

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

Revision Date: February 18, 2020

Brookings Municipal Utilities
525 Western Avenue
P.O. Box 588
Brookings, SD 57006-0588
(605) 692-6325

PART 1.0 - GENERAL REQUIREMENTS	1
1.1 SCOPE OF WORK	1
1.2 WARRANTY PERIOD	1
1.3 CONTRACTOR LICENSE AND PERMITS	1
1.4 BMU FURNISHED MATERIALS & WATER SERVICE TAPPING FEES.....	1
1.5 QUALITY CONTROL.....	2
1.6 SUBMITTALS.....	2
1.7 TRAFFIC CONTROL.....	3
1.8 GEOTECHNICAL REPORT	3
PART 2.0 - PRODUCTS	4
2.1 TRENCH STABILIZATION MATERIAL	4
2.2 PIPE BEDDING MATERIAL.....	4
2.3 IMPORTED ENGINEERED FILL MATERIAL	4
2.4 IMPORTED CLAY MATERIAL	4
2.5 AGGREGATE BASE MATERIAL	5
2.6 GRAVEL SURFACING MATERIAL	5
2.7 POLY VINYL CHLORIDE (PVC) WATER MAIN PIPE.....	5
2.8 RESTRAINT JOINT PVC WATER MAIN PIPE.....	6
2.9 TRACER WIRE FOR WATER MAINS.....	6
2.10 WATER MAIN FITTINGS.....	8
2.11 BOLTS, NUTS, GASKETS AND OTHER HARDWARE.....	8
2.12 COUPLING ADAPTORS.....	8
2.13 MECHANICAL JOINT RESTRAINER DEVICES.....	9
2.14 BELL RESTRAINER DEVICES.....	9
2.15 GATE VALVES.....	9
2.16 VALVE BOXES AND COVER	10
2.17 VALVE BOX ADAPTOR	11
2.18 FIRE HYDRANTS.....	11
2.19 FIRE HYDRANT MARKER.....	12
2.20 WATER SERVICE PIPE (1-inch, 1.5-inch or 2-inch).....	12
2.21 CURB STOPS (1-inch, 1.5-inch or 2-inch).....	12
2.22 CURB STOP BOX	13
2.23 DOUBLE CHECK VALVE BACKFLOW ASSEMBLY (1/2-inch - 2-inch).....	13

Standard Specifications for Water Main Construction

2.24	PIPE INSULATION	13
2.25	ENCASEMENT PIPE - PVC	14
2.26	ENCASEMENT PIPE - STEEL.....	14
2.27	CASING SPACERS.....	14
2.28	CASING END SEALS.....	15
2.29	TEMPORARY WATER MAIN BYPASS PIPE.....	15
2.30	GALVANIC ANODES.....	15
2.31	TAPPING SADDLE	16
2.32	CORPORATION STOPS.....	16
2.33	PACK JOINT COUPLING.....	17
2.34	BLOW-OFF ASSEMBLY.....	17
PART 3.0	- EXECUTION	18
3.1	OWNER OPERATE.....	18
3.2	NOTIFICATION OF INTERRUPTION OF SERVICE	18
3.3	ALIGNMENT AND GRADE.....	18
3.4	WATER PIPE MATERIAL HANDLING & STORAGE.....	18
3.5	MATERIAL INSPECTION	19
3.6	BMU ACCESS TO PROJECT SITE	19
3.7	REMOVAL OF WATER MAIN AND WATER MANHOLES AND SALVAGING VALVES AND FIRE HYDRANTS	20
3.8	TRENCH EXCAVATION	20
3.9	DEWATERING	20
3.10	WATER MAIN PIPE INSTALLATION	21
3.11	WATER MAIN CONNECTIONS.....	22
3.12	TRACER WIRE SYSTEM FOR WATER MAINS.....	22
3.13	CONCRETE THRUST BLOCKS.....	23
3.14	VALVES AND FITTINGS	23
3.15	VALVE BOXES	23
3.16	FIRE HYDRANTS.....	24
3.17	GALVANIC ANODES.....	25
3.18	BEDDING, BACKFILL, COMPACTION AND COMPACTION TESTING	25
3.19	UNDERGROUND INTERFERENCE.....	27
3.20	WATER MAIN AND SANITARY SEWER MAIN SEPARATION	27

Standard Specifications for Water Main Construction

3.21	WATER MAIN AND STORM SEWER SEPARATION	28
3.22	WATER SERVICES.....	29
3.23	CASING PIPE VIA BORING (JACKING).....	30
3.24	TEMPORARY WATER MAIN BYPASS SYSTEM	30
3.25	SURFACE RESTORATION.....	31
3.26	WATER MAIN TESTING SEQUENCE	31
3.27	HYDROSTATIC TESTING	32
3.28	DISINFECTION AND BACTERIOLOGICAL TESTING.....	33

PART 1.0 - GENERAL REQUIREMENTS

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 water main system, as shown on the plans, standard plates and/or called for in these specifications or its addenda.

1.2 WARRANTY PERIOD

- A. The corrective period of three (3) years shall commence from the BMU determined Substantial Completion date. The corrective period shall cover the contract as to workmanship and materials for a period of time as specified in the City of Brookings "EXCAVATING & BACKFILLING ON PUBLIC RIGHT-OF-WAY" Ordinance.
- B. The Contractor shall be held responsible for workmanship, materials, settling trenches or any other deficiencies in the water main system during the corrective period. The Contractor shall repair and/or replace all deficiencies in the water system during the three (3) years 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.

1.3 CONTRACTOR LICENSE AND PERMITS

- A. The Contractor shall be required to have any required licenses (sanitary sewer and water installation Contractor license or sanitary sewer and water installer license) for water/sewer installation or water/sewer repairing as stated in the South Dakota State Plumbing Code.
- B. The Contractor shall obtain an "EXCAVATION PERMIT" issued at no charge from the Brookings City Engineering Office before any water/sewer installation or water/sewer repairing will be allowed.
- C. 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.

1.4 BMU FURNISHED MATERIALS & WATER SERVICE TAPPING FEES

- A. If indicated on the project plans and/or as indicated on the project bid form, BMU shall furnish fire hydrants and isolation valves to the Contractor to install.
- B. BMU provided fire hydrants and isolation valves shall only be used for the operation of BMU water mains in utility easements or public right-of-ways as identified in the executed Application to Connect.
 - 1. BMU Provided Fire Hydrants, Gasket and Bolts
 - a. On projects that BMU is providing the fire hydrants, BMU shall be responsible for providing fire hydrants, gasket and bolts for each hydrant

identified in the plans. BMU shall be responsible for providing fire hydrants with bury depths as indicated in the project plans.

