

SECTION 8A

WATER

8A.1 DESCRIPTION

- A. General:** This work consists of furnishing and installing water mains, water service lines, and appurtenances. This includes all equipment, tools, materials, labor, and other incidentals to provide water mains and water service lines complete and ready for immediate and continuous use. The work includes all necessary excavation, backfilling, compaction, testing, clean up, and restoration required for a complete installation of water mains, water service lines, and appurtenances. **All connections to the City water system, directly or indirectly, need to be designed and constructed in accordance with City Criteria.**

Standard specifications for corrosion protection of metallic fittings, valves, hydrants and other miscellaneous metallic pieces associated with the installation of plastic pipe are provided in Section 8B Corrosion Protection – Plastic Pipe Systems. Specifications regarding tracer wire, coatings for metallic pieces, for fasteners and for field coating repairs are included in Section 8B Corrosion Protection – Plastic Pipe Systems.

B. Related Work:

Section 7	General Conditions
Section 8B	Corrosion Protection – Plastic Pipe Systems
Section 9	Sanitary Sewer
Section 11	Utility Excavation and Backfill
Section 18	Erosion Sediment and Water Pollution Control
Section 19	Incidental Work
Section 41	Utility Trench Resurfacing
Section 56	Class M6 Concrete for Curb and Gutter and Flatwork
Section 92	Temporary Traffic Control
Section 112	Select Granular Backfill
Section 200	Controlled Low Strength Material
Section 203	Submittals

- C. License and Permit Requirements:** Shall comply with Section 7 General Conditions.

Water main flushing activities shall be conducted in accordance with this Section and in accordance with the following additional requirements.

Water main flushing activities shall be conducted in compliance with the "General Surface Water Discharge Permit for Temporary Discharge Activities Under The South Dakota Surface Water Discharge System (SDG07000)". A copy of the permit is available through the South Dakota Department of Agriculture and Natural Resources

(SD DANR). The contractor is required to furnish the "Notice of Intent (NOI) To Obtain Coverage under the SWD General Permit for Temporary Discharge Activities and A Temporary Water Rights Use Permit" to SD DANR as required under the permit, obtain SD DANR authorization, and furnish a separate copy of the authorization to the respective owner and Public Works Director at the preconstruction conference.

The contractor is responsible for performing any self-monitoring activities including sampling, testing and reporting as may be determined to be required under the authorization. Payment for obtaining the necessary authorization to discharge, and for all compliance activities and obligations by the contractor shall be absorbed into the item to which it relates. No additional payment will be made.

D. Submittals: Shall comply with Section 203 Submittals

Submittals shall be required unless otherwise specified in the Construction Plans, Detailed Specifications or Special Provisions.

8A.2 MATERIALS

A. Compliance Requirements Between Section 8A Water and Section 8B Corrosion Protection - Plastic Pipe Systems: All materials specified within this specification shall meet the requirements of Section 8B Corrosion Protection - Plastic Pipe Systems. Materials referenced within specification Section 8A Water do not imply that the stock material item is in compliance with Section 8B Corrosion Protection - Plastic Pipe Systems. The supplier and Contractor are responsible for complying with specification Section 8A Water and Section 8B Corrosion Protection - Plastic Pipe Systems collectively.

B. Pipe: Water pipe shall be polyvinyl chloride (PVC) up to and including 24 inches in diameter, unless another water pipe material is pre-approved for use by the Public Works Director. Water pipe larger than 24-inches in diameter shall be ductile iron pipe or steel pipe unless indicated otherwise.

1. PVC Pressure Pipe, 4 Inches Through 24 Inches: Shall conform to the requirements of AWWA Specification C900, pipe thickness dimension ratio (DR) DR18 (235 psi pressure class) or DR14 (305 psi pressure class), cast iron outer diameter (CIOD) as designed and called for in the approved construction plans and meet one of the below standards. Installation procedures shall conform to AWWA C-605 standards.

a) PVC Bell and Spigot Pipe: PVC bell and spigot pipe shall have bell ends with elastomeric gaskets. Pipe joints shall use the Rieber joining system, which has the gasket formed into the pipe during the pipe manufacturing process. Every pipe and coupling shall pass the AWWA C900 hydrostatic proof test requirements.

Acceptable Products:

- NAPCO Pipe & Fittings, AWWA C900/IB PVC Pressure Pipe;

- JM Eagle, Blue Brute™ C900;
- Diamond Plastics, C900 or C900/Trans-21™;
- Northern pipe Products C-900;
- Or approved equal.

b) Restrained Joint Coupling PVC Pipe: Utilize non-metallic couplings with locking splines. High strength, flexible thermoplastic splines shall be inserted into mating, precision machined grooves in the pipe and coupling to provide full 360-degree restraint with evenly distributed loading. Couplings shall be designed for use at or above the pressure class of the pipe with which they are utilized, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F477. Joints shall be designed to meet the zero leakage test requirements of ASTM D 3139. Every pipe and coupling shall pass the AWWA C900 hydrostatic proof test requirements.

Acceptable Products:

- NAPCO Pipe & Fittings, LLC Certa-Lok™ C900/RJ;
- Or approved equal.

c) Restrained Joint Integral Bell (RJIB) PVC Pipe: Shall have integral bells with a non-corrosive joint restraint mechanism that is specifically designed and constructed to restrain the bell/spigot pipe joint. The joint restraint mechanism shall provide full 360 restraint with evenly distributed loading. Fluid-Tite™ profile shaped gaskets meeting the requirements of ASTM F477 shall be utilized. Every pipe shall pass the AWWA C900 hydrostatic proof test requirements.

Acceptable Products:

- NAPCO Pipe & Fittings, LLC Certa-Lok™ C900/RJIB;
- Or approved equal.

d) Restrained Joint Thermally-Fused PVC Pipe: Shall have been pre-approved for use by the Public Works Director and shall conform to the construction plans and detailed specifications prepared by the Engineer of Record. Pipe fusion process shall be in accordance with the Engineer as well as the manufacturer of the pipe. Pipe joints shall be designed to meet the zero leakage test requirements of ASTM D 3139. Fusion joints shall have met all the qualification requirements of AWWA C900. Fusible pipe shall comply with all AWWA C900 hydrostatic pressure integrity test requirements. All fusible pipe shall be marked in accordance with the requirements of AWWA C900 and the manufacturer's requirements. Unless otherwise specified, fusible PVC pipe lengths shall be assembled by means of thermal butt-fusion per the pipe supplier's written instructions.

Acceptable Products:

- Underground Solutions, Inc., Fusible PVC® Pipe;
- Or approved equal.

2. **Ductile Iron Pipe:** Shall have been pre-approved for use by the Public Works Director and shall conform to detailed specifications prepared by the Engineer of Record including cathodic protection requirements. Ductile iron pipe shall conform to the requirements of AWWA Specifications C150 and C151, Pressure Class 350 for 3 inches through 12 inches diameter, Pressure Class 250, or greater for 14 inches through 20 inches diameter, and Pressure Class 200, or greater for 24 inches and larger diameter, unless specified otherwise on the plans or Detailed Specifications. Ductile iron pipe shall be coated on the outside with a minimum bituminous coating thickness of 1-mil unless coating or thickness is otherwise specified within the contract documents. Ductile iron pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be full thickness to the end of the spigot and to the seat of the bell, or shall be tapered for a length of not more than two inches.
 - a) Bituminous coating is not corrosion protection coating.
 - b) Rubber gasket joints for all Ductile Iron pipe shall meet the requirements of AWWA C111. Installation procedures shall conform to AWWA C600 Standards.
3. **Steel Pipe:** Shall have been pre-approved for use by the Public Works Director and shall conform to detailed specifications prepared by the Engineer of Record including cathodic protection requirements.
4. **Water Service Line Pipe:** Water service line pipe 1-inch minimum through 2-inch maximum diameter pipe size shall be:
 - a) **Type "K" Soft Copper Tubing:** Shall be US Government Type K Soft Tubing in minimum 60 - foot single or double pancake coils for 1 inch and 1 ½ inch diameter material. The minimum center coil diameter shall not be less than 16 inches. Tubing material for 2-inch material shall be supplied in 20 - foot lengths with ends of tubing to be cut off evenly. The use of 2-Inch coiled material requires prior approval by exception by the Public Works Director.
 - 1) **Tracer Wire:** Tracer wire is required to be connected via heavy duty cast bronze ground clamp to the customer side water service line in accordance with the Section 8B Corrosion Protection - Plastic Pipe Systems.
 - 2) **Tracer Wire Access Box:** Tracer wire access box is required in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems.
 - b) **High Density Polyethylene Pipe (HDPE):** HDPE shall conform to the applicable requirements of the current versions of AWWA C901, ASTM D2737, ASTM D2239, ASTM D3350, ASTM D4976, NSF 61, and shall meet the following:
 - 1) **Size:**

- I. 1-1/2-inch, and 2-inch Copper Tubing Size (CTS) pipe. 1-inch CTS HDPE pipe is no longer approved for buried water service line because the inner diameter is less than the inner diameter of 1-inch copper as specified.
- II. 1-inch, 1-1/2-inch, and 2-inch Iron Pipe Size (IPS) pipe. IPS pipe may be used provided all appurtenant water service line fittings including curb stops and corporation stops are appropriately sized for the use of IPS pipe.

2) Material:

- I. **CTS:** Polyethylene HDPE Standard Dimension Ratio (SDR) 9 for CTS pipe, PE4710, 250 psi water service line pipe.
- II. **IPS:** Polyethylene HDPE, Standard Inside Dimension Ratio, (SIDR) 7 for IPS pipe, PE4710, 250 psi water service line pipe.

3) Pipe Marking: Shall include the minimum of the following:

- I. **CTS:** HDPE, DR9, CTS, 250 psi, PE4710, AWWA C901, ASTM D2737, NSF61.
- II. **IPS:** HDPE, SIDR7, IPS, 250 psi, PE4710, AWWA C901, ASTM D2239, NSF61.

4) Color:

- I. **CTS:** Blue with white lettering.
- II. **IPS:** Blue with white lettering.

5) Stainless Steel Solid Sleeve Stiffener Inserts: Are required at all HDPE water service line connections whenever HDPE is inserted into a compression fitting. Stiffeners shall be appropriately sized for use of CTS and IPS. City shall inspect all HDPE pipe ends for presence of stiffeners prior to final installation in the appurtenance.

6) Tracer Wire: Is required in accordance with the Standard Specifications including Section 8B Corrosion Protection - Plastic Pipe Systems.

7) Tracer Wire Access Box: Is required in accordance with the Standard Specifications including Section 8B Corrosion Protection - Plastic Pipe Systems.

8) Bedding Material: Shall comply with Section 11 Utility Excavation and Backfill.

- 9) Certifications Manufacturer:** Shall certify that the materials used to manufacture HDPE Water service line meets the above requirements.

Acceptable Products:

- Centennial Plastics, CenCore;
- Cresline CE Blue®;
- JM Eagle Pure-Core;
- ADS Polyflex® Potable water service pipe;
- Or approved equal.

- 5. Water Service Pipe, Larger Than 2 Inches:** Shall meet the specifications for PVC water pipe or ductile iron pipe as specified for water pipes in this specification.

