4. The Contractor, as witnessed by BMU staff, shall then pour a determined amount of water, such as five gallons, in the high end of the sanitary sewer service line with a minimum of 95% of the water being retrieved at the low end of the sanitary sewer service line for the service line to pass inspection. This is to ensure that there are no sags in the sanitary sewer service line where directional boring or hole hogging was utilized.
- M. All sanitary sewer service taps must be adequately supported prior to backfilling. The Contractor must coordinate all BMU installed sanitary sewer service taps with BMU crews.
- N. The trench for the sanitary sewer service taps shall be excavated to meet all applicable OSHA trench safety requirements prior to any work to be completed by BMU personnel. If the trench is unsafe to complete sanitary sewer tapping operations, the Contractor shall be required to provide the necessary additional work to ensure safety of the trench to the satisfaction of the BMU tapping personnel.
- O. At locations where reconnecting sanitary sewer service lines to the new sanitary sewer main, all new service lines shall be connected with a wye connection.
1. A tapping tee will only be allowed where determined necessary by the BMU Engineer. A coupling will be allowed for connecting the new service line to the existing service line.
- P. Existing clay service lines that are to be abandoned shall be capped with non-shrink grout placed continuously for a 1-foot distance into the pipe.

3.26 ABANDON SEPTIC TANK

- A. If a sanitary sewer service is being installed to replace an existing septic tank system, the Contractor shall decommission the septic tank after installation of the sanitary sewer service.
- B. If the septic tank system is not completely removed, the Contractor shall pump out and dispose of all existing sludge in the septic tank and then remove and dispose of the top section of the concrete septic tank.
- C. The Contractor shall break up or punch holes in the floor of the remaining bottom section of the septic tank to allow the ground water through and keep the tank from floating. The Contractor shall fill the septic tank with IMPORTED ENGINEERED FILL MATERIAL.

3.27 BACKFLOW PREVENTER INSTALLATION

- A. Backflow preventers shall be installed on all new construction with sub-grade levels. Slab on grade buildings or basement injector pumps are exempt from this requirement. The backflow preventer shall be plumbed on the main sewer service main to protect sub-grade levels from surcharges in the public sanitary sewer collection system. Sanitary sewer flows from the at-grade and/or above-grade levels shall be plumbed to by-pass the backflow preventer.
- B. Installer shall follow backflow preventer manufacturer's installation requirements and ensure the 2% minimum slope on the sewer service line continues through the backflow preventer valve installation. All new construction shall have the backflow preventer installed within the building footprint for accessibility and maintenance purposes. An exterior located backflow preventer valve will not be allowed on new construction.
- C. Backflow preventers, installed with new construction, shall be installed in the mechanical, or utility room. Plumber shall be responsible for installing the backflow preventer per the requirements of these specifications and SD State Plumbing Code. Backflow preventers installed in finished areas or areas that will be finished at a later date (future living rooms, bedrooms, etc.) shall not be allowed and shall be relocated to an approved location.
- D. The access cover for the backflow preventer shall be brought up to the sub-grade finished floor for ease of access and maintenance as required by SD State Plumbing Code 710.6.
- E. Installer shall install a 4.5"x4.5" (minimum size) adhesive-backed sticker indicated that a backflow preventer is installed at this location and be affixed in a visible spot near the backflow preventer installation. Sticker shall include information to let the customer know that there is backflow preventer installed in this location and that regular maintenance is required with this type of equipment.

3.28 CASING PIPE VIA BORING (JACKING)

- A. Additional technical specifications shall be included with project plans and specification to ensure correct installation of the bore and casing.
- B. It shall be the responsibility of the Contractor to maintain the alignment and grade specified. The boring (jacking) specifications shall be in accordance with these specifications, plan sheets, plan notes and Standard Plates.