- b. If a hydrant extension is needed to accommodate the indicated bury depth, BMU will provide and install the hydrant extension.
- c. Concrete blocking, tracer wire, grounding rod, restrain joint, hydrant markers and other associated hardware shall be furnished and installed by the Contractor.
- d. Contractor is responsible for including any and all taxes, included but not limited to excise tax, sales tax, and use tax, in the established bid price for all BMU provided fire hydrants.

2. BMU Provided Valves

- a. On projects that BMU is providing the isolation valves, BMU shall be responsible for providing only the valve for each location identified in the plans.
- b. Gaskets, bolts, concrete blocking, restrain joints, valve boxes, lids and other associated hardware shall be furnished and installed by the Contractor.
- c. Contractor is responsible for including any and all taxes, included but not limited to excise tax, sales tax, and use tax, in the established bid price for all BMU provided fire hydrants.

C. Contractor shall be responsible for payment to BMU for all water tapping fees. Water tapping fees shall be charged to the Contractor at the cost identified on the BMU annually published "SERVICE CHARGES – WATER/SEWER" rate sheet.

1. The Contractor will be responsible for furnishing all pipe saddles and corporation stops needed to complete the project.
2. BMU shall install the saddle, drill and tap the water up to and including 2-inch corporations. Upon completion of work, BMU will generate an invoice and will bill accordingly. Water services 2-inch or larger shall require prior BMU approval.

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. Pipe, pipe fittings, bedding material, stabilization material, road topping material, and any other pertinent information concerning construction materials that the Engineer of Record deems necessary for the review of the materials used on the project in accordance with the specifications and drawings.
- 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 water mains as indicated in these standard specifications.
- D. If a Temporary Water Main Bypass System is deemed necessary by the Engineer of Record, the Contractor shall submit a comprehensive Temporary Water Main 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 water 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 water 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 water main 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 POLY VINYL CHLORIDE (PVC) WATER MAIN PIPE

- A. Water main pipe 4-inches in diameter and greater shall be Poly Vinyl Chloride (PVC) with a gasket joint. Pipe shall sustain a working pressure of 150 pounds per square inch (psi). Pipe classes shall be as follows:

Table 4- PVC Water Main Material

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

- B. All PVC pipe shall be manufactured in full conformance with the most current edition of AWWA C900 and C905 Standards. All PVC pipe shall meet NSF/ANSI Standard 61 - Drinking Water System Components, Health Effects and NSF/ANSI 61 Annex G, NSF/ANSI 372.
- C. Sealing pipe joints for all C900 and C905 PVC pipe shall use the Rieber joining system, which has the gasket formed into the pipe during the pipe manufacturing process. All gaskets shall meet NSF/ANSI Standard 61 - Drinking Water System Components, Health Effects.
- D. Acceptable Manufacturers are Diamond, JM Eagle, or prebid BMU Engineer approved equal.

2.8 RESTRAINT JOINT PVC WATER MAIN PIPE

- A. 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 5- PVC Water Main Material

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. All PVC pipe supplied for potable water applications shall be blue in color. 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.

2.9 TRACER WIRE FOR WATER MAINS

- A. Tracer Wire – Direct Bury

1. All components of the tracer wire system shall be suitable for direct bury applications. The conductor shall be 12 AWG, solid, soft-drawn copper, with a minimum insulation thickness of 0.045-inches of high molecular weight polyethylene, and shall be blue in color.
 - a. Acceptable Manufacturers for direct bury tracer wire shall be CCI, Kris Tech, Copperhead or prebid BMU Engineer approved equal.
 2. Splice kits shall utilize Scotchlok Y electrical spring connector, to electrically connect two or more pre-stripped copper wire ends in a pigtail application and moisture seal the connection for direct burial. The device shall be UL listed as wire connector system for use with underground conductors.
 - a. Acceptable Manufacturers for splice kit shall be 3M DBR/Y or prebid BMU Engineer approved equal.
- C. Tracer Wire – Pipe Burst or Directional Drill
1. The conductor shall be 12 AWG, 21% conductivity copper-clad hard drawn high carbon steel with copper cladding, pipe burst and extreme horizontal directional drill tracer wire, 4,700 lb average tensile break load, 50 mil high molecular weight-high density polyethylene jacket complying with ASTM D1248, 30 volt rating. Tracer wire shall be blue in color.
 - a. Acceptable Manufacturers for pipe bursting or directional drill tracer wire shall be Copperhead Soloshot Xtreme PBX-50 or prebid BMU Engineer approved equal.
 2. Splice kits shall provide water-proof, corrosion-proof dielectric sealant that protects wires and prevents breaks in wire conductivity. Splice kit shall be provided with a clear body to view/verify that wires are fully inserted into splice kit. Splice kit shall utilize 90-degree twist-lock design that makes wire connections easy and keeps wires locked in place.
 - a. Acceptable Manufacturers for splice kits in pipe bursting or directional drill applications shall be Copperhead SnakeBite or prebid BMU Engineer approved equal.
- D. Ground Rod
1. Ground rods, shall be pointed copperbonded ground rods, 1/2-inch diameter, 60-inch long steel rod uniformly coated with 5-mil metallically bonded electrolytic copper.
 2. Acceptable Manufacturers for ground rods shall be Erico, Nvent, Eritech 611350 or prebid BMU Engineer approved equal.
- E. Ground Rod Clamps
1. Ground rod clamps shall be standard duty bronze rod clamp used to attach ground wire to rod. Rod camp size shall retain up to 10 solid conductors. Rod clamp shall be suitable for direct burial and UL listed for direct burial in earth or concrete.
 2. Acceptable Manufacturers for ground rod clamps shall be Erico, Nvent, Eritech CP58 or prebid BMU Engineer approved equal.

2.10 WATER MAIN FITTINGS

- A. Mechanical joint water main fittings with accessories, 3-inch through 48-inch shall be manufactured from ductile iron in accordance with and meet all applicable terms and provisions of standard ANSI/AWWA C153/AWWA C111.
- B. Ductile Iron mechanical joint fittings 3-inch through 24-inch shall be rated for 350 psi working pressure. Fittings 30-inch through 48-inch shall be rated for 250 psi working pressure.
- C. All fittings shall be cement lined on the interior and 1-mil nominal thickness bituminous coated on the exterior as specified for cast iron fittings. Coating and cement lining shall be manufactured in full conformance with the most current edition of ANSI/AWWA C104/A21.4.
- D. Mechanical joint fittings shall be provided with gaskets, glands, bolts, and other appurtenances.
- E. Acceptable Manufacturers are Sigma, Star, Tyler-Union or prebid BMU Engineer approved equal.