- C. Fittings:** Fitting types applicable to this specification include but are not limited to bends, crosses, tees, reducers/increasers, plugs, caps, couplings, sleeves, and clamps.

- 1. Ductile Iron Water Main Fittings:** Shall be ductile iron with 350-psi pressure rating and rubber gasket joints meeting all applicable requirements of the latest edition of AWWA C110, C111, and C153. Push-on joint fittings shall be furnished with restraining lugs. The lug pattern for all sizes shall accommodate gripper-type restrainers. All internal and external ferrous surfaces shall be coated per Section 8B Corrosion Protection - Plastic Pipe Systems. Unless specified otherwise in the plans or detailed specifications the following fitting joint shall be provided:

- a) Fittings 8 inches and smaller shall be push-on joint. If the fitting is required to be restrained per the construction plans, then the fitting may be mechanical joint.
- b) Fittings 10 inches and 12 inches shall be push-on joint or mechanical joint. If the fitting is going to be restrained then it shall be a mechanical joint.
- c) Fittings 14 inches and larger shall be mechanical joint.

- 2. PVC Water Main Fittings:** May be used in-lieu of ductile iron fittings for PVC pipe installations 12-inch and smaller. PVC fittings shall not be used for Ductile iron pipe or PVC pipe greater than 14-inch. PVC fittings shall meet all applicable requirements of the latest edition of AWWA C900 pipe thickness DR18 (235 psi pressure class) or DR14 (305 psi pressure class), CIOD and AWWA C907. Fitting DR shall correspond to the pipe DR. The PVC fitting bell ends shall have elastomeric gaskets. Installation procedures shall conform to AWWA C605 Standards.

- 3. Couplings:** Straight, transition, repair, and restrained couplings may be used as necessary. Type of coupling shall be in accordance with the pipe material being coupled, as designed and called for in the approved construction plans and in

accordance with the manufacturer's written instructions and shall be coated and cathodically protected in accordance with the Standard Specifications including Section 8B Corrosion Protection - Plastic Pipe Systems.

Acceptable Products:

- a) Romac Style 501 as manufactured by Romac Industries, Inc., shall have ductile iron center rings and end rings meeting ASTM A536-80, Grade 65-45-12. Center rings shall be epoxy coated. Gaskets shall be styrene-butadiene rubber (SBR) or Nitrile, both of which shall be compounded for water service. Materials shall be NSF/ANSI Standard 61 approved for water service.
 - b) Hymax®2 Cathodic or Hymax Grip® Cathodic Coupling as manufactured Krausz for various uses, shall be an epoxy coated sleeve type design meeting the requirements of AWWA C219-17. End rings shall be either one or two bolt design. Gaskets shall be multi-range ethylene-propylene diene monomer (EPDM) or Nitrile, both of which shall be compounded for water service. Coupling working pressure shall be a minimum of 230 psi. Materials shall be NSF/ANSI-Standard 61 approved for water service.
 - c) 421 Top Bolt by Smith-Blair, 422 Top Bolt as manufactured by Smith-Blair, shall be an epoxy coated sleeve type design meeting the requirements of AWWA C219-17. Gaskets shall be SBR or Nitrile, both of which shall be compounded for water service. Coupling working pressure shall be a minimum of 260 psi. Materials shall be NSF/ANSI-Standard 61 approved for water service.
 - d) NAPCO Pipe & Fittings, LLC Certa-Lok™ C900/RJ Restrained Joint PVC pipe shall use non-metallic couplings specifically designed by the manufacturer for use with their pipe. Couplings for 12-inch and larger pipe shall be a minimum 12 inches in length. Restrained couplings are reserved for use with corresponding restrained pipe or fitting.
 - e) Solid DI MJ sleeve coupling shall comply with the Ductile Iron Water main fittings product requirements of this section;
 - f) Or approved equal.
- 4. Tapping Sleeve:** Shall be stainless steel, flanged branch ends, with test plugs for pressure testing. The sleeve shall be approved for use at pressures equaling or exceeding those of the pipe classification being installed. Stainless steel tapping sleeves shall have a 300 Series stainless steel shell with SBR or Nitrile gaskets, both of which shall be compounded for water service, a stainless-steel flange, and shall have 304 stainless steel nuts, bolts, and washers. Materials shall be NSF/ANSI-Standard 61 approved for water service.

Acceptable Products:

- Romac SSTIII;

- Smith Blair model 665;
- Robar 6606BB;
- Ford style FTSS;
- PowerSeal 3490-AS/CS;
- Or approved equal.

5. **Foster Adapters:** Are acceptable for uses as called for in the construction plans and as approved by the manufacturer except between the fire hydrant and auxiliary valve and shall be NSF 61, fusion bonded epoxy coated.

Acceptable Products:

- INFACT Corporation (Epoxy Coated);
- Or approved equal.

6. **Repair Clamps:** For use on water service line abandonments up to 2 inches only and shall be stainless steel single or multiple section clamps as required for the repair. The clamps shall be approved for use at pressures equaling or exceeding those of the pipe classification being installed. The clamps shall be used for repair of tap holes in accordance with the manufacturer's requirements. Stainless steel repair clamps shall be 300 series stainless steel with SBR or Nitrile gaskets, both of which shall be compounded for water service and shall have 304 stainless steel nuts bolts and washers.

Acceptable Products:

- Romac SS1, SS3;
- Smith Blair 261;
- Robar 5616, 5626, 5636;
- Ford FS1;
- PowerSeal;
- Or approved equal.

- D. **Valves: General:** Valves 24 inches and smaller shall be gate valves. Valves 30 inches and larger shall be butterfly valves or gate valves as specified on the construction plans or detailed specifications. All internal and external ferrous surfaces shall be epoxy coated. Restraint accessories shall be factory installed. 24-inch and larger gate valves shall be positioned horizontally with 90-degree operator nuts. All valves shall meet applicable requirements as set forth in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems.

1. **Gate Valves:** Shall conform to the requirements of AWWA Standard C509 and C515 with a minimum 250-psi pressure rating and shall have a ductile iron-body and bonnet, be resilient seated, utilize mechanical joints including gaskets and bolts, and include all accessories. Gate valves shall have ductile iron wedge fully encapsulated with a SBR rubber or Nitrile elastomer coating. Stems shall be non-rising, one-piece cast, forged or rolled bronze. Valves shall have 2-inch ductile iron operating nuts and shall open left, counterclockwise. Bonnet bolts and nuts shall be Series 300 stainless steel and shall be rust proofed after threading and final

tightening. Gate valves utilizing the ALPHA™ restrained joint in lieu of a mechanical joint are acceptable for use with 4-inch to and including 12-inch resilient wedge valves. Restraint accessories shall be factory installed. Gate valves utilizing the ALPHA™ restrained joint shall meet all other requirements for gate valves as specified in this specification.

2. **Butterfly Valves:** Shall conform to the requirements of AWWA C504, Class 250B pressure rating for buried installation. Butterfly valve box body and disk shall be ductile iron ASTM A-536. Shaft shall be stainless steel. Seat shall be Buna-N, field replaceable without special tools and shall provide tight shutoff as required by AWWA C504. Mating surfaces shall be stainless steel. Bearings shall be self-lubricating, corrosion-resistant, and shall be designed for horizontal and/or vertical shaft loading. Shaft seals shall be designed for the use of bi-directional, self-adjusting packing, replaceable without removing the valve shaft.

Actuator shall be designed for buried service and shall be grease-packed, totally sealed. Actuator shall be equipped with a mechanical stop-limiting device to prevent over-travel of the valve disc in the open and closed positions. Actuator shall be sized in accordance with the needs of the valve being actuated and shall be equipped with 2-inch operating nut, which is hex-mated to the input stem and shall open by turning counterclockwise. Actuator shall be calibrated to close and seal completely prior to bury.

E. Valve Boxes:

1. **Valve Box for Gate Valves 12 Inches and Smaller and All Butterfly Valves:** Shall be a 2-piece screw-type construction with five and one-fourth (5 1/4) inches riser and shall be adjustable from four and one half (4 1/2) feet to 6-feet, with the top section to be at least 24 inches in length. Drop lids shall be marked "Water" and are to be of all-metal construction.

Acceptable Products:

- Tyler 6850-666-S series heavy duty valve box with adapter;
- Or approved equal.

2. **Valve box for Gate Valves 14-inch to and Including 24-inch:** Shall be a 2-piece screw-type construction with five and one-fourth (5 1/4) inches riser and shall be adjustable from three (3) feet to four and one half (4 1/2) feet, with the top section at least 24 inches in length. Drop lids shall be marked "Water" and are to be of all-metal construction.

Acceptable Products:

- Tyler 6860 Series heavy duty valve box with #6 base and adapter;
- Or approved equal.

3. **Valve Box Adaptor:** A valve box adaptor shall be installed on the valve bonnet prior to installing the valve box. The valve box adaptor eliminates shifting of the valve box, protects the coatings, centers the valve box, and seals the valve box

with a resilient material. The valve box adaptor shall be installed per the manufacturer's recommendations.

Acceptable Products:

- Valve Box Adaptor II as manufactured by Adaptor Inc., for valves 12 inches and smaller and all Butterfly valves, or approved equal.
- #6 Base Adapter as manufactured by Adaptor Inc. for Valves greater than 14 inches and greater, or approved equal.

F. Fire Hydrants: Shall meet AWWA C502 and shall have 6-inch mechanical joint inlets. Hydrants shall have 5 ¼-inch minimum valve openings, having O-ring packings and oil chamber to hold soft oil for stem thread lubrication, and shall have all operating parts, including valve seat, removable through the barrel. Barrel and upper standpipe shall be ductile iron with breaker flange and operating stem at ground level. A steel breakaway coupling shall be installed on the operating stem so that, in case of breakage, no damage will result to the fire hydrant other than safety breakers.

Fire Hydrants utilizing the ALPHA™ design hydrant inlet base are acceptable for use. Restraint accessories shall be factory installed. Fire Hydrants utilizing the ALPHA™ design hydrant inlet base shall meet all other requirements for fire hydrants as specified in this specification and in Section 8B Corrosion Protection - Plastic Pipe Systems.

All internal and external ferrous surfaces shall be epoxy coated.

All hydrants shall be capable of being extended in 6-inch increments. However, the minimum hydrant adjustment shall be 12 inches.

Hydrants shall be constructed so that they will close with the existing water pressure acting on the hydrant. Drain valves shall be bronze and shall be positively operated by the main operating rod. All threads shall be National Standard threads. Operating nuts shall be 1 ½ inches point-to-flat, pentagon (National Standard). Hydrants shall open left, counterclockwise. Fire Hydrants shall have an internal travel stop nut.

Hydrants shall have two, 2 ½-inch nozzles and one, 4 ½-inch steamer nozzle, all with National Standard threads. The minimum distance from the hydrant breaker flange to the centerline of the lower nozzle shall be 16 inches. Caps shall be nut type and shall be provided with chains. Hydrants shall be epoxy coated fire hydrant red.

All Fire Hydrants shall have a minimum bury depth of 6 ft from the ground line to the top of connecting pipe (6 ½-foot distance from ground line to connecting pipe invert). All fire hydrants shall have a maximum bury depth of 8 ft from the ground line to the top of connecting pipe (8 ½-foot distance from ground line to the connecting pipe invert) to facilitate their installation per the grades and lines shown on the construction plans. Vertical adjustments along the hydrant lead shall be accomplished using vertical bends (45-degree, 22½-degree, or 11¼-degree).