3.29 TEMPORARY SANITARY SEWER BYPASS SYSTEM

- A. The Contractor shall coordinate with all property Customers for a planned disruption of sanitary sewer service or accessibility issues created by the temporary sewer main bypass system.
- B. Contractor shall provide a 24-hour contact person who has adequate parts and equipment readily accessible to make necessary repairs to temporary sanitary sewer main bypass system in a timely manner.
- C. The Contractor shall contact all property Customers (that are at the property at the time of service interruption) along any sanitary sewer main project where the property Customers 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 Customers not to discharge sanitary sewer during the time(s) when the Resident's sanitary sewer service is not connected to the BMU 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.
- D. The Contractor shall also install door hangers (furnished by the BMU) on each affected property Customers door. The door hanger shall indicate the time when the property will not be allowed to discharge sewage to the sanitary sewer system and a Contractor phone number for answering questions.
- E. Sanitary Sewer Bypass System
 - 1. A minimum of 2-weeks prior to bypass pumping, the Contractor shall submit a detailed written description, with detailed drawing, of the temporary sanitary sewer bypass system for BMU Engineer approval.
 - a. The submittal shall include information on the quantity, capacity, and location of all pumping equipment. The submittal shall include pump Manufacturers' pump performance curves.
 - b. The size, type, and routing of all suction and discharge piping shall be provided. Materials, joint types, and calculated static head and friction values for flows and diameters relative to the length of discharge piping for the bypass shall be submitted.
 - c. When calculating static head, Contractor should take into account the maximum discharge pipe elevation. The Contractor shall also provide a written emergency plan.
 - 2. The BMU Engineer shall be given written notice, at least 2-days in advance, of intent to commence sanitary sewer bypass pumping operations.
 - 3. Bypass piping required for an extended period of time, if directed, shall be buried or covered by granular material ramps where the pipe crosses bike trails, sidewalks, driveways, roads, pedestrian crossings, entrances, etc.
 - 4. When bypass pumping is in operation, bypass system shall be monitored continuously by personnel familiar with the bypass pumping system operation and maintenance, and has in possession the BMU Engineer approved written emergency plan. Contractor shall provide the necessary labor, equipment and fuel to ensure uninterrupted and sufficient pumping at all times. Bypass

pumping will be required for the duration of the project until the new sewer main has passed all required tests and is capable of conveying the wastewater flows.

5. Where existing flow cannot be maintained, interruption of service shall be minimized such that no discharge of sanitary sewage to any natural waterway, storm sewer, open trench, trench excavation, ground surface, street, gutter or any other place which may constitute a health hazard.
6. The Contractor is hereby notified that the temporary bypass system is critical to the Owners' overall operation. The Contractor shall provide adequate supervision, fuel, labor and materials to ensure continuous operation of the temporary sanitary sewer bypass system. The Contractor shall be liable for any environmental damages, sewage backups in homes or fines caused by the failure to maintain continuous operation of the temporary bypass system.
7. Bypass operations must be approved by the Owner and/or BMU Engineer before starting. Bypass pumping equipment shall include pumps, piping, and related equipment necessary to divert the flow of sewage around the section in which the work is to be performed. In addition, the Contractor shall maintain at the same location and in operable condition, duplicate equipment to be used in case there is equipment failure. In this event, the Contractor shall promptly repair or replace the failed equipment to the satisfaction of the BMU Engineer. The new sewer line may be used by the Contractor to carry the sanitary flows after the new pipe has passed inspection and required testing. Any "temporary" connections to the new sewer main are subject to BMU Engineer approval.
8. All pumps and piping systems shall have sufficient capacity to accommodate the peak flow of the sanitary sewer main being bypassed. The temporary bypass shall consist of no less than 2-pumps at each pumping location and each must be capable of conveying the peak flow with any single pump out of service. The pumps shall be provided with suction piping and plumbed as required. Only specified sanitary sewer manholes may be used for sewage access. To achieve favorable pumping conditions and to prevent suction lines from impacting the flow in the interceptor, temporary sumps shall be installed at the Contractor's desired pumping locations as per the BMU Engineer approved Contractor's detailed drawing. The sump is to be installed adjacent to BMU Engineer approved sanitary sewer manholes and in accordance with the temporary bypass Supplier's requirements. The pumps and drives shall be rated for continuous duty and shall be capable of pumping the flow range without surging, cavitation's, or vibration. The pump shall not overload the driver at any point on the pump-operating curve. The pump shall be suitable for use with raw unscreened sewage and trash.
9. The pump shall be a self-contained unit designed for temporary use. All pumps shall be equipped with prime assist features to ensure re-prime. Pumps shall be capable of re-prime lift of up to 15-feet. The pumps must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of wastewater flows. The Contractor shall provide the necessary start/stop controls for each pump.
10. See Standard Plates for bypass pump and piping arrangement requirements. Provide pressure gauges on the suction and discharge side of all pumps. The Contractor shall provide a flow meter at the discharge of each pump used for

the bypass for mains 24-inches and larger. Provide LCD displays capable of showing instantaneous, peak, daily and monthly flows with an accuracy of +/- 5%. Provide mechanical indicators on all check valves. Field demonstrate two points on the pump curve for each pump to verify capacity. The bypass pumping system shall be in operation a predetermined time prior to any existing piping may be removed. At the bypass location, pumps, motors, engines, suction sanitary sewer manholes and generators shall be surrounded by a safety fence.