2.11 BOLTS, NUTS, GASKETS AND OTHER HARDWARE

- A. Bolts shall be fluorocarbon coated (Cor-Blue) low alloy corrosion-resistant high-strength steel manufactured in full conformance with the most current edition of ANSI/AWWA C111/A21.11.
- B. Gaskets shall SBR rubber and shall be resistant to water containing normal concentrations of chloramine. Gaskets shall meet NSF/ANSI Standard 61: Drinking Water System Components-Health Effects and NSF/ANSI 61 Annex G, NSF/ANSI 372 approved for contact with drinking water.

2.12 COUPLING ADAPTORS

- A. Coupling adaptor shall be suitable for all pipe materials including Ductile Iron, Cast Iron, Steel and PVC. Provide a long body design that provides extra flexibility and allows connecting pipe of two different pipe materials.
- B. Coupling adaptor shall meet AWWA C219 and NSF 61 requirements. Gaskets shall be provided with Ethylene Propylene Monomer Rubber (EPDM) compound suitable for water and sewer service in accordance with ASTM D2000 and NSF 61.
- C. Product shall be available in pipe nominal diameter ranging from 1.5-inch to 24-inch. Coating on coupling adaptor shall be 100% fusion bonded epoxy for corrosion protection. Minimum coating thickness shall be 12 mils.
- D. Coupling shall be provided with integral AISI 3054 Stainless steel all thread, bolts, washers and nuts.
- E. Acceptable Manufacturers are Krausz Hymax Long Body, Romac Macro or prebid BMU Engineer approved equal.

2.13 MECHANICAL JOINT RESTRAINER DEVICES

- A. Restraining mechanisms shall be with wedges or full circle contact and support of the pipe wall. Restraint shall be accomplished by a series of ring or wedge segments mechanically retained inside the gland housing and designed to grip the pipe wall in an even and uniform manner.
- B. Restraining devices shall be actuated by bolts featuring twist-off heads to ensure proper installation torque is applied. All components of the restrainer, including the gland, bolts, and restraint segments, shall be of high-strength ductile iron and shall be manufactured in full conformance with the most current edition of ASTM A536.
- C. Restrainer devices shall be coated with 12-mil 100% fusion bonded epoxy body with fluorocarbon coated ring/wedge.
- D. Appropriate restrainer devices shall be supplied for the specific type of piping material being used on the project.
- E. Acceptable Manufacturers are EBAA Iron Inc., Megalug Flanges, Romac Industries, RomaGrip DI Grip Rings, Star Products Stargrip, Tyler Union TuFGrip Series 2000 or prebid BMU Engineer approved equal.

2.14 BELL RESTRAINER DEVICES

- A. Restraint for PVC pipe (AWWA C900 or C905 CI O.D.) at the bell shall consist of the following:
 - 1. The restraint shall be manufactured of ductile iron conforming to ASTM A536. A solid, non-split, backup ring shall be used behind the PVC bell.
 - 2. A restraint ring, incorporating a plurality of individually-actuating gripping surfaces, shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring.
 - 3. Restrainer devices shall be coated with 12-mil 100% fusion bonded epoxy body with fluorocarbon coated ring/wedge..
- B. Acceptable Manufacturers are for bell restrains shall be EBAA Iron Series 2800, or prebid BMU Engineer approved equal.

2.15 GATE VALVES

- A. Resilient wedge gate valves (4-inches to 30-inches) shall utilize ductile iron components and be manufactured in full conformance with the most current edition of AWWA C515. The valve seat shall be rated for 250 psi cold water working pressure.
- B. Valves shall have a ductile iron 2-inch ductile iron operating nut and open left (counter-clockwise).
- C. Gate valves shall be provided with mechanical joint connections meeting the requirements of AWWA C111.

- D. All valves supplied shall meet the requirements of NSF/ANSI Standard 61: Drinking Water System Components-Health Effects and NSF/ANSI 61 Annex G, NSF/ANSI 372.
- E. Valves shall have a ductile iron wedge encapsulated with nitrile rubber or an EPDM rubber compound. Wedge shall be symmetrical and seal equally well with flow in both directions. Resilient seats shall be bonded or mechanically attached to the gate.
- F. Stems shall be non-rising, bronze or stainless steel, and shall be sealed by three O-rings.
- G. All exterior bolting, including but not limited to bonnet and stuffing box bolts, shall be 304 stainless steel. Seal between bonnet and valve body shall utilize a flat gasket with integral O-ring; therefore, allowing bolting to pass through and hold the gasket in place.
- H. All internal and external ferrous surfaces shall have a 100% fusion bonded epoxy coating applied electrostatically prior to assembly meeting the requirements of AWWA C550.
- I. Tapping valves shall meet all the requirements specified within this section. Tapping valves shall have a mechanical joint end and a flanged end to correspond to the branch flange of the tapping sleeve
- J. Acceptable Manufacturers are Waterous, American AVK, American Flow Control (AFC), Mueller or prebid BMU Engineer approved equal.

2.16 VALVE BOXES AND COVER

- A. Valve box shall be a 2 or 3 piece cast iron valve box for 4-inch to 12-inch gate valves. Valve box shall be adjustable for required trench depth.
- B. Valve boxes shall be domestic (heavy wall) cast iron and shall include all pieces as required for installation. The valve boxes shall meet the following requirements:
 - 1. 5 1/4-inch shaft.
 - 2. Standard drop covers marked "WATER."
 - 3. Screw-type.
 - 4. Circular base for 8-inch valve.
 - 5. Heavyweight 35,000-pound tensile strength.
 - 6. Adjustable for trench depth.
 - 7. Covers shall have a skirt length of 1 1/2-inch.
 - 8. Extensions shall be in lengths shown and be compatible with the valve boxes bid.
- C. The valve box top section extensions and caps shall be compatible with the above valve box specifications.
- D. Acceptable Manufacturers are Sigma, Star, Tyler or prebid BMU Engineer approved equal.

2.17 VALVE BOX ADAPTOR

- A. Valve box adaptor shall be manufactured from recycled "Green" rubber compound. Adaptor shall be custom-molded for a precise fit on all types and sizes of gate valves 2-inch through 16-inch and can be used with 5 ¼-inch cast iron valve boxes.
- B. Valve box adaptor shall be installed between the valve and valve box to eliminate settling and shifting of the valve box over the gate valve, allow proper keying of the valve, and center valve box over the operating nut.
- C. Acceptable Manufacturers are VBA-II by Adaptor Inc. or prebid BMU Engineer approved equal.