The use of a Fire Hydrant Extension will not be an acceptable method of adjustment

for a new fire hydrant, provided the necessary information was communicated on the construction plans. If this information was communicated, and the hydrant requires adjustment for final grade, then the Contractor shall replace the fire hydrant with a new fire hydrant with the correct barrel length or install the appropriate vertical bends on the hydrant lead.

In cases where a fire hydrant extension will be installed, the Contractor shall furnish the appropriate extension and notify the City Utility Maintenance Department for installation. City crews shall install all fire hydrant extensions.

Acceptable Products:

- Mueller A-423;
- American Darling B-84-B-5;
- American AVK Series 27;
- Waterous Pacer, traffic model.

G. Water Service Line Valves and Fittings: Shall meet AWWA Standard C800. If HDPE water service line pipe material is being utilized, Contractor shall ensure that the appropriately sized appurtenances (curb stops, corporation stops, valves, fittings, etc.) are provided for the service line size (CTS or IPS) being installed. Water service line transition couplings from CTS to IPS shall not be used unless directly connected to the appurtenant fitting. Plastic HDPE valves and fittings are not allowed.

1. Water Service Line Copper Splicing Couplings: Shall be flared or compression style in CTS or IPS. Soldered joints shall not be used for water service lines installed underground. For new installations (not repairs) 1-inch through 1½-inch water service lines shall avoid the use of couplings except as required at fittings.

Acceptable Products:

- Mueller 110 Conductive Compression;
- Hayes-Tite;
- Or approved equal.

2. HDPE Transition and Repair Couplings: Shall be compression by compression style in CTS or IPS.

3. Curb Stop Valves: Shall be a ball valve type with a 300-psig working pressure rating. A double O-ring port seal shall be provided in the stem and the O-rings shall be supported in precision-machined grooves. The end pieces shall be O-ring sealed to provide additional protection against leaking. 90-degree valve operation, with internal movement restraint, is required. Drains are not permitted on valves. Buffalo type valve boxes are required and therefore the Minneapolis Pattern threads on the valve are not a requirement. All Curb stops that are connected to copper water service lines shall incorporate isolators per Section 8B Corrosion Protection - Plastic Pipe Systems.

Acceptable Products:

- Mueller 300 Curb Ball Valve with Mueller 110 Conductive Compression Connection (CTS or IPS);
 - Y. McDonald Minneapolis Pattern Ball Valves - 300 PSIG Water;
 - Ford B44 Series;
 - Or approved equal.
- 4. Corporation Stops:** Shall be ball valve type with a 300 pound per square inch (psi) working pressure rating. The inlet shall have a taper thread (AWWA Standard) and the outlet shall be a conductive compression connection. Corporation stops that are used to connect copper water services to metallic water mains shall be insulated per Section 8B Corrosion Protection - Plastic Pipe Systems.

Acceptable Products:

- Mueller 300 Corporation Ball Valve with Mueller 110 Conductive Compression Connection (CTS or IPS);
 - Y. McDonald Ball Valves - 300 PSIG Water with A.Y. McDonald McQuick Compression-Q Series;
 - Ford FB1000 Series;
 - Or approved equal.
- 5. Service Saddles:** For 1-inch through 2-inch water service pipe shall utilize a wide band/strap with a minimum of 2 bolts and nuts, per width of the band/strap, for securing the band/strap to the main. The saddle shall provide full support around the circumference of the pipe. Nuts and bolts shall be rolled thread stainless steel or silicone bronze. Gaskets shall be SBR, EPDM, or Nitrile compounded for water service. It shall be the Contractor's responsibility to ensure that saddles and corporation stops are compatible with the pipe on which they are to be installed. If a compatibility question arises, the Contractor shall inform the Engineer immediately.
- a) Saddles for 6-inch to 12-inch Mains:** Shall utilize a stainless steel, cast brass per ASTM B62, or bronze body. Stainless steel saddles shall be cathodically protected in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Cast brass or bronze saddles, including those which have stainless steel straps, shall be protected by being wrapped with petrolatum system coating in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Saddles shall be pre-sized if required or recommended by the saddle or pipe manufacturer. Pre-sized saddles will conform to the pipe outer diameter (O.D.) without placing undue stress on the PVC pipe. Not all of the following indicated saddles are pre-sized and it is the responsibility of the Contractor and supplier to ensure that the saddle is pre-sized if required or recommended by the saddle or pipe supplier.

Acceptable Products for Saddles for 6-inch to 12-inch Water Mains Shall Be:

1-inch Service Taps: Provide a minimum total band/strap width of 2 inches

along the axis of the pipe. Saddles for 1-inch taps on 6-inch to 12-inch mains shall be:

- Ford Style FS313, FS323;
- Romac Style 306, Style and 202BS with stainless steel straps;
- A.Y. McDonald Model 3845;
- Mueller BR2W series with double studs;
- Or approved equal.

1½-inch and 2-inch Service Taps: Provide a minimum total band/strap width of 3¼ inches along the axis of the pipe. Saddles for 1½-inch and 2-inch taps on 6-inch to 12-inch pipe shall be:

- Ford Style FS313, FS323;
- Romac Style 306, Style and 202BS with stainless steel straps;
- A. Y. McDonald Model 3845;
- Mueller BR2W series with double studs;
- Or approved equal.

- b) Saddles for 14-inch and Larger Water Mains:** Saddles for 14-inch and larger water mains shall utilize cast brass per ASTM B62 or bronze, stainless steel, or a high strength ductile iron body with a minimum 12 mils of fusion applied epoxy or Nylon 11 coating and a stainless steel band. Stainless steel and ductile iron saddles with stainless steel straps shall be cathodically protected in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Cast brass or bronze saddles, including those which have stainless steel straps shall be protected by being wrapped with petrolatum system coating in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Saddles shall be pre-sized if required or recommended by the saddle or pipe manufacturer. Pre-sized saddles will conform to the pipe outer O.D. without placing undue stress on the PVC pipe. Not all of the following indicated saddles are pre-sized and it is the responsibility of the Contractor and manufacturer to ensure that the saddle is pre-sized if required or recommended by the saddle or pipe supplier.

Acceptable Products for Saddles for 14-inch and larger water mains shall be:

1-inch Service Taps: Provide a minimum total band/strap width of 2 inches along the axis of the pipe. Saddles for 1-inch taps on 14-inch and larger pipe shall be:

- Ford Style FS323, FS333, and FC202;
- Romac Style 202B, 202BS, and 202NS;
- Mueller BR2S, BR2W, and DR2S with SS straps;
- Or approved equal.

1½-inch and 2-inch Service Taps: Provide a minimum total band/strap width of 3 inches along the axis of the pipe. Saddles for 1½-inch and 2-inch taps on 14-inch and larger pipe shall be:

- Ford Style FS323, FS333, and FC202;

- Romac Style 202B and 202BS, 202NS;
- Mueller BR2S, BR2W, and DR2S with SS straps;
- Or approved equal.

- c) Curb Boxes:** Shall be cast-iron. The box shall be capable of telescoping at a minimum, from 5 feet to a length of 6 feet. Lid shall be marked "water" and have a 13/16 inches (point to flat) pentagon brass nut. Risers shall be a minimum of 2 ½ inches in diameter.

Acceptable Products:

- Tyler 6500 Series, Buffalo Type;
- Or approved Equal.

- d) Tapping Sleeves and Valve:** Shall be used for water service lines 4-inch and larger and shall comply with the requirements of this specification.

- H. Concrete Thrust Blocks:** Shall be M-6 concrete as specified in Section 56 of the Standard Specifications. For fittings and joint restraining devices which utilize thrust blocks, incorporate an 8-mil thickness of polyethylene meeting AWWA C105 as a bond breaker. Joint tape for polyethylene shall be 3M Scotchwrap 50, or approved equal.

I. Joint Restraining Devices:

- 1. Joint Restraint Devices at Fittings:** Shall be as follows:

- a) Push-On (Ductile Iron Pipe to Ductile Iron Push-on Fitting) Acceptable Products:**

- 1) EBAA Series 15PF00TD Tru-Dual®, (Split Ring);
- 2) Or approved equal.

- b) Mechanical Joint (Ductile Iron Pipe to Ductile Iron Mechanical Joint fitting) Acceptable Products:**

- 1) EBAA Series 1100 MEGALUG®, (Solid Ring), or approved equal.
- 2) EBAA series 1100SD Split MEGALUG®, (Split Ring) (use only for connection to existing ductile iron pipe), or approved equal.

- c) Push-On (PVC Pipe to Ductile Iron Push-on Fittings) Acceptable Products:**

- 1) EBAA Series 15PF00, (Split Ring);
- 2) Or approved equal.

- d) Mechanical Joint (PVC Pipe to Ductile Iron Mechanical Joint Fittings)**

Acceptable Products:

- 1) EBAA Series 2000PV MEGALUG®, (Solid Ring), or approved equal.
- 2) EBAA Series 2000SV MEGALUG® Split Restraint, (Split Ring), (use only for connecting to existing PVC pipe), or approved equal.

e) Push-on (PVC Pipe to PVC Push-on Fittings) Acceptable Products:

- 1) EBAA Series 2500 Restraint Harness for C900 PVC Fittings, (Split Ring);
- 2) Or approved equal.

2. Joint Restraint Devices at Pipe Bells: Also referred to as bell restraints, shall be as follows:**a) For Ductile Iron Pipe Acceptable Products:**

- 1) EBAA Series 1700 MEGALUG® Harness, (Solid Ring/ Split Ring) or approved equal.
- 2) In lieu of bell restraint devices, push on joints with the American Fastite Joint system with Fast Grip Gasket, or approved equal may be used when approved by the Engineer.

b) For PVC Pipe 4" to 12" Acceptable Products:

- 1) EBAA Series 1600 Split Serrated Restraint harness, (Split Rings);
- 2) Or approved equal.

c) For PVC pipe 14" to 30" Acceptable Products:

- 1) EBAA Series 2800 MEGALUG® Restraint Harness, (Solid Ring);
- 2) Or approved equal.

J. Insulation: Shall comply with Section 11 Utility Excavation and Backfill.**K. Temporary Water Service/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 372.

All PVC piping systems shall be manufactured in conformance with the most current edition of AWWA C900-16 Standards and shall meet NSF/ANSI Standard 61: Drinking Water System Components-Health Effects and NSF/ANSI 372.

L. Air Release Valves: Shall be as specified by the Engineer of Record.

8A.3 Construction Requirements

A. Materials Handling and Storage: The Contractor shall be responsible for the safe handling and storage of all materials furnished by them and shall replace, at their expense, all such materials found defective in manufacture or damaged in transportation, handling, or storage. Pipe, fittings, and accessories shall be loaded and unloaded by lifting with hoists or palletized to avoid shock or damage. Under no circumstances shall such materials be dropped. All material shall be stored in a neat and orderly manner.

Pipe shall be stored, to the greatest extent possible, in unit packages or bundles and shall be handled to prevent stress to bell joints and prevent damage to bevel ends. In addition, materials shall be handled and stored in accordance with manufacturer's recommendations.