11. Sanitary sewer manholes and/or sumps opened for use as suction or discharge points must be kept sealed to prevent odors from escaping.

- F. Contractor shall comply with City sound ordinance and obtain a noise permit if pumping is required between the hours of 10:00 PM and 7:00 AM. Each pump setup shall meet the following noise requirement as measured on the dBA scale at the measured distance from the suction point: 85 dBA at 23 feet.
- G. Temporary electric power for the temporary sanitary sewer bypass system pumps may be available at a cost to the Contractor. Contact Brookings Municipal Utilities for temporary electric power availability and cost estimates.
- H. The sanitary sewer bypass system shall be hydrotested at 50-psi prior to commencing bypass pumping. The system shall hold the pressure for a minimum of 1-hour without dropping more than 5-psi. If pressure drops more than 5-psi, the Contractor must drain the line and retest after repairs have been made. Water for hydrotesting may be drawn from a BMU fire hydrant, which shall be operated only by BMU Personnel. The Contractor will not be charged for water usage for hydrotesting. Discharge shall go into the BMU sanitary sewer system.
- I. The Contractor shall provide adequate fittings for the discharge piping to accommodate flushing after use. Discharge pipes shall be flushed after each use before they can be moved. Water for flushing the bypass lines may be drawn from a BMU fire hydrant, which shall be operated only by BMU Personnel. The Contractor will not be charged for water usage for flushing the discharge pipes. Discharge shall go into the BMU sanitary sewer system.
- J. The temporary sanitary sewer bypass pumping system supplier shall be prebid BMU Engineer approved:

3.30 SURFACE RESTORATION

- A. The Contractor shall replace all surface material and shall restore paving, curb and gutter, sidewalks, lawn irrigation, fences, trees, sod, topsoil, and other items disturbed to a condition equal to or better before the work began; furnishing all labor, materials, and equipment necessary to do this work. Surface restoration shall conform to all City or DOT right-of-way requirements.

3.31 CLEANING AND CCTV INSPECTION

- A. After each section of sanitary sewer between sanitary sewer manholes has been completely installed and backfilled, the line and sanitary sewer 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.

1. The repair of leaks may require the removal and replacement of sanitary sewer manhole sections and pipe sections.
 2. The use of grout to repair leaks will not be allowed.
 3. The actual method of correction shall be approved by the BMU Engineer prior to performing the repair.
- B. 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 and manholes unacceptable for final acceptance and usage.
1. BMU will not be responsible for cleaning mains prior to televising the sewer.
 2. 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.
- C. BMU will perform an inspection of the completed sewer line through the use of a closed circuit television camera. The expense of the initial television inspection and one additional re-inspection will be borne entirely by BMU.
1. If defective workmanship of material or construction is noted, the deficiency shall be corrected by the Contractor at no expense to the Owner.
 2. BMU 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 and one additional re-inspection will be borne entirely by the Contractor.
 3. 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.

3.32 DEFLECTION TEST

- A. Deflection tests shall be performed by the Contractor on all PVC sanitary sewer mains.
1. The Contractor shall provide and pull a BMU approved deflection gauge (mandrel) device through the sanitary sewer main after the sanitary sewer main backfilling has been completed.
 2. The diameter of the deflection gauge device shall be 95-percent of the un-deflected 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.
 3. All pipes exceeding the 5-percent deflection within the initial deflection test and within the corrective period (warranty period) shall be re-laid or replaced by the Contractor at no additional cost to the Owner.
 4. The Contractor shall be responsible for all restoration costs, including all streets, alleys, boulevards, etc.

3.33 SEWER PIPE INFILTRATION/EXFILTRATION TEST

- A. Sanitary sewer piping shall be tested using one of two methods, infiltration test or pipe exfiltration test (low pressure air test).
 - 1. 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 of Record.
 - 2. 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 of Record. Exfiltration testing of the pipe with water will only be allowed where specifically specified.
- B. 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 BMU Engineer.
- C. Repair of leaks may require the removal and replacement of pipe sections. The use of grout to repair leaks will not be allowed.
- D. The Contractor shall notify the BMU Engineer 24-hours prior to performing the test to enable the Engineer and/or representatives to be present during the testing operations. All data will be recorded and evaluated by the Engineer. All lined sanitary sewer manholes and pipe shall be tested prior to welding the joints.
- E. Infiltration Test
 - 1. This test shall be performed by the Contractor using a V-notched weir in the downstream sanitary sewer 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 sanitary sewer manhole to the next adjacent sanitary sewer manhole). The V-notched weir shall have volumetric calibrations (gallons/24 hours) and shall be easy to read.
 - 2. 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 sanitary sewer 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 sanitary sewer manhole installation.
- F. Pipe Exfiltration (Water) Test
 - 1. 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.