2.18 FIRE HYDRANTS

- A. Fire hydrants shall be open left (counterclockwise), constructed of ductile iron nozzle section, including but not limited to caps, upper/lower standpipes and hydrant base, and meet or exceed AWWA C502, latest revision. The hydrant shall be rated for a working pressure of 250-psi.
- B. The section of the hydrant above ground shall be painted with epoxy primer and high-gloss urethane coating. Hydrants shall be provided with Red coating. Hydrants shall be capable of being extended in 6-inch increment (7'6", 8'0", 8'6", 9'0" and 9'6") and shall be equipped with traffic features that include a breakaway flange and stem with a shaft coupling.
- C. Nozzle section shall be designed for easy 360 degree rotation by loosening connecting bolts and rotating entire nozzle section.
- D. Fire hydrant shall meet the requirements of NSF/ANSI Standard 61: Drinking Water System Components-Health Effects and NSF/ANSI 61 Annex G, NSF/ANSI 372.
- E. The main valve closure shall be of the compression type, opening against the pressure and closing with the pressure. The main valve opening shall not be less than 5 1/4-inches and be designed so that removal of all working parts can be accomplished without excavating.
- F. Hydrant shall be provided with an internal travel stop nut located in the top-housing of the hydrant. A double oil reservoir to lubricate the operating threads of the hydrant and utilize a O-ring to seal interior components from water, moisture and foreign materials.
- G. The draining system of the hydrant shall be bronze and be positively activated by the main operating rod.
- H. Hydrants shall have two 2 1/2-inch hose nozzles and one 4 1/2-inch pumper nozzle, all located on the same horizontal plane. The centerline of the nozzles shall be 24-inches above the ground line groove (16" upper barrel section). Operating nuts shall be pentagon shaped and measure 1 1/2-inches point to flat. Nozzle cap nuts shall be the same dimension and shape as the operating nuts, and the nozzle caps shall be furnished with security chains.

- I. All internal and external threads and bolting shall be National Standard threads and utilize a nut and bolt design. Metric, or allen bolts will not be acceptable. All below grade exterior bolting shall be constructed of 304 stainless steel.
- J. Provide fire hydrants with a 6-inch mechanical joint connection. Bolts shall be fluorocarbon coated low alloy corrosion-resistant high-strength steel manufactured in full conformance with the most current edition of ANSI/AWWA C111/A21.11.
- K. Acceptable Manufacturers are Waterous Pacer WB67-250 or prebid BMU Engineer approved equal.

2.19 FIRE HYDRANT MARKER

- A. Hydrant marker shall be impregnated polycarbonate material, red color with adhesive reflector, and with a flexible galvanized hinge riveted to hydrant marker.
- B. Each marker shall be hinge mounted to bonnet with bonnet bolt at 48-inch length and 3-inch width.
- C. Fire hydrant markers to be the FH 800 Series American model manufactured by Flexstake or prebid BMU Engineer approved equal.

2.20 WATER SERVICE PIPE (1-inch, 1.5-inch or 2-inch)

- A. Crosslinked Polyethylene (PEX)
 - 1. Crosslinked Polyethylene (PEX) shall be a minimum pressure class of 200 psi, and shall conform to the most current edition of ANSI/AWWA C904.
 - 2. Pipe shall have a co-extruded UV Shield made from UV-resistant high-density polyethylene, color blue. Fittings and valves shall meet the requirements of AWWA C800 and ASTM B62.
 - 3. PEX pipe shall be either 1-inch, 1.5-inch or 2-inch nominal diameter. No other size is acceptable and shall not be provided.
 - 4. Acceptable Manufacturers are Rehau-Municipex or prebid BMU Engineer approved equal.
- B. Copper
 - 1. Copper pipes shall be U.S. Government Type K soft copper tubing. Fittings and valves shall meet the requirements of AWWA C800 and ASTM B62.
 - 2. Type K Copper pipe shall be either 1-inch, 1.5-inch or 2-inch nominal diameter. No other size is acceptable and shall not be provided.
 - 3. Acceptable Manufacturers are Cambridge-Lee Copper, Cerro, Halstead, Mueller Copper Company, and Wolverine or prebid BMU Engineer approved equal.

2.21 CURB STOPS (1-inch, 1.5-inch or 2-inch)

- A. No lead brass curb stop with copper tub size (CTS) compression connection shall be Minneapolis pattern valves, conforming to the latest revision of the

ANSI/AWWA C800 Standard for Underground Service Line Valves and Fittings, or prebid BMU Engineer approved equal.

- B. Curb stops shall not be the drain back type.
- C. Acceptable Manufacturers are A.Y. McDonald 6104, Ford B-22, Mueller B-25154 or prebid BMU Engineer approved equal.

2.22 CURB STOP BOX

- A. Curb stop box shall be adjustable and include a base tapped to attach to the threaded top of a Minneapolis pattern curb valve. The upper part of the box is adjustable and telescopes in the base to allow for grade adjustments.
- B. Box shall be furnished with a cast iron lid and brass pentagon plug. Lid shall be provided with a stainless steel screw for attaching tracer wire to the lid.
- C. Curb box shall be provided with an electrostatically applied, cationic epoxy coating system that provides complete corrosion protection.
 - 1. If an epoxy coating cannot be provided on the curb stop box, the cast iron curb stop box shall be furnished and installed with a 5 lb anode bag.
- D. All curb stop boxes shall be provided with 60" steel stationary rod with ductile iron tee head socket and brass cotter pin.
- E. Acceptable manufacturers for curb boxes shall be Ford EM2-XX-56-XXR-TW Series or BMU Engineer approved equal.

2.23 DOUBLE CHECK VALVE BACKFLOW ASSEMBLY (1/2-inch - 2-inch)

- A. Double check valve assembly shall be designed to protect drinking water supplies from dangerous cross-connection in accordance with national plumbing codes. The assembly shall consist of two (2) positive seating check modules with captured springs and rubber seat discs.
- B. The check module seats and seat disc shall be replaceable single cover, top entry cover that allows for convenient access for maintenance.
- C. The assembly shall also include two (2) resilient seated, quarter turn isolation ball valves and four (4) top mounted resilient seated test cocks.
- D. The assembly shall meet the requirements of latest revision of the ASSE STD 1015 and AWWA C510
- E. Acceptable manufacturers for double check valve backflow assembly are: Watts Series LF007, or BMU Engineer approved equal.

2.24 PIPE INSULATION

- A. Water 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.

2.25 ENCASEMENT PIPE - PVC

- A. PVC encasement pipe shall meet the requirements of the “RESTRAINT JOINT PVC WATER MAIN PIPE” specification included in this specification.

2.26 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 6- Steel Encasement Pipe Material

Carrier Pipe Size	Carrier Pipe Type	Wall Thickness
4” – 12”	C900 PVC, DR 18	0.250”
16”	C905 PVC, DR 18	0.312”
20”	C905 PVC, DR 18	0.375”
24”	C905 PVC, DR 18	0.438”
30”	C905 PVC, DR 18	0.500”
>36”	C905 PVC, DR 18	0.563”

2.27 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).
- C. 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).
- D. 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.
- E. 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.
 - F. 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.
 - G. 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.
 - H. 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.

2.28 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.