The Contractor shall cover all PVC pipe and fittings in accordance with manufacturer recommendations. In the absence of manufacturer recommendations to cover, PVC pipe and fittings shall be stored to minimize direct rays of sun and UV exposure. This may be accomplished with a minimum of a light opaque material covering the pipe. The covering shall be positioned to allow adequate ventilation to prevent heat buildup. The submittal for this material shall identify the proposed method of storage. Pipe material that shows signs of UV impact including impacts such as chalking, faded colors will be removed from use on the project.

If, in the opinion of the Engineer, damage or defects to the factory applied external coatings on steel or ductile iron pipe and fittings (including fire hydrants) cannot be repaired, then the Contractor shall replace the damaged items with new materials. If in the opinion of the Engineer damage or defects to the factory applied external coatings on steel or ductile iron pipe and fittings (including fire hydrants) can be repaired, then the Contractor shall make repairs to damaged coating per Section 8B – Corrosion Protection – Plastic Pipe Systems.

B. Alignment and Grade: Pipe shall be laid true to the line and grade established on the construction plans. Where the construction plans indicate that the finished ground surface elevations are to be modified from the existing elevations by current or future construction, the Contractor shall exercise care to ensure that pipe, fittings, hydrants, valves and valve boxes are placed to the elevations indicated on the plans. Tolerances shall be within 0.5 feet for alignment and within 0.2-feet of the specified grade.

C. Underground Obstructions: The Contractor shall expose existing underground obstructions shown on the plans or located in the field and shall determine their elevations far enough in advance of pipe laying that the proposed water main can be installed without the use of fittings at or near the points of crossing. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere with the proposed horizontal or vertical alignment of the pipeline, the Engineer will change the plans and order a deviation in the line and/or grade, or may

arrange for the removal or relocation of the obstructions. The Contractor shall not deviate from plan line or grade without the Engineer's approval.

- D. Contaminated Materials:** If contaminated materials are encountered as defined in Section 11 "Unsuitable Backfill Material Excavation", Contractor shall immediately contact the Engineer of Record to confirm suitability of pipe materials and appurtenances.
- E. Water Main and Sewer Main/Storm Sewer Separation:** Shall comply with Section 11 Utility Excavation and Backfill.

F. Installation:

1. **Trenching:** Shall comply with Section 11, Utility Excavation and Backfill for Trenching Requirements.
2. **Minimum Cover:** Depth from top of pipe to finished grade shall be as follows:

Size of Pipe (In.)	Minimum Cover (Ft.)
12 or less	6
14 to 18	5 ½
20 or larger	5

In the event adequate cover cannot be achieved by alignment or grade adjustment, then, with prior approval of the Public Works Director, the water pipe may be insulated. Insulation shall comply with Section 11 and the Insulation Standard Detail in cases where minimum cover cannot be provided. Insulation may also be required if adequate separation between a storm sewer or culvert and the water pipe cannot be achieved.

3. **Cleaning:** Shall be done as necessary so that the interior of all water pipe and fittings is free from all dirt, concrete, or other foreign material before installation.
4. **Pipe Cutting:** Shall be done without damage to the pipe with saw or abrasive wheel and shall be smooth, straight, and at right angles to the pipe axis. Ends of pipe shall be dressed and beveled to remove roughness and sharp corners.
5. **Laying and Joining of Pipe:** Shall be in accordance with AWWA C900, AWWA C605, and with the pipe manufacturer's instructions, unless specifically required otherwise by these specifications. Laying and joining of ductile iron pipe shall be in accordance with AWWA C600, Installation of Ductile-Iron Water Mains and their Appurtenances, and with the pipe manufacturer's instructions, unless specifically required otherwise by these Specifications.

In most applications, pipe shall be laid with bell ends facing in the direction of laying. Each pipe length shall be inspected for defects prior to being lowered into the trench. All pipe and fittings shall be carefully lowered into the trench piece by

piece by means of pipe slings to prevent damage to the pipe and/or coating. Full lengths of pipe shall be installed except where connecting to appurtenances and fittings. The Contractor shall leave an appurtenance or fitting with a full length of pipe whenever possible.

Water main pipe shall not be installed in frozen ground or in water, and no water shall be allowed to run into or through the pipe.

During the course of construction, a water tight plug shall be kept in the end of the pipe so as to prevent any dirt and 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.

- a) **Push-on Joints:** The spigot end of field-cut piping shall be cut square and then beveled. Joint surfaces shall be cleaned and lubricated immediately before completing the joint.
 - b) **Certa-Lok C900/RJ Coupling:** Certa-Lok C900/RJ grooved end pipe shall be inserted into Certa-Lok C900/RJ couplings only. Only insert plain-end pipe into Certa-Lok C900/RJ couplings outside of the restrained "L" length for the pipe system or utilize thrust blocking or other approved joint restraint devices.
 - c) **Restrained Joint Integral Bell (RJIB) PVC Pipe Joints:** The pipe end shall be cut off to remove the groove and the pipe end shall be beveled when connecting RJIB PVC pipe to connections including fittings, couplings, or mechanical joint bells.
 - d) **Mechanical Joints:** Joints shall not be over-tightened; if an effective seal is not obtained the joint shall be disassembled, cleaned thoroughly and reassembled. Where joint restraint devices are used with a mechanical joint, the holes shall be carefully aligned to permit installation of harness bolts. At mechanical joints, a beveled PVC spigot may not be used. Rather a non-beveled spigot shall be used for insertion into mechanical joint.
6. **Protection of the Work:** Whenever pipe laying operations are stopped temporarily during the work day or at the end of the work day, the contractor shall plug, with a water tight plug, all open ends, to prevent soil, water, or other matter from entering the pipe.
7. **Pipe Deflection:** Deflection or bending of the pipe or deflection of the pipe joint (bell and spigot) shall not be permitted except as approved by the Engineer. Changes in horizontal and vertical direction shall be achieved using standard fittings, fabricated fittings, and Couplings specifically designed and approved for use in joint deflection.

The Engineer may approve deflection of 12-inch diameter or smaller pipe or pipe joints if the Engineer of Record specifically designed for the deflection and the deflection is approved in writing by the pipe manufacturer specifically for the

project. A condition of approval is the City of Rapid City receiving a letter from the pipe manufacturer stating they have reviewed the proposed pipe or pipe joint deflections for (state the project name and City tracking number) and they approve and warranty the pipe for the proposed deflections. Deflection of pipe or pipe joints for diameters greater than 12 inch is strictly prohibited.

Restrained joint pipe and couplings may be deflected in accordance with the manufacturer's written recommendations. The Engineer of Record shall specifically indicate the use of restrained joint pipe and indicate the designed deflections on the construction plans.

8. **Fittings:** Bends and tees shall be placed on a stable foundation, which may require the use of concrete pads of equal size or larger than specified for valves. Fittings shall be provided with thrust blocks, as specified herein.
9. **Couplings:** Shall be placed on a stable foundation, which may require the use of concrete pads of equal size or larger than specified for valves. Couplings shall be approved by the pipe manufacturer for the use with the pipe and shall be installed according to the coupling manufacturer's recommendations.
10. **Thrust Blocks:** Concrete thrust blocks are required at the locations indicated in the specifications unless there is an exception not to use them. If restrained joint pipe is being used, thrust blocks are still required at the locations indicated in the specifications unless there is an exception not to use them. Thrust blocks and joint restraints as redundant systems are not a requirement of the specification unless the construction plans call for redundant systems. Concrete thrust blocks shall be provided at tees, crosses, horizontal bends, plugs, caps, and fire hydrants, whether specifically indicated on the construction plans or not. Refer to the subsection "Joint Restraining Device Installations" for fittings that allow the use of joint restraints in-lieu of concrete thrust blocks.

Concrete thrust blocks shall have a thickness at the fitting equal to at least half the diameter of the pipe being installed but shall not be less than six (6) inches thick under any circumstances. They shall extend from the fitting to the undisturbed wall of the excavation. The Contractor shall insure that the concrete does not cover or render inoperable nuts or bolts on the fittings. All metal fittings, valves, or appurtenances shall have a polyethylene bond breaker (separation barrier) between the fitting and the concrete.

Concrete Thrust blocks shall be allowed to cure for 48 hours prior to activating the water main. If the water main needs to be activated prior to the concrete curing (48 hours), then the water main shall be restrained using joint restraining devices. Under this circumstance, the thrust block is still required and the cost of furnishing and installing the joint restraint device is incidental. If the water main needs to be activated prior to the concrete curing (48 hours) and joint restraints are applied, then thrust blocks shall be allowed to cure for a minimum of 4 hours prior to

backfilling.

Thrust Blocks shall be installed as shown on the construction plans and shall meet or exceed the minimum volume or bearing area requirements as specified on the construction plans or specifications for the water pressures and soil conditions.

In muck, peat, or similar weak soils, thrust loads shall be restrained by using joint restraining devices and thrust blocks, or by removal of the soil and replacement with a material of sufficient stability to resist thrust loads as determined by the Engineer.

11. Joint Restraining Device Installations: Shall be installed per the manufacturer's recommendations and for the appropriate water pressures and soil conditions as shown on the construction plans and/or described in the Detailed Specifications. Refer to Section 7 for the definition of "L" length for Joint restraining devices. Joint Restraining Devices shall be used at the following locations:

- a) All Valves and pipe joints within their corresponding "L" lengths shall be restrained with joint restraining devices;
- b) All Reducers/Increases and their corresponding "L" lengths shall be restrained with joint restraining devices;
- c) All Vertical Bends and pipe joints within their corresponding "L" lengths shall be restrained with joint restraining devices; and
- d) All Water Main Lowering and pipe joints shall be restrained. Water main lowering restraint shall include restraining all joints within the fitting's corresponding "L" length plus restraining all pipe joints which lie between the start of the lowering and the end of the lowering, regardless of whether or not the pipe joint is located within the fitting's "L" length.

12. Insulation: Shall comply with Section 11 Utility Excavation and Backfill.

13. Fire Hydrants and Auxiliary Valves: Fire Hydrants shall stand plumb and shall have their nozzles parallel with or at right angles to the street, with the pumper nozzle facing the street. At intersections, the pumper nozzle shall face the higher classification street. Hydrants shall be set with the bottom of the breaker flange 2 inches above the finished ground elevation as shown on the Standard Details, resulting in the centerline of the lowest nozzle being at least 18 inches above finished grade. In no case shall hydrants be set closer than 4-feet from curb or edge of pavement, measured from outside of hydrant barrel to back of curb or edge of pavement. In no case shall hydrants be set closer than 1-foot from the edge of a sidewalk, measured from outside of hydrant barrel to edge of sidewalk.

The Contractor shall set each fire hydrant on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness and shall place a minimum of 1/3 cubic yard of Type 1 Bedding Material around the lower part of the hydrant to at least 6 inches above

the drain port to provide a drainage area for the hydrant barrel. The Contractor shall insure that the drain port at the base of the hydrant is open to allow for the hydrant to drain properly when closed. Cast in place concrete may be used in lieu of the pre-cast pad if the hydrant lead is not charged for at least 48 hours, the drainage ports are maintained and 4 hours cure time is allowed before backfilling. An appropriately sized thrust block shall be installed between the hydrant and the undisturbed trench wall. The thrust block shall meet the thrust block requirements on the construction plans and herein.