2. 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:
 - a. 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.
 - b. Place watertight bulkhead in inlet of the upstream and downstream sanitary sewer manholes of sewer to be tested.
 - c. Fill section of sewer and upstream sanitary sewer manhole with water until the elevation of water in the upstream sanitary sewer 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.
 - d. Allow the water to stabilize for 1/2-hour, then fill the sanitary sewer manhole with water to the original level and begin the test.
 - e. The amount of water lost in the sanitary sewer manhole during 1-hour will be measured and used to determine the exfiltration. The maximum allowable drop in vertical water height in the sanitary sewer manhole shall be 1/4-inch for all diameter sanitary sewer manholes. If the water level in the sanitary sewer manhole drops below the allowable drop amount, the Contractor shall repair the leak and retest.

G. Pipe Exfiltration (Low Pressure Air) Test

1. 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.
2. The Contractor shall adhere to the following procedure for testing the sanitary sewer pipe:
 - a. 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.
 - b. Isolate the section of sewer line to be tested by inflatable stoppers or other suitable test plugs.
 - c. 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.
 - d. 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.
 - e. Add air slowly to the test section until the pressure inside the pipe reaches 4.0-psi.

- f. After the pressure of 4.0-psi is obtained, regulate the air supply so that the pressure is maintained between 3.5-psi 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-psi is required.
- g. Determine the rate of air loss by the time-pressure drop method.
- h. 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:
 - 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 the Low Pressure Air Test Table and are also listed in ASTM 1417.
3. 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.
4. The Low Pressure Air Test Table 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).
5. 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 Low Pressure Air Test Table.

Table 8- Low Pressure Air Test Table

Nominal Pipe Diameter (in)	Minimum Time, (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec)
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
L = Length of Pipe being Tested (ft)			

3.34 MANHOLE INFILTRATION/EXFILTRATION TEST

- A. All sanitary sewer manholes shall be tested and inspected for leakage by the Contractor. Repair of leaks may require the removal and replacement of sanitary sewer manhole sections. The use of grout to repair leaks will not be allowed.
- B. The Contractor shall perform sanitary sewer manhole vacuum tests when the ground water table elevation is lower than 2-feet above the top of the pipe. Exfiltration testing with water will only be allowed where specifically specified.
- C. Sanitary Sewer Manhole Vacuum Test
 1. The sanitary sewer 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 sanitary sewer manhole, excluding the adjusting rings and sanitary sewer manhole frame and cover. Testing will be allowed after backfilling has occurred or as specified in the specifications. Sanitary sewer manhole vacuum tester assembly and vacuum pumps shall be as manufactured by Cherne Industries, Inc. or prebid Engineer approved equal.
 2. Contractor shall adhere to the following procedure:
 - a. All lift holes shall be plugged.
 - b. All pipes entering the sanitary sewer manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the sanitary sewer manhole.
 - c. The test head shall be placed at the top of the sanitary sewer manhole in accordance with the Manufacturer's recommendations.
 - d. A vacuum of 10-inches of mercury shall be drawn on the sanitary sewer 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-inches of mercury.
 - e. The sanitary sewer manhole shall pass if the time for the vacuum reading to drop from 10-inches of mercury to 9-inches of mercury meets or exceeds the values indicated in Sanitary Sewer Manhole Vacuum Test Table.
 - f. If the sanitary sewer manhole fails the initial test, necessary repairs shall be made by an approved method. The sanitary sewer manhole shall then be retested until a satisfactory test is obtained.

Table 9 - Sanitary Sewer Vacuum Test Table

Minimum Test Times for Various Depth and Manhole Sizes			
MH Inside Diameter, (inches)			
48 60 72			
Depth, (ft)	Time, (seconds)	Time, (seconds)	Time, (seconds)
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

D. Sanitary Sewer Sanitary Manhole Exfiltration Test:

1. The sanitary sewer manhole water exfiltration test shall only be allowed where specified.
2. To perform this test, the inlet and outlet of the sanitary sewer manhole shall be plugged and the sanitary sewer 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.
3. Allow the water to stabilize for 1/2-hour and refill the sanitary sewer manhole to the original elevation. Mark the initial depth of the water, and after 1-hour record the drop in the water level in the sanitary sewer manhole.
4. The maximum allowable drop in vertical water height in the sanitary sewer manhole shall be 1/4-inch for all diameter sizes of sanitary sewer manholes. If the water level in the sanitary sewer manhole drops below the allowable drop amount, the Contractor shall repair the leak and retest.