2.29 TEMPORARY WATER MAIN BYPASS PIPE

- A. Temporary water/water main bypass pipe and associated appurtenances that may come into contact with water shall meet the requirements of NSF/ANSI Standard 61: Drinking Water System Components-Health Effects and NSF/ANSI 61 Annex G, NSF/ANSI 372.
- B. All PVC piping systems shall be manufactured in full conformance with the most current edition of AWWA C900 and C905 Standards.
- C. Temporary water main shall be a minimum of 2-inch diameter unless otherwise specified.
- D. Approved Products are CertainTeed-Certa-Lok Yelomine or prebid BMU Engineer approved equal.

2.30 GALVANIC ANODES

- A. Anodes utilized for typical galvanic anode system installation are prepackaged magnesium style anodes weighing five (5) or eighteen (18) pounds. Anode composition is to be in accordance with ASTM B843-2003 Table 1, Grade HP, M1C.

- B. Anodes are to be packaged in a low resistive backfill consisting of seventy-five percent (75%) gypsum, twenty percent (20%) bentonite, and five percent (5%) sodium sulfate.
- C. Anodes shall be provided with #10 AWG stranded copper, single-conductor cable with HMWPE insulation. Lead wire cable shall be rated for six hundred (600) volts and designed for direct burial applications.
- D. Lead wires must be of sufficient length for splice-free routing between the anode and the pipe and is to be #10 AWG stranded copper, single-conductor cable with HMWPE insulation. Lead wire cable must be rated for six hundred (600) volts and designed for direct burial applications.
- E. Equipment and materials used to bond the #10 AWG HMWPE to the pipeline is of the "CADWELD" type as manufactured by ERICO Products, Inc. of Cleveland, Ohio, or approved equal. Thermite weld caps, designed to protect the CADWELD bonds from corrosion, is to be Royston "Handy Cap 2" or approved equal.

2.31 TAPPING SADDLE

- A. Saddle body and strap are to be permanently held together with a silicon bronze pin for saddles sized 2" thru 8". Saddles 10" and larger shall utilize a two (2) or three (3) piece bolted design. O-ring seal between tapping saddle and pipe shall be made of EPDM. Threads are to be CC Taper.
- B. Water service saddles shall be intended for use on C900 PVC water main.
- C. No lead brass is to conform to AWWA Standard C800 (Latest Revision). Tapping saddles shall have a maximum nominal outlet diameter of 2".
- D. Acceptable Manufacturers for tapping saddle are Ford Meter Box S90, AY McDonald 3895 or prebid BMU Engineer approved equal.

2.32 CORPORATION STOPS

- A. Corporation stops shall be a quarter turn (1/4) ball type, full 100% flow opening valve with compression outlet. Corporation stop shall be rated for 300 psi working pressure. Corporation Stop shall be provided as the same size as service piping.
- B. All brass that comes in contact with water shall be no lead and manufactured in full conformance with AWWA Standard C800 (Latest Revision). Product shall have the letters "NL" cast into the main body for lead-free identification.
- C. Inlet Threads are to be AWWA/CC Taper. Outlets shall utilize a EPDM rubber gasket to provide hydraulic seal and pack joint compression nut to secure outlet pipe.
- D. Acceptable Manufacturers for corporation stops are Ford Meter Box FB1000, AY McDonald 74701B-22 or prebid BMU Engineer approved equal.

2.33 PACK JOINT COUPLING

- A. All brass that comes in contact with water shall be no lead and manufactured in full conformance with AWWA Standard C800 (Latest Revision). Product shall have the letters "NL" cast into the main body for lead-free identification.
- B. Coupling shall include pack joint nuts for CTS. Provide a beveled EPDM rubber gasket to provide hydraulic seal on pipe material. Coupling shall have anti-friction washer, integral clamp containing machined grooves for axial restraints and stainless steel screw to activate clamp.
- C. Manufacture shall provide pack joint to match a wide variety of pipe materials including, PVC, PEX, Copper, and HDPE and a variety of different sizes.
- D. Acceptable Manufacturers for corporation stops are Ford Meter Box C44-XX-NL AY McDonald 74758-XX or prebid BMU Engineer approved equal.

2.34 BLOW-OFF ASSEMBLY

- A. Blow-off assembly shall consist of a restrained cap that installs on a plain-end piece of pipe, galvanized piping isolation valve and fittings necessary to route flow to surface.
- B. Restrained cap shall be fusion bonded epoxy, ductile iron material meeting ASTM A536 and utilize integral gripper rings to grip the pipe. Draw hooks shall be fabricated from 304 stainless steel. Cap shall have a threaded 2-inch bung to allow connection of piping. Restrained cap shall be Alpha EC as manufactured by Romac.
- C. Provide 2-inch galvanized piping and fittings to plumb water from the restrained cap to the surface. Include 2-inch curb stop and box to isolate flow.

PART 3.0 - EXECUTION

3.1 OWNER OPERATE

- A. No valve, hydrant or other controls on the existing water distribution system shall be operated for any purpose by the Contractor. BMU staff shall be the only authorized operator of existing valves and hydrants.

3.2 NOTIFICATION OF INTERRUPTION OF SERVICE

- A. The Contractor shall coordinate with BMU staff of any interruption of water service at least 24-hours before the interruption of water service. BMU Staff shall notify all customers affected by any the water outage.
- 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 and initiate operation of valve and/or fire hydrant requests 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 and/or BMU Staff 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 water 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 WATER PIPE MATERIAL HANDLING & STORAGE

- A. All pipe, fittings, valves, hydrants, 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. Valves and hydrants shall be drained and stored in a manner that will protect them from damage by freezing.
- 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. PVC piping and Crosslinked Polyethylene (PEX) piping that has been exposed to more than the Manufacturers' maximum allowed UV exposure (sunlight) shall be rejected.
- E. Gaskets for mechanical and 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.
- F. Mechanical-joint bolts shall be handled and stored in a dry location in a manner that will ensure proper use with respect to types and sizes.

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 OF WATER MAIN AND WATER MANHOLES AND SALVAGING VALVES AND FIRE HYDRANTS

- A. Water main, water manholes, unsalvageable valves, and unsalvageable hydrants shall be removed at the locations shown on the plans or as directed by the BMU Engineer.
- B. Water manholes shall be entirely removed and disposed of by the Contractor.
- C. Valves and fire hydrants shall be salvaged at the locations shown on the plans or as directed by the BMU Engineer. Any salvaged items shall be properly disconnected and transported to Brookings Municipal Utilities (BMU) at 525 Western Avenue and neatly stockpiled. The Contractor shall contact BMU prior to delivery of the materials.