An auxiliary valve matching the size of the fire hydrant lead and a valve box shall be installed on the fire hydrant lead. Auxiliary valves shall be installed as detailed on the standard detail and shall be placed on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness, and shall be fitted with a joint restraining device as approved by the Engineer. Cast in place concrete may be used in lieu of the pre-cast pad if the hydrant and hydrant lead are not charged for 48 hours, and 4 hours cure time is allowed before backfilling. If the auxiliary valve needs to be moved away from the fire hydrant to avoid a conflict it may be moved up to 7 feet away from the hydrant.

Tracer wire conduit shall be attached to the fire hydrant barrel section prior to backfill. The tracer wire access box may be installed after initial backfill. Refer to Section 8B – Corrosion Protection for Plastic Pipe Systems for tracer wire installation requirements.

In cases where a fire hydrant needs to be rotated or an extension needs to be installed, City Utility maintenance staff shall perform the work. Refer to Section 8A.2. "Materials" for further information regarding the use of hydrant extensions.

- 14. Valves:** Valve interiors and adjacent piping shall be cleaned of foreign material prior to making valve to pipe connection. Pipe/valve joints shall be straight and without deflection. All valves shall be placed on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness, and centered on the valve. Cast in place concrete may be used in lieu of the pre-cast pad if the pipe and valve is not charged for 48 hours, and 4 hours cure time is allowed before backfilling. Valves shall be backfilled with Type 1 bedding material to one (1) foot above the valve. The Contractor shall check all operating mechanisms for proper functioning; valves, which do not operate easily or are otherwise defective, shall be replaced at the Contractor's expense.

When butterfly valves are being installed, the actuator shall be calibrated to close and seal completely prior to bury. Engineer shall inspect the butterfly valve for complete closure prior to bury. This inspection does not constitute final acceptance of the valve.

- 15. Valve Boxes:** Shall be installed straight and plumb directly over the valve stem and placed over a valve box adaptor. The top of the valve box shall be placed flush to $\frac{1}{4}$ inches below flush with the surfacing in paved or graveled areas and shall be flush with the finished grade in grass surfaced areas. Where the construction plans

indicate that the future grade at the valve location will be higher or lower than the existing grade at the time of valve installation, the Contractor shall provide the correct combination of extension pieces so that the valve box can be adjusted to the future finished grade without replacing the valve box.

A Valve Box Adaptor shall be installed on the valve bonnet prior to installing the valve box.

The Valve box shall be wrapped with polyethylene in accordance with Section 8B – Corrosion Protection for Plastic Pipe Systems details.

16. Tapping Sleeves and Valves for Taps 4 Inches and Larger: Where new 4-inch or larger water service lines or mains are to be connected to a main, the Contractor shall furnish all material necessary for connection to the water main, as specified herein. The Tapping Sleeve and valve shall be assembled in accordance with the manufacturer's instructions. Tapping Sleeves and valves shall be supported independently from the pipe prior to tapping and shall be provided with thrust restraint as specified for other fittings. The Tapping Sleeve requires the installation of a thrust block per specifications.

City Utility maintenance will perform all taps and the Contractor shall schedule all 4 inch and larger taps between 7:30 AM and 12:30 PM, Monday through Thursday, or as alternately scheduled by the City Utility Maintenance Group.

The Contractor shall obtain and pay for all applicable permits and fees.

17. Corrosion Protection: Shall be completed per Section 8B - Corrosion Protection for Plastic Pipe Systems or as outlined in the Detailed Specifications.

18. Dewatering: Shall be accomplished per Section 11 Utility Excavation and Backfill.

G. Disinfection: Disinfection shall comply with the requirements of AWWA C600, C605, and C651. All new water mains and appurtenances shall be disinfected before they are placed in service. All water mains taken out of service for inspecting, repairing, or other activity that might lead to contamination shall be disinfected before they are returned to service.

Unless specified otherwise in the detailed specifications or construction plans, or required by other provisions of this specification, disinfection shall be accomplished by the tablet method. The Contractor shall obtain the Engineer's approval prior to using a method other than the tablet method. The slug disinfection method, continuous feed method, or spray method shall be as specified by the Engineer of Record in accordance with AWWA C651. In the event that a condition arises during construction that triggers the need for one of these methods, the contractor shall refer to AWWA C651.

A submittal will be required to be submitted by the Contractor for approval by the

Engineer of the use of any of these methods.

1. **Preventative Methods:** The tablet method specified below may be used only if the pipes and appurtenances are kept clean and dry during construction. Therefore, the Contractor shall take precautions to protect the interiors of pipes, fittings, and valves against contamination. Pipe delivered for construction shall be strung so as to minimize the entrance of foreign material.

If dirt enters the pipe, it shall be removed and the interior of the pipe surface swabbed with a 1-percent to 5-percent hypochlorite disinfecting solution. If a water main is contaminated with sediment or debris, flushing will not be allowed as a method of cleaning the sediment or debris. If, in the opinion of the Engineer, the sediment and debris cannot adequately be removed by the Contractor, then the Contractor shall clean the interior of the pipe by mechanical means, such as a hydraulically propelled foam pig. Following mechanical cleaning the Contractor shall flush the line achieving minimum flushing velocities of at least 3.0 ft/s and shall then disinfect the pipe using either the continuous-feed or the slug method per AWWA C651.

All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks, meal periods, or weather events. If water accumulates in the trench, the plugs shall remain in place until the trench is dry. If, for any reason, the water pipe is flooded during construction, it shall be cleared of the floodwater by draining and flushing with potable water until the water main is clean. The section exposed to floodwater shall then be filled with chlorinated potable water that, at the end of a 24-hour holding period, will have a free chlorine residual of not less than 25 milligrams per liter (mg/l). The chlorinated water shall then be flushed from the water main and after construction is completed, the main shall be disinfected using the continuous-feed or slug method.

2. **Disinfectant:** The tablet method requires that the pipes and appurtenances be kept clean and dry. This method may not be used if the pipes and appurtenances are not kept clean and dry. In the event the pipes and appurtenances are not kept clean and dry, the Engineer must be contacted.

Tablets shall be 5-gram calcium hypochlorite tablets conforming to AWWA B300 and shall contain between 65-percent and 70-percent available chlorine. Tablets shall be fresh and shall be stored in a cool, dry, and dark environment to prevent loss of strength, which occurs upon exposure to the atmosphere.

The contractor shall not use calcium hypochlorite intended for swimming pool disinfection, because this material has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time has been achieved.

3. **Dosage:** Unless otherwise specified, the Contractor shall place calcium hypochlorite tablets in each section of water pipe installed, including the hydrant branch, according to Table 8-1, below.

Table 8A-1
NUMBER OF 5-GRAM CALCIUM HYPOCHLORITE
TABLETS REQUIRED
(50 mg/l Dose)

Length of Pipe Section (Ft.)	Diameter of Pipe (In.)						
	4	6	8	10	12	14	16
13 or less	1	2	2	3	5	6	8
13 - 18	1	2	3	5	6	8	11
18 - 20	1	2	3	5	7	9	12
20 - 30	2	3	5	7	10	14	18
30 - 40	2	4	6	9	14	18	24

For pipes larger than 16 inches, refer to construction plans or detailed specifications for disinfection requirements. The Engineer of Record is responsible for establishing the disinfection requirements for pipes larger than 16 inches.

4. **Placing Tablets:** Tablets shall be adhered to the inside top section of each pipe length using a food-grade adhesive. Adhesives shall meet the requirements of a food-grade adhesive per either NSF/ANSI 51-2005: Food Equipment Materials or NSF/ANSI 61-2005: Drinking Water System Components - Health Effects. NSF/ANSI 61 lists several adhesives that are approved for drinking water contact. It is recommended to use an adhesive that sets quickly and isn't reactive with the water main's composition or with the disinfectant tablet. There shall be no adhesive on the tablet except on the broad side attached to the surface of the pipe. If the tablets are attached before the pipe section is placed in the trench, the tablets' position shall be marked on the pipe section to indicate the pipe has been installed with the tablets at the top.
5. **Filling and Contact:** The water main shall be filled slowly so that the water velocity is no greater than 1-foot per second (fps). Precautions shall be taken to assure that air pockets are eliminated. The water shall be allowed to stand in the pipe for at least 24 hours. Valves shall be positioned so that the strong chlorine solution in the treated main will not flow into water mains in active service. The Contractor shall not fill a main without the Engineer being present.
The chlorinated water shall remain in the pipe for at least 24 hours. The Contractor shall notify the Engineer at the end of the 24-hour retention period prior to flushing to allow the Engineer to check the chlorine residual in the pipe. If the chlorine residual is less than 25 mg/l, the Contractor shall, at his expense, disinfect the water main again by the continuous-feed method or the slug method, as approved by the Engineer.
6. **Flushing:** Within 48 hours of the end of the 24-hour retention period, the Contractor shall flush the heavily-chlorinated water from the main until the chlorine concentration in the water leaving the main is no higher than that prevailing in the system or is less than 1 part per million (ppm) as determined by the Engineer. In addition to the above requirements, a minimum flushing velocity of 3.0 fps and flushing duration of one minute per 100 feet of pipe being flushed shall be achieved

per Table 8A-2.

Table 8A-2

REQUIRED FLOW AND MINIMUM FLOW DURATION TO FLUSH PIPELINES

Pipe Diameter (In.)	Flow required to produce 3.0 fps Velocity in Main*	Fire Hydrants		Minimum Flushing Duration (minutes per 100 feet of pipe)
		Number of Fire Hydrants	Outlet Size (In.)	
4	120	1	2-1/2	1
6	280	1	2-1/2	1
8	480	1	2-1/2	1
10	740	1	2-1/2	1
12	1100	2	2-1/2	1**
14	1450	2	2-1/2	1**
16	1950	3	2-1/2	1**

Table 8A-2 shows the rates of flow required to produce a velocity of 3.0 fps in pipes of various sizes and the minimum flushing duration per 100 feet of pipe length.

For pipes larger than 16-inch, refer to construction plans or detailed specifications for requirements. The Engineer of Record is responsible for establishing flushing requirements for pipes larger than 16 inches.

* Requires a minimum 40-psi pressure in the main and the hydrant flowing to atmosphere.

** Assumes that the corresponding flow rate is being met.

Flushing shall be done in accordance with AWWA C651. Flushing shall be accomplished through use of hydrants or temporary fittings installed for the purpose; flushing through corporations and/or water service lines is prohibited. The Contractor shall obtain the Engineer's approval prior to installing special fittings for flushing.

Heavily-Chlorinated water used to disinfect water mains shall be neutralized prior to release. The Heavily-Chlorinated water shall be neutralized at the discharge from a hydrant using approved dechlorination equipment and materials. At the option of the Contractor, the Heavily-Chlorinated water may be contained and transported to an approved location for land application. The contractor shall remain responsible for meeting all the requirements of the Standard Specifications for required flow and minimum flow duration to flush pipelines and surface water quality standards. Neutralization of Heavily-Chlorinated water shall be incidental to the installation of all water mains.

Flushing shall be conducted in such a way as to prevent contamination of existing water mains and/or water service lines and to minimize traffic and pedestrian hazards and nuisance conditions. When possible, flushing shall be to the nearest storm sewer or drainage way. Flushing to the sanitary sewer is prohibited.