3.8 TRENCH EXCAVATION

- A. 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.
- B. Trenches shall be excavated with vertical sides from pipe flow line to a point 1-foot above top of pipe where possible.
- C. Trench excavation below pipe grade shall be backfilled with bedding material to provide a uniform and continuous bearing and support for the pipe.
- D. 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.
- E. The Contractor will be fully responsible for constructing the water 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 Environment and Natural Resources (SD DENR). 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. Water main installation shall be accomplished in a 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 WATER MAIN PIPE INSTALLATION

- A. Installation of PVC water main shall conform to the latest revision of AWWA C605 "UNDERGROUND INSTALLATION OF POLYVINYL CHLORIDE (PVC) AND MOLECULARLY ORIENTED POLYVINYL CHLORIDE (PVCO) PRESSURE PIPE AND FITTINGS", and BMU Standard Plates.
- B. Water main shall be installed in the locations shown on the plans or as directed by a BMU representative or Engineer of Record. Water main shall not be installed in frozen ground or in water, and no water will be allowed to run into or through the pipe. Before installing the water 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. The lubricant shall be approved for use with potable water.
- C. Water 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. Field cut spigot ends of push-on joints shall have a square end with beveled edge equal to a factory cut prior to being pushed into the bell. Every pipe shall be bedded uniformly throughout its length with water main bedding material. Care shall be taken to not have any part of the pipe bearing on rocks or stones.
- E. Water main shall have a minimum of 6.0-foot of cover. If 6.0-foot of cover to the top of the pipe cannot be achieved or maintained, the BMU Engineer shall be notified. In special circumstances that 6.0-foot of cover cannot be obtained over the water main, the BMU Engineer may require the use of insulation over or insulation wrapped around the water main pipe.
- F. Pipe shall be carefully installed to line and grade in accordance with line and grade stakes set by the Engineer of Record so that the finished water system will present a uniform alignment. Any noticeable variations from true alignment or grade will be cause for rejection of the work.
- G. 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.

- H. A suitable plug or cap 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.
- I. Standard length pipe shall be utilized for all installations. Shorter lengths will only be allowed for use at fitting locations.

3.11 WATER MAIN CONNECTIONS

- A. To keep interruption of service to surrounding properties at a minimum when making a water main connection, the Contractor shall have all materials for the connection on site, and to the extent possible, have fittings assembled and restrained prior to cutting the existing water main and making the connection.
- B. Pipe cutting shall be neat and completed in a manner so that damage to the pipe, interior lining, or exterior coating. Cutting shall be performed with an approved mechanical cutter, using a wheel cutter when applicable and practical.
- C. Where indicated on plans, the Contractor shall remove an existing plug, cap, reaction blocking or hydrant, prepare the end of the existing water main, and complete the new water main connection.
- D. Where indicated on plans, the Contractor shall cut into an existing water main, prepare the ends of the existing water main, and complete the new water main connection.
- E. Where indicated on plans, the Contractor shall excavate a trench at the water main to install a smith tap into the existing water main. The Contractor will be required to furnish and install the valve box.

3.12 TRACER WIRE SYSTEM FOR WATER MAINS

- A. Tracer wire system, including ground rods and all appurtenances, shall be installed with PVC water mains. 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 to existing piping and in the locations specified on the plans. The tracer wire shall be brought to each fire hydrant and connected to a 60-inch ground rod that extends up to the bottom of the breakaway flange. The ground rod shall be duct taped to the fire hydrant barrel in at least four locations below the ground surface.
- C. Tracer wire shall be installed on all water services. Additional requirements for the installation of the tracer wire on services can be found in the "WATER SERVICES" section.
- D. All underground splices shall be inspected by the Engineer of Record and/or BMU representative prior to backfilling.
- E. Prior to the road surfacing be placed and after the water service connections made, 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 CONCRETE THRUST BLOCKS

- A. The Contractor shall brace all valves, hydrants, fittings, plugs and caps 12-inch in diameter and smaller by means of restrain joint glands and precast concrete thrust blocks.
- B. No wood shimming or bracing will be allowed in conjunction with the concrete blocks.

3.14 VALVES AND FITTINGS

- A. Valves and fittings shall be installed at the locations shown on the plans or as directed by the Engineer of Record. Valves and fittings shall be installed in accordance with the most current edition of AWWA C600. Proper precast concrete blocking shall be installed under all valves. Pipe shall be supported in such a manner as to prevent stress on the valve.
- B. Valves and fittings shall remain exposed until the BMU Engineer or Representative has visually inspected and measured the as-built locations.
- C. All mechanical joint valves and fittings shall be installed with two restrainer devices per valve.
- D. All mechanical joint valve and fittings connections shall not exceed a horizontal or vertical deflection of 5-percent. In no case shall valves be used to bring misaligned pipe into alignment during installation.
- E. Valves and associated valve box shall not be located in areas that will be future curb and gutters or valley gutters. Any valve located in these areas will not be acceptable to BMU Engineer and shall be removed and relocated at no expense to BMU.
- F. All new dead-end water mains shall be closed with plugs or caps that are suitably restrained to prevent blowing off under test pressure. All dead-end water mains shall be equipped with suitable temporary fire hydrant or blow-off assembly.
- G. If a blow-off valve precedes the dead-end plug or cap it shall have two (2) joint restraint devices included, and rodding to a fitting may also be required, to insure the valve does not blow off when extension of the water main resumes.

3.15 VALVE BOXES

- A. The Contractor shall adjust the valve boxes to the final grade as shown on the Standard Plates. All buried valves shall be installed with the valve box adapter to allow secure and aligned placement of the valve box on the valve.
- B. The Contractor shall furnish and install valve box extensions (additional sections) as needed if the valve box has inadequate adjustment length remaining or if extra depth water main had been installed that requires the use of an extension.

- C. The Contractor shall replace existing valve boxes as specified. This work includes excavating to the existing valve and removing the existing valve box. A new valve box shall be installed and the trench backfilled.
- D. All valve boxes, new installation and adjustment of existing valve boxes, shall be backfilled with pipe bedding material to a depth as indicated on the BMU Standard Plates. The Contractor shall ensure that valve boxes are plumb prior to and during backfilling.
- E. Valve operating nut within valve boxes shall be clear of any debris. BMU Staff shall check valve boxes so they can be freely operated after backfilling operations, prior to paving, and again prior to the completion of the project. It shall be the Contractor sole responsibility to remove any debris or correct any alignment problems that might prevent BMU staff from properly operating the valve.