The Contractor will be responsible for any damage to fish and/or aquatic life caused by the chlorine residual. If Chlorine reaches or is detected in a stream,

river, or other waterway the Contractor will be in violation for that discharge. For more information, contact SD DANR Surface Water Quality Program at (605) 773-3351. Refer to section below, "Disposal of Chlorinated Water" for additional information regarding neutralizing chlorine residual.

7. **Sampling:** Per AWWA C651, the contractor shall sample for coliform bacteria contamination. After the water lines have been flushed, the contractor shall sample the water mains. Two consecutive samples of water from the end of the disinfected/flushed water main must be collected at least 16 hours apart. These samples must be submitted to the State Health Laboratory in Pierre, or another laboratory acceptable to the SD DANR and the Engineer. At least one set of samples shall be collected from every 1,200 feet of new water main, plus one set from the end of the main and at least one set from each branch. The samples shall be collected in the presence of the Engineer.

The samples must show the absence of coliform bacteria contamination before any taps may be made to the main or the main is activated and placed into service. Copies of all sample results shall be submitted to the Engineer within 48 hours of receipt thereof.

Because of the high risk of contamination during sampling, the Contractor shall use certified lab personnel or a trained sampler to collect all samples submitted for testing.

8. **Disposal of Chlorinated Water:** The Contractor shall apply a neutralizing chemical to the water to be wasted to neutralize thoroughly the chlorine residual remaining in the water as listed in Appendix B of AWWA C651. The Contractor will be responsible for any damage to fish and/or aquatic life caused by the chlorine residual. If Chlorine reaches or is detected in a stream, river, or other waterway the Contractor will be in violation for that discharge. For more information, contact SD DANR Surface Water Quality Program at (605) 773-3351.

H. **Pressure and Leakage Test for Mains and Water Service Lines 4 Inches or Larger:**

1. **General:** Pressure and leakage tests shall be performed on all newly installed water mains. The "Simultaneous Pressure and Leakage Tests" will be used unless otherwise specified. The testing methods specified in this section are specific for water pressure testing only; air pressure testing is prohibited due to the catastrophic nature of failure should failure occur.
2. **Test Restrictions:** The pressure shall be 150-percent of the working pressure at the point of test, but not less than 125-percent of normal working pressure at the highest elevation, whichever is greater. Test pressure shall not exceed pipe, valve, or thrust-restraint design pressures and shall not vary by more than 5 psi (plus 5 psi or minus 5 psi) for the duration of the test. The duration of the hydrostatic test shall be a minimum of 2 hours.

The Contractor shall anticipate the need to conduct multiple tests in areas of varying topography and shall conduct testing in such a manner and sequence that the pressure requirements indicated above are achieved.

3. **Pressurization:** Before applying the specified test pressure, each valved section of pipe to be tested shall be slowly filled with potable water and all air expelled from the pipe, valves, fittings, and hydrants. Where City water is not available, the Contractor shall furnish sufficient potable water to fill and test the pipe. The specified test pressure, based on the elevation of the lowest point of the section under test and corrected to the elevation of the test gauge, shall then be applied by means of a suitable pump connected to the pipe in a manner satisfactory to the Engineer and shall be sustained for the specified time.

The test pump shall be equipped with two (2) accurate pressure gauges, between the pump shut-off valve and water main being tested, both to show the line pressure reading during testing. When hydrants are in the test section, the test shall be made against closed hydrant valves. Pressure gauges shall have graduation marks, at minimum, for every 2 psi and be capable of interpreting pressure readings within 1 psi. The pressure reading deviation between the two pressure gauges shall not be greater than 2.0 psi. During the pressure test the pressure loss indicated between the two gauges shall not deviate more than 0.5 psi between the two gauges.

4. **Leakage:** Shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by the decrease in pressure for a test section over a period of time.
5. **Allowable Leakage for PVC Pipe and Ductile Iron Pipe:** The PVC pipe shall be pressure and leakage tested in accordance with AWWA C605. The ductile iron pipe shall be pressure and leakage tested in accordance with AWWA C600. No pipe installation, PVC pipe or ductile iron pipe will be accepted if the leakage is greater than that indicated in Table 8A-3.

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Table 8A-3
ALLOWABLE LEAKAGE IN GALLONS
PER HOUR PER 1000 FT OF PIPE
(GPH)

Pipe. Dia. (in.)	Average Test Pressure (PSI)					
	50 psi (gph)	100 psi (gph)	150 psi (gph)	200 psi (gph)	250 psi (gph)	300 psi (gph)
4	0.19	0.27	0.33	0.38	0.43	0.47
6	0.29	0.41	0.50	0.57	0.64	0.70
8	0.38	0.54	0.66	0.76	0.85	0.94
10	0.48	0.68	0.83	0.96	1.07	1.17
12	0.57	0.81	0.99	1.15	1.28	1.40
14	0.67	0.95	1.16	1.34	1.50	1.64
16	0.76	1.08	1.32	1.53	1.71	1.87
18	0.86	1.22	1.49	1.72	1.92	2.11
20	0.96	1.35	1.66	1.91	2.14	2.34
24	1.15	1.62	1.99	2.29	2.56	2.81
30	1.43	2.03	2.48	2.87	3.21	3.51
36	1.72	2.43	2.98	3.44	3.85	4.21

- 6. Acceptance:** Shall be determined on the basis of allowable leakage. If any test of installed pipe discloses leakage greater than that specified in Table 8A-3, the contractor shall, at the contractor's own expense, locate and make approved repairs as necessary until the leakage is within the specified allowance. All visible leaks shall be repaired, regardless of the amount of leakage.

Any damaged or defective pipe, fittings, valves, hydrants, or joints discovered following the pressure test shall be repaired or replaced with approved material at the Contractor's expense, and the test shall be repeated until it is within the specified allowance.

- 7. Example:** A pipe segment is required to be tested at 140 psi. At the start of the test, pressure gauge number (#) 1 indicates an initial pressure of 141 psi and pressure gauge #2 indicates an initial pressure of 143 psi. Both gauges are recording the test pressure within 2 psi, and, therefore, the test may proceed. After completing the 2-hour test duration, pressure gauge #1 indicates a pressure of 134 psi and pressure gauge #2 indicates a pressure of 136.5 psi. The pressure decrease for pressure gauge #1 is 7 psi and the decrease for pressure gauge #2 is 6.5 psi. The 2 gauges record a pressure decrease within 0.5 psi of each other therefore the deviation of the pressure reading between the two gauges is acceptable.

If the pressure test had indicated a pressure loss of less than 5 psi then the "Pressure and Leakage Test" would have been considered as passing. Because in this example, the pressure loss is more than 5 psi, the Contractor may elect to re-pressurize the system and repeat the two-hour test or the Contractor may elect to measure the quantity of water required to pressurize the pipe segment so that the pressure loss is less than 5 psi. For this example, if the quantity of water required to pressurize the pipe segment so that pressure gauge #1 indicates a pressure of 137 psi (loss of 4 psi) and pressure gauge #2 indicates a pressure of

137.5 psi (loss of 4.5 psi), is within the quantity of water allowed per Table 8A-3 then the test would be considered as passing without having to repeat pressure test for 2 hours.

I. Pressure and Leakage Test for Water Service Lines Less Than 4 Inches: Pressure and leakage tests shall be performed on all newly installed water service lines if the water service line has one or more couplings installed between the corporation and the curb stop and/or one or more couplings installed between the curb stop and the Property Water Distribution System. The testing method shall be as specified in the currently adopted version of the Plumbing Code with the exception that air pressure testing is prohibited.

J. Water Main Closures and Temporary Service:

1. Water Main Closures: Shall be scheduled to minimize the inconvenience to the public. Consequently, water main closures shall be scheduled between 8:00 A.M. and 4:00 P.M. Monday through Thursday, when possible. Short duration closures (closures scheduled to last no longer than 2 hours) may be scheduled on Friday between the hours of 8:00 AM and 11:30 AM. Water main closures scheduled to begin prior to or continue beyond those times listed above, will require approval from the Engineer. In any case, water main closures will not be allowed until the Engineer gives his approval.

Temporary water for private residences affected shall be provided by the Contractor when the water main closure will exceed 8 hours. The Contractor shall notify all affected businesses that temporary water service shall be provided to them, if requested, regardless of the length of closure. When temporary service is to be provided to businesses, the Contractor shall obtain the name and phone number of a responsible contact person at each affected business and submit the information to the Engineer at least 48 hours prior to closure.

The Contractor shall obtain notification of closure cards from the Engineer and shall deliver the closure cards by hand to the affected properties at least 48 hours prior to closure of any water main, unless a shorter time of notice is approved by the Engineer.

Water main closures shall be considered incidental to the project and no separate payment will be made.

2. Temporary Water Service/Water Main Bypass Pipe: Piping shall be as specified and approved by the Engineer of Record. In the event that a condition arises during construction that triggers the need for temporary water service, Contractor shall be responsible for plan development and obtaining approval from the Engineer to commence this work. No additional payment shall be provided for temporary water and this work shall be considered incidental the water distribution pipe being installed unless specifically called out as a pay item by the Engineer of Record.

The work shall include a minimum of the following:

- a) The Contractor must provide a 24-hour contact person who has adequate parts and equipment on hand to make necessary repairs to temporary water service in a timely manner.
 - b) Temporary water main is required to be pressure tested, disinfected, flushed, and sampled prior to any service connections being made in accordance with AWWA C651 and this specification.
 - c) Temporary service connections shall be connected at the curb stop.
 - d) Provisions for freeze protection of the temporary system shall be provided if weather requires it.
 - e) Provisions for tamper protection shall be provided.
 - f) Adequate pipe supports shall be provided to prevent tipping, movement, or pipe deflection and shall be spaced so as to limit pipe deflection. Any deflection of the piping shall be limited to manufacturer recommendations.
 - g) Contractor shall provide a submittal for approval to outline the products and procedures to be used for the Temporary water service/water main bypass piping. The submittal shall be submitted with the requirements of this specification for approval. Submittal shall include temporary water main layout, sequence of operations, and all material and fitting specifications to be used in the temporary water setup. The submittal shall also include detail for temporary water mains crossing roads and driveway approaches as well as provisions for freeze and vandal protection.
 - h) When in service, the entire length of temporary water service/water main bypass piping shall be inspected by the contractor a minimum of 2 times per day. Documentation of this inspection shall be delivered to the Engineer upon request.
- 3. Operation of Valves:** Only City personnel shall operate valves on existing water mains. The Contractor may operate valves on newly installed water mains that are under his control, until such time as, they are accepted by the City for operation and maintenance.
- K. Air Release Valves:** Shall be constructed in accordance with the detailed construction plans and specifications.
- L. Abandonment and/or Salvage of Water Main and Appurtenances:**
- 1. **Water Mains:** The Contractor shall seal all open ends of water mains to be abandoned with a concrete plug having a length equal to the diameter of the pipe being plugged. All open pipe ends shall be abandoned and plugged. Maximum

pipe length between abandonments shall not exceed 450 feet.