3.16 FIRE HYDRANTS

- A. Fire hydrants shall be installed at the locations and elevations as shown on the plans or as directed by the Engineer and in accordance with the most current edition of AWWA C600.
 - 1. The centerline of the nozzles shall be a minimum of 24-inches above the finished surface elevation but no higher than 26-inches.
 - 2. The bottom of the breakaway flange shall be a minimum of 2-inches and a maximum of 4-inches above the finished surface elevation.
 - 3. Fire hydrants shall be installed 3 to 5-feet behind the back of curb unless otherwise indicated on the plans, stand plumb, and have their nozzles parallel with or at right angles to the street centerline, with the pumper nozzle facing the street.
 - 4. Hydrants installed near intersections shall be located 5-feet minimum from the intersection sidewalk.
- B. The Contractor and/or supplier will be responsible for providing fire hydrants with the appropriate bury depths. If a hydrant is provided with an unacceptable bury depth, supplier shall furnish the necessary hydrant extension to BMU. BMU will be responsible for installing any extensions needed to install the fire hydrant at the appropriate grade and in accordance with BMU standards. BMU may back-charge the Contractor for the labor necessary to install the hydrant extension.
- C. Hydrants shall be set on a precast concrete block to prevent settlement. Precast concrete thrust blocks shall be installed against undisturbed soil to prevent movement of the hydrant lead.
- D. Hydrant bases shall be backfilled with a minimum of 1/3-cubic yard of pipe bedding material to facilitate drainage from the hydrant weep holes. The bedding material shall be placed at a depth of approximately 36-inches above the hydrant base. Contractor shall install one layer of heavy duty construction grade plastic at the interface of bedding material and the native backfill material. Plastic material shall be installed to minimize fines from migrating into the bedding material and potentially plugging the hydrant weep holes.

- E. Tracer wire and a ground rod shall be installed at each fire hydrant location. Tracer wire and grounding rod shall be installed in strict accordance with BMU requirements indicated in previous sections and standard details.
- F. Flushing hydrants installed for testing purposes shall be removed once testing has been completed. If the flushing hydrants will remain in place for the duration of a winter season, they shall be installed behind the existing or proposed curb and gutter.

3.17 GALVANIC ANODES

- A. Anodes are to be installed eighteen to thirty-six inches (18" to 36") from the curb box, to a centerline depth in line with the approximate depth of the curb stop.
- B. The #10 AWG HMWPE lead wires must be attached to the curb stop box. Lead wire connections to the curb box are to utilize exothermic weld connection methodology and follow the manufacturer's instructions for use.
- C. Extreme care shall be taken not to damage the anodes or direct buried lead wires during backfill procedures.

3.18 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 water 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. 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.

E. 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 material, 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.

3.19 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 water main will be relocated, altered, or reconstructed by the Owners, or the Engineer of Record may direct 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 of Record may order a deviation from alignment and grade.

3.20 WATER MAIN AND SANITARY SEWER MAIN SEPARATION

- A. Horizontal Pipe Separation
 1. Water main shall be laid at least 10-feet horizontally from any existing or proposed sanitary 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 water main closer to a sanitary sewer 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 Sanitary Sewer 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 sanitary sewer 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.

3.21 WATER MAIN AND STORM SEWER SEPARATION

A. Horizontal Pipe Separation

1. Water main 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 water main 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 water main 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 water main.
2. The minimum vertical separation of the water 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 water mains from freezing.
3. In the event that vertical pipe separation cannot be maintained, adhere to one of the following:
 - a. Use vertical bends to lower the water main under the storm sewer main and install rigid insulation between the storm sewer and water 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 and install rigid insulation between the storm sewer and water main.

3.22 WATER SERVICES

- A. Water services, corporation stops and curb stops for house connections, multiple dwellings, and commercial connections shall be installed as shown on the project drawings or as directed by the Engineer of Record.
- B. Water service pipe shall be bedded in accordance with the requirements of "BEDDING, BACKFILL, COMPACTION AND COMPACTION TESTING".
- C. For new construction, splices on the water service will not be allowed from the corporation to the curb stop, and from the curb stop to the meter for new construction. Splice locations for rehab or water service replacement shall be prior approved by BMU Inspector.
- D. All water services shall be installed with tracer wire from the water main to the curb stop box and from the curb stop box to the structure.
 - 1. Contractor shall provide a loop or slack in the tracer wire at each proposed water service. The loop shall be configured to allow for excess tracer wire to be used to connect the water service tracer wire to the tracer wire installed with the water main.
 - 2. Contractor shall splice the water service tracer wire to the main line by using a moisture displacement connector kit.
 - 3. Tracer wire shall be terminated on the curb stop box lid from both the main line and the wire extending to the structure.
 - 4. Tracer wire shall be terminated immediately adjacent to the structure foundation with a grounding rod and associated connectors.
 - 5. BMU shall verify the installation of the tracer wire by energizing and locate the water service via the tracer wire prior to backfilling of the water service.
- E. All curb stops that are installed without a valve box shall be marked to help locate them and prevent breakage when excavating.
 - 1. Water services shall be marked by a vertical section of PVC pipe or an approved marker. The PVC pipe shall be painted blue on the top 1-foot portion of the marker.
 - 2. The marker should be placed near the curb stop or at the termination point of the water service stub-in.
 - 3. The water service marker shall remain in place and be maintained by the Developer or Property Owner until the water service is extended into the property to serve a house, building, or other structure.
- F. Contractor shall coordinate with BMU to installed service connections or disconnections with BMU crews. Water service connections or taps to new or existing water main will not be permitted until the water main has passed the necessary pressure testing and disinfection requirements. All service taps/saddles must be adequately supported prior to backfilling.

- G. Water saddle and taps shall be installed by BMU, using a service saddle and located at 10 o'clock or 2 o'clock on the circumference of the pipe. If cover over a service line is shallow and frost may become a factor, corporations may be installed at 3 o'clock or 9 o'clock on the water main to get additional cover over the water service.
- H. Service connections or disconnects are made using one of the following methods, unless otherwise specified:
 - 1. The Contractor shall excavate a trench to allow BMU crews to install saddles and connect (tap) the water main with a water service corporation stop. The trench shall then be backfilled by the Contractor.
 - 2. The Contractor shall excavate a trench and disconnect the water service at the water corporation stop in the presence of BMU personnel. The trench shall then be backfilled by the Contractor.
- I. The trench for the water 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 water service 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.
- J. Curb stops shall be located on, or within 12-inches either side of the property line. Curb stops not installed at the property line, shall be removed and relocated at no expense to BMU.
 - 1. Curb stops installed short of the property line shall be relocated to the property line by removing the entire water service back to the corporation stop and reinstalled to prevent the installation of a splice on the water service.
 - 2. Curb stops installed long of the property line shall be relocated by isolating the water service and cutting the water service back to the property line.
- K. Curb stop boxes which are installed where there is concrete or asphalt surfacing will require a 4-inch PVC casing furnished and installed by the Contractor. 4-inch PVC curb box casing shall be ASTM D3034 with an SDR 35 rating, and shall be cut longer than the concrete or asphalt topping thickness.

3.23 CASING PIPE VIA BORING (JACKING)

- A. 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.