2. **Fire Hydrants:** Fire hydrants and auxiliary valves are to be removed and salvaged, unless indicated otherwise on the construction plans or Detailed Specifications, and shall be delivered by the Contractor to the City Utility Maintenance Shop in good working condition. Any damage to the hydrant and/or appurtenances as a result of removing, salvaging, and delivering, shall be repaired by the Contractor at no cost to the City.
3. **Valves:** Unless indicated otherwise on the construction plans or Detailed Specifications, valves and valve boxes are to be removed, salvaged, and delivered by the Contractor to the City Utility Maintenance Shop in good working condition. Any damage to the valve as a result of removing, salvaging, and delivering, shall be repaired by the Contractor at no cost to the City.
4. **Valve (Authorized) to be Abandoned in Place:** Prior approval from the Engineer is required to abandon a valve in place. Valves shall not be abandoned in place on a water main that is in service and not abandoned. Valves indicated on the plans to be abandoned in-place shall be abandoned by closing the valve and removing the top valve box sections. The valve box sections shall be delivered to the City Utility Maintenance Shop. The resulting holes shall be backfilled with either low strength concrete material or material acceptable to the Engineer that prohibits settlement of the hole and shall be resurfaced with the appropriate material; i.e. seed, sod, asphalt, concrete, etc.
5. **Water Main Branch Connections:** Contractor shall coordinate all water main closures necessary to carry out this work with Utility Maintenance in accordance with this specification. Contractor shall expose the branch connection at the water main, and remove section of water main pipe containing the branch connection and all branch water main appurtenances such as Tapping Sleeves, in line tees or crosses, valves, etc. in its entirety. The contractor shall disconnect the branch pipe and plug the branch pipe per the specification for the abandonment of water mains. All debris associated with the abandonment shall be removed in its entirety. Contractor shall repair the in-line water main with new PVC pipe of the same size and equivalent pressure class and appurtenant coupling connections suitable for use as specified in this section. Couplings shall be restrained unless sufficient demonstration can be provided that the water main being repaired is unrestrained. This demonstration is the responsibility of the contractor. Corrosion protection continuity and tracing continuity shall be maintained with the abandonment in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. City shall be present to inspect the repair prior to backfill.

Abandonments of water main branch connections on Steel water mains shall be as called for in approved construction plans and specified by the Engineer.

6. **Others:** When the construction plans indicate items are to be removed or salvaged, the Contractor shall deliver the items to the City Utility Maintenance Shop in good working condition. Any damage to the items as a result of removing,

salvaging, and delivering, shall be repaired by the Contractor at no cost to the City. Unless an item is indicated as salvaged, the item will be considered a Contractor obligation to remove and dispose of.

M. Water Service Lines and Fittings: Refer to Specification Section 8B Corrosion Protection - Plastic Pipe Systems for water service line cathodic protection requirements.

1. Permits: Will be required for all connections to the City's water distribution system and are obtainable from City Utility Maintenance.

2. Service Pipe:

a) Copper pipe shall be laid with sufficient waving as to prevent rupture in settlement. A "goose-neck" shape shall be constructed in the copper pipe leading from the corporation stop. Copper splicing couplings shall be as described in this specification.

b) PVC and ductile iron service pipe shall be laid in accordance with this specification for water mains. Minimum cover depth for water service lines shall be 6 feet.

c) HDPE water service line pipe shall be laid horizontally in a "snake-like" laying configuration to allow for both expansion/contraction movement of the pipe in the trench. Installation of the HDPE water service line shall be per these specifications, as specified in AWWA M55, and in accordance with the pipe manufacturers recommendations. HDPE shall not be placed in contact with concrete without the use of a sleeve. Tracer wire in accordance with Specification Section 8B Corrosion Protection - Plastic Pipe Systems shall be extended the entire length of the HDPE service.

1) New: HDPE may be used for new water service lines for installations either/both between the corporation stop and the curb stop and between the curb stop and the structure. New HDPE water service line installations shall not use couplings but shall be continuous for the length of the service. A HDPE stub that is installed in anticipation of future connection (for example, underneath a common utility trench) is considered new and may not be connected to via couplings. When HDPE is used for the water service line material, a roll of HDPE of sufficient length to serve the structure may be connected and stored for future use to avoid excavation back to the curb stop.

2) Repairs: A copper water service line may be replaced in its entirety with an HDPE water service line between the corporation stop and the curb stop or between the curb stop and the structure. Existing HDPE Water service lines may be repaired, and couplings may be used. Splicing couplings shall be as described in this specification. HDPE shall not be used for repair of existing copper water service lines if there will be remaining copper water

service line between the curb stop and the structure. HDPE shall not be used for repair of copper water service line if there will be remaining copper water service line between the corporation stop and the curb stop.

3. **Service Line Bedding:** Copper and HDPE service lines shall be bedded in accordance with Section 11 Utility Excavation and Backfill.
4. **Water Service Line Separation:** Shall be in accordance with Section 11 Utility Excavation and Backfill.
5. **Service Saddles:** Shall be installed for all connections to water mains. Unless specified otherwise on the Construction plans or Detailed Specifications, the Contractor shall furnish and install all service saddles.
6. **Corporation Stops:** Shall be provided by the Contractor, except for 1-inch corporation stops, which the City provides. The Contractor shall communicate the water main material type and size to Utility Maintenance at the time a tap is requested. Corporation stops that are used to connect copper water services to metallic water mains shall be the isolator style. City personnel, in all cases, will tap the water main and install all corporation stops. If a Contractor is installing a copper water service on private property but is not replacing the service to the main and the copper water services connects to a metallic water main then an insulating union for copper water services shall be installed near the curb stop or at the location where the new copper connects to the existing copper. This is only required for copper water services connecting to metallic mains.
7. **Water Service Lines Larger Than 2 Inches Diameter:** Shall be connected to the main with either an appropriately sized tapping sleeve and valve or a ductile iron tee as specified for water main fittings elsewhere in these specifications.
8. **Curb Stops and Boxes:** Shall be installed on all water service lines and shall be located entirely within the public ROW. The curb stop and box shall be located between the property line and 7-feet from the property line in the ROW, unless otherwise approved by the Engineer. Curb stop must be accessible and access to the curb stop shall not be limited by any fencing. If any curb box is farther from the property line than 7.1 feet, measured to the center of the box, then the box shall be reset to within the allowable tolerance. Curb Stop interiors and adjacent piping shall be cleaned of foreign material prior to making curb stop to pipe connection. Pipe/valve joints shall be straight and without deflection. All curb stops shall be placed on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness and centered on the curb stop. Curb stops shall be backfilled to one (1) foot above the curb stop with the same material required to bed the water service line. The Contractor shall check all operating mechanisms for proper functioning. Curb stops, which do not operate easily or are otherwise defective, shall be replaced at the Contractor's expense. Curb boxes shall be installed straight and plumb directly over the curb stop. The curb box shall be wrapped with polyethylene in accordance with Section 8B – Corrosion Protection for Plastic Pipe Systems details. The top of the curb box shall be placed flush to ¼-inch below flush with the surfacing in

paved or graveled areas and 1-inch to 2 inches above finished grade in grass surfaced areas. Where the Construction plans indicate that the future grade at the curb box will be higher or lower than the existing grade at the time of installation, the Contractor shall provide a curb box that is applicable for the future finished grade without having to replace the curb box.

9. Water Service New Connections: Water service lines shall be laid directly from the premises served to the City's main and shall not be extended across one premises to another. Notwithstanding this subsection, and notwithstanding the normal exception process contained in this document, the Public Works Director may allow water service lines to be located in a manner that crosses premises if, and only if, the conditions of Ordinance 13.12 are satisfied.

- a) Where new water service lines are to be installed for undeveloped property or future buildings or additional services added to an existing building, the Contractor shall furnish all materials necessary for connection of new water service lines to the water main, except 1-inch corporation stops, as specified herein and shall obtain and pay permits and tapping fees as established by Ordinance.
- b) Where the new water service line is terminated, the water service line shall be capped and plugged water tight to prevent leakage if the curb stop is inadvertently opened. New service connections shall have curb stops left turned off at the time of installation and the termination point shall be marked with a minimum three 3-foot long steel fence post. The steel post shall be buried below the surface at least 8 inches. The post needs to be steel to facilitate location by magnetic locators.
- c) City personnel shall tap all City water mains. The Contractor shall schedule all service taps as follows:
 - 1) Winter Schedule: Between 7:30 AM to 3:00 PM, Monday through Friday.
 - 2) Summer Schedule: Between 6:30 AM to 4:00 PM, Tuesday through Friday.
 - 3) It is the Contractors responsibility to call Utility Maintenance to determine which schedule they are following if there are questions.
- d) Water Service New Connections for water service lines 4 inches or larger shall be made as described in the section for Tapping Sleeves.

10. Water Service Reconnections: Water service lines shall be laid directly from the premises served to the City's main and shall not be extended across one lot to another. Notwithstanding this subsection, and notwithstanding the normal exception process contained in this document, the Public Works Director may allow water service lines to be located in a manner that crosses lot lines if, and only if, the conditions of Ordinance 13.12 are satisfied.

- a) The Contractor shall furnish all materials necessary for reconnecting water service lines existing prior to reconstruction of a water main, except 1-inch corporation stops as specified herein. On City projects, all permits and tapping fees will be waived; however, the Contractor shall obtain a no-charge permit to work in the ROW. Permits will be required for all reconNECTIONS to the Rapid City water system and are obtainable from City Utility Maintenance. On non-City projects, the new account set-up / inspection permit (tap permit) will be waived. However, the Right-to-Work permit and tapping fees are still applicable and are obtainable from City Utility Maintenance.
- b) City personnel shall tap all city water mains. The Contractor shall schedule all service taps as follows:
 - 1) Winter Schedule: Between 7:30 AM to 3:00 PM, Monday through Friday.
 - 2) Summer Schedule: Between 6:30 AM to 4:00 PM, Tuesday through Friday.

It is the Contractors responsibility to call Utility Maintenance to determine which schedule they are following if there are questions.

- c) Water service reconNECTIONS for water service lines 4 inches or larger shall be made as described in the section for Tapping Sleeves.

11. Inspection: All water service installations and abandonments, regardless of whether or not the service is located on private property or in public ROW, shall be inspected by the City Utility Maintenance Group prior to the Contractor backfilling the trench. The Contractor shall notify the City Utility Maintenance Group a minimum of four (4) hours prior to the time he needs the inspection. Any trench backfilled without being inspected and approved by authorized City personnel shall be re-excavated by the Contractor to expose the work for the required inspection. Discrepancies shall be corrected by the Contractor and re-inspected by City personnel.

N. Abandonments of Water Service Lines and Appurtenances, 2 Inches and Smaller: Contractor shall coordinate all water main closures necessary to carry out this work with Utility Maintenance in accordance with this specification. Contractor shall expose the service connection at the water main and remove the service saddle and corporation stop in its entirety. The contractor shall disconnect the service from the corporation stop and crimp or plug the water service line openings. All debris associated with the abandonment shall be removed in its entirety. Contractor shall repair the water main with a repair clamp as specified and in accordance with the manufacturer's requirements. If there is a condition of the water main that prevents the use of a repair clamp, repair in accordance with "Abandonments of Water Service lines and Appurtenances, larger than 2-inch." City shall be present to inspect the repair prior to backfill.