3.24 TEMPORARY WATER MAIN BYPASS SYSTEM

- A. A minimum of 1-weeks prior to operation of the water bypass system, the Contractor shall submit a water main layout and sequence of operations for the temporary water main bypass system for BMU Engineer approval. The BMU Engineer shall be given written notice, at least 2-days in advance, of intent to commence water bypass operations.

- B. The Contractor shall provide a 24-hour contact person who has adequate parts and equipment readily accessible to make necessary repairs to temporary water bypass system or temporary water service in a timely manner.
- C. The Contractor shall notify BMU staff at least 24-hours prior to the planned outage. The Contractor shall inform BMU staff of the estimated time that the water service will be disrupted. BMU shall coordinate with all property Customers for the planned disruption of water service or accessibility issues created by the temporary water main bypass system.
- D. The BMU shall contact customers (that are at the property at the time of service interruption) along the water main project where the customers will have a disruption of water service.
- E. BMU shall furnish and install door hangers on each affected property Customers door. The door hanger shall indicate the time when the property will not have water service.
- F. 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.
- G. Contractor shall make water service connections either during the day or at other suitable times to minimize the Customers disruption of water service.
- H. Contractor shall provide all chlorinating, testing, pipe, necessary isolation valves, bends, fittings, hydrants, all necessary appurtenances, gravel ramp construction, maintenance and removal, and all other materials and labor necessary to construct the temporary water main and flush each individual service before connection to the BMU water system.
 - 1. Temporary water main is required to be disinfected, flushed, and sampled (Two consecutive coliform bacteria tests shall be taken 24-hours apart) prior to any service connections being made. The temporary water main shall be tested at static main pressure for a period of 2-hours.

3.25 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.

3.26 WATER MAIN TESTING SEQUENCE

- A. The following sequencing shall be followed by the Contractor unless an alternative sequencing plan is provided in writing by the Contractor and approved by BMU prior to performing any of the required sampling or pressure testing:
 - 1. Once water main construction is complete, the Contractor shall request to have the pipe segment filled by BMU personnel. Contractor shall make their request during normal business hours, between 8 a.m. to 5 p.m., Monday-Friday. Filling of the pipe segment will be done by BMU at a time determined by the BMU to have minimal impacts to the existing customers.

2. Upon completion of the minimum chlorine contact time, the Contractor shall request to have BMU personnel assist with purging air from line segment.
3. Once air has been purged from the line segment, the line segment shall be hydrostatically tested in accordance with these specifications.
4. The BMU Engineer or his appointed representative shall observe the pressure gauge readings before acceptance of the test. The BMU representative shall verify that the test hydrant lead valve(s) is in the open position prior to initiating the pressure test.
5. Should the test disclose damaged or defective materials or leakage greater than that permitted, the Contractor shall at his own expense locate and repair and/or replace any defective materials. The test shall be repeated until the leakage is within the permitted allowance.
6. Once a passing hydrostatic test has been obtained, the water main shall be adequately flushed by BMU personnel. BMU will be responsible for disposal of heavily chlorinated water.
7. Once flushing is complete, the line segment shall be bacteriological tested in accordance with these specifications.

3.27 HYDROSTATIC TESTING

- A. The Contractor shall furnish all pumping equipment, labor, gauges, and other appurtenances required for the pressure test.
- B. Upon completion of the water main installation, the water main shall be hydrostatically tested using the following guidelines:
 1. For water mains, a pressure of 120 psi shall be maintained for a period of 2-hours. The BMU Engineer or his appointed representative shall observe the pressure gauge readings before acceptance of the test.
 2. If after 2-hours the pressure has dropped less than 2 psi, the test shall be considered acceptable. If the pressure dropped greater than 2 psi, the volume of water needed to re-pressurize the water main shall be calculated and the Contractor shall be responsible for re-pressurizing the main.
- C. If at any time during the test the pressure drops below the specified test pressure, the Contractor shall re-pressurize the pipe by pumping in potable water in sufficient quantity to bring the pressure back to the original test pressure. Accurately measure the amount of water required to re-pressurize the system to the initial test pressure.
 1. Maximum allowable leakage rate:
$$Q = \frac{L D \sqrt{P}}{148,000}$$
Where:
 - Q = Allowable makeup water, gallons per hour
 - L = Length of pipe section being tested, in feet
 - D = Nominal Diameter of pipe, in inches
 - P = Avg Test Pressure, PSI Gauge
($\sqrt{120\text{psi}}=10.95$)

- D. If the average measured leakage per hour exceeds the maximum allowable leakage rate, repair and retest the water main. Repair all visible leaks regardless of the amount of leakage.

3.28 DISINFECTION AND BACTERIOLOGICAL TESTING

- A. The Contractor shall place sufficient granular chlorine in the water main as it is installed as required by the most current addition of AWWA C651 disinfection standards. Once water main construction is complete, the Contractor shall request to have the water main segment filled by BMU personnel.
- B. Once the water main is completely filled, the chlorinated water shall remain in the water main for a minimum of 24-hours. Upon completion of the minimum contact time, the Contractor shall request to have the water main flushed by BMU personnel. In order to prevent damage to the pipe lining, heavily chlorinated water shall not remain in contact with the water main for more than 72-hours.
- C. The water main shall be adequately flushed to remove all heavily chlorinated water and remaining particulates. BMU will be responsible for disposal of heavily chlorinated water such that residual levels of chlorine in the discharge water do not exceed 0.05 mg/L when entering the Waters of the State.
- D. One set of bacteria tests is required for every 1,200 lineal feet of water main installed.
- E. Once flushing is complete, BMU personnel will collect a water sample(s) from the water main at an acceptable location for coliform bacteria testing. Contractor shall deliver the water sample(s) to the lab for analysis.
- F. After collection of the first water sample(s), the water shall remain in the water main for an additional 24-hours. After a minimum of 24 hours, BMU personnel will collect a second water sample(s).
- G. Two consecutive passing samples (coliform bacteria absent), at all of the sample location(s), shall be required for a passing bacteria test. Upon receiving notification of the second sample passing, the water main can be put into service and service lines tapped.
- H. If one of the two consecutive coliform bacteria test fails (coliform bacteria present), the Contractor must request that the water main be re-flushed. After the water main is re-flushed, a water sample(s) will be taken and second water sample(s) shall be taken a minimum of 24 hours later than the first re-sample.
- I. If one of the two consecutive re-test samples fails, the Contractor is required to re-chlorinate the water main by the AWWA continuous feed or slug method (liquid chlorine injection through a service tap). The sample testing and retesting protocol established in the previous section will be required until consecutive coliform bacteria test passes.
- J. Contractor shall be responsible for paying, shipping, delivering and/or transporting all samples to the appropriate testing laboratory. Contractor shall provide Engineer of Record and BMU staff a copy of the successful bacterial testing results.