The contractor shall expose the water service line at the curb stop and remove the curb stop and curb box in its' entirety. The Contractor shall disconnect the service from

the curb stop and crimp or plug the water service line openings. All open water service line pipe ends shall be crimped or plugged.

- O. Abandonments of Water Service Lines and Appurtenances, Larger Than 2-Inches:** Contractor shall coordinate all water main closures necessary to carry out this work with Utility Maintenance in accordance with this specification. Contractor shall expose the service connection at the water main, and remove section of water main pipe containing the service connection and all water service line appurtenances such as Tapping Sleeves, in line tees or crosses, service valves, etc. in its entirety. The contractor shall disconnect the service pipe and plug per the specification for the abandonment of water mains. All debris associated with the abandonment shall be removed in its entirety. Contractor shall repair the water main with new PVC pipe of the same size and equivalent pressure class of the water main being repaired and appurtenant coupling connections suitable for use as specified in this section. Couplings shall be restrained unless sufficient demonstration can be provided that the water main being repaired is unrestrained. This demonstration is the responsibility of the contractor. Corrosion protection continuity and tracing continuity shall be maintained with the abandonment in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. City shall be present to inspect the repair prior to backfill.

The contractor shall expose the water service line at the curb stop or valve and remove the curb stop and curb box or valve and valve box in its' entirety. The Contractor shall disconnect the service from the curb stop or valve and plug the water service line openings in accordance with the specification for the abandonment of water mains.

Abandonments of Water Service Lines and Appurtenances, Larger than 2-Inch on Steel water mains shall be as called for in approved construction plans and specified by the Engineer.

- P. Reuse of Water Service Line Tap Hole, 2 Inches and Smaller:** In the case of a "Water Service Reconnection", where the existing water service line tap can be reused, the Contractor may do so by placing a new service saddle of equivalent service hole size over the existing service hole. If the service connection is $\frac{3}{4}$ -inch, a 1-inch service saddle shall be used over the existing service hole. The service hole will remain the original tapping size and shall not be drilled to a larger size. If the condition of the hole prevents the use of a new service saddle, the hole may not be reused and shall be abandoned in accordance with "Abandonments of Water Service Lines and Appurtenances, larger than 2-inch".
- Q. Water Service Repairs:** Service pipe of conforming material shall be repaired with like material, pressure class and size, unless minimum existing size is not approved for use by the current version of the adopted Plumbing code.
- R. Acceptance of Curb Stops and Main Valves:** As a condition for project acceptance, all curb stops and water main valves within the project boundaries shall be in proper operating condition. City personnel will inspect and operate each curb stop and water main valve as part of the final inspection. The Contractor shall correct any deficiencies discovered during the inspection.

8A.4 METHOD OF MEASUREMENT

- A. Water Main Pipe:** Installed pipe quantities shall be determined by measuring from centerline to centerline of all pipe and fittings. Measurements shall be to the nearest whole foot.
- B. Water Main Fittings and Couplings:** Fittings furnished and installed shall be counted on a per each basis. Measurement for concrete thrust blocks, cable and rods, and thrust restraint devices will not be made; such work shall be incidental to the respective work item. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- C. Valves:** Shall be counted on a per each basis. Valve boxes and valve box adapters shall be included with the valves as a complete unit. Measurement for concrete blocks, cable and rods, and thrust restraint devices will not be made; such work shall be incidental to the respective work item. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- D. Fire Hydrant and Auxiliary Valve:** Fire hydrants will be counted on a per each basis. Auxiliary valve, valve box, and valve box adapter shall be included with the hydrant as a complete unit. No separate payment will be made for auxiliary valves, boxes and adapters. Measurement for concrete thrust blocks, cable and rods, and thrust restraint devices will not be made; such work shall be incidental to the respective work item. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- E. Fire Hydrant Lead:** The pipe for the hydrant lead from the main to the fire hydrant shall be measured from centerline to centerline of pipe and fittings. Measurements shall be to the nearest whole foot.
- F. Fire Hydrant Extensions:** Fire hydrant extension quantities shall be determined by measuring the vertical length of the extension. Measurement shall be to the nearest half foot.
- G. Fire Hydrant Bollards:** Fire Hydrant Bollards shall be counted on a per each basis. All materials for a complete installation shall considered as incidental to the respective work item.
- H. New Water Main Connections:** New water main connections shall be counted on a per each basis and shall include such items including but not limited to fittings, pipe, couplings, joint restraints, thrust blocks, concrete blocks, tracer wire, cathodic protection and all other appurtenant materials to facilitate the new water main connection per the standard specification. The bid item, New Water Main Connections, is intended for use where a tapping sleeve and valve is not used and where an in-line

tee must be cut into an existing main, a pipe is being connected to, or where a cap/plug with thrust block must be removed prior to connecting.

- I. **Water Service Lines:** Installed pipe quantities shall be determined by measuring from centerline to centerline of all pipe and fittings. Measurements shall be to the nearest whole foot.
- J. **Service Saddles:** Service saddles furnished and installed will be counted on a per each basis.
- K. **Service Corporation Stops:** Service corporation stops furnished by the Contractor will be counted on a per each basis. No measurement will be made for service corporation stops furnished by the City.
- L. **Curb Stops and Boxes:** Curb stops and boxes furnished and installed, will be counted on a per each basis.
- M. **Water Service New Connections:** New water service connections will be counted on a per each basis. The pipe used for connections shall be measured and paid for under the bid item for water service pipe.
- N. **Water Service Reconnections:** Water service reconnections will be counted on a per each basis. The pipe used for reconnections shall be measured and paid for under the bid item for water service pipe.
- O. **Thrust Blocks and Joint Restraints:** No separate measurement will be made for thrust blocks or joint restraint devices, such work will be incidental to the pipe.
- P. **Polyethylene Bond Breaker:** No separate measurement will be made for polyethylene bond breaker such work will be incidental to the pipe and fittings.
- Q. **Tapping Sleeves and Valves (Includes Tee, Valve, and Thrust Block):** Tapping Sleeves and valves furnished and installed will be counted on a per each basis.
- R. **Adjust Valve Box:** Adjust valve box shall be counted on a per each basis.
- S. **Adjust Curb Stop Box:** Adjust curb stop box shall be counted on a per each basis.
- T. **Abandonment of Water Main and Appurtenances:** No separate measurement will be made for abandonment of water mains and appurtenances, when called for on the construction plans; such work will be incidental to the project unless otherwise specified.
- U. **Abandonment Water Main and Appurtenances, Water Main Branch Connections:** Abandonment of Branch water main connections will be counted on a per each basis and shall include such items including but not limited to repair pipe, couplings, joint restraints, thrust blocks, concrete blocks, tracer wire, cathodic protection and all other appurtenant materials to facilitate the abandonment per the

standard specification.

- V. Salvaging Fire Hydrants, Valves and Valve Boxes:** No separate measurement will be made for salvaging and delivering salvaged materials including fire hydrants, auxiliary valves, valves and boxes; such work will be incidental to the project unless otherwise specified.
- W. Removal and Disposal of Pipe:** No separate measurement will be made for the removal of pipe materials to facilitate the progression of the work; such work will be incidental to the project unless otherwise specified.
- X. Abandonment of Water Services and Appurtenances, 2 Inches and Smaller:** Abandonment of Water Services and Appurtenances will be counted on a per each basis and shall include such items including but not limited to repair clamp, tracer wire, cathodic protection, and all other appurtenant materials to facilitate the abandonment per the standard specification.
- Y. Abandonment of Water Services and Appurtenances, Larger than 2 Inches:** Abandonment of Water Services and Appurtenances will be counted on a per each basis and shall include such items including but not limited to repair pipe, couplings, joint restraints, thrust blocks, concrete blocks, tracer wire, cathodic protection and all other appurtenant materials to facilitate the abandonment per the standard specification.
- Z. Reuse of Water Tap Hole, 2 Inches and Smaller:** Reuse of Water tap hole, 2 inches and smaller will be counted on a per each basis and shall include such items including but not limited to removal and disposal of existing saddle and furnish and install new service saddle.

8A.5 BASIS OF PAYMENT

- A. Water Main Pipe:** Payment will be at the unit price bid for the appropriate size of water pipe, furnished and installed, including trenching, excavation, Type 1 bedding material, compacting, backfilling, dewatering, sheeting or shoring, pressure and leakage testing, disinfection. Unless otherwise specified, no extra payment will be made for excavation deeper than that required to provide minimum specified cover. The cost of providing temporary water service and plugging abandoned water mains shall be incidental to the project.
- B. Water Main Fittings and Couplings:** Payment will be made at the unit price bid for the appropriate fitting, furnished and installed, including polyethylene bond breaker, and thrust blocks and/or restraints. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- C. Valves:** Payment will be made at the unit price bid for the appropriately sized valve, furnished and installed, including valve box, valve box adapter, concrete blocks, cable and rods, and thrust restraint devices. Corrosion protection devices and

appurtenances tied to valves shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.

- D. Fire Hydrant and Auxiliary Valve:** Payment will be made at the unit bid price, complete, furnished and installed, including trenching, excavation and backfilling, dewatering, sheeting or shoring, and disinfection. Auxiliary valve, valve box, and valve box adapter shall be included with the hydrant as a complete unit and no separate payment will be made.
- E. Fire Hydrant Lead:** The pipe for the hydrant lead (branch) from the main to the fire hydrant shall be at the unit price bid for the appropriate size of water pipe, furnished and installed, including trenching, excavation, Type 1 bedding material, compacting, backfilling, dewatering, sheeting or shoring, pressure and leakage testing, disinfection. Unless otherwise specified, no extra payment will be made for excavation deeper than that required to provide minimum specified cover. The cost of providing temporary water service and plugging abandoned water mains shall be incidental to the project.
- F. Fire Hydrant Extension:** When a fire hydrant extension is necessary due to no fault of the Contractor, as specified herein, payment will be made under the bid item for the fire hydrant extension per price bid. City personnel shall install all Fire Hydrant Extensions. However, if the hydrant could have been installed or ordered with the correct barrel length such that an extension was not necessary, the Contractor shall furnish and install a new Fire Hydrant with the correct barrel length. Hydrant Extensions in these cases will not be permitted.
- G. Fire Hydrant Bollards:** Payment for Fire Hydrant Bollards will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- H. New Water Main Connection:** Payment for new water main connection will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- I. Water Service Lines:** Payment will be made at the unit price bid for the appropriately sized pipe, furnished and installed, including trenching, excavation and backfilling, compacting, dewatering, and sheeting or shoring. The cost for any connections between the new water service line and existing water service lines shall be included in the unit price bid for the appropriately sized pipe.
- J. Service Saddles:** Payment will be made at the unit price bid for the appropriately sized service saddle, furnished and installed.
- K. Service Corporation Stops:** Payment for Contractor furnished corporation stops will be made at the unit price bid for the appropriately sized corporation stops. No payment will be made for 1-inch corporation stops, which shall be furnished by the City Utility Maintenance Group. The Utility Maintenance Group will also furnish one-inch

isolator/insulated corporation ball valves when required.

- L. Curb Stops and Boxes:** Payment will be made at the unit price bid for the appropriately sized curb stop and box, complete, furnished and installed.
- M. Water Service New Connection:** Payment will be made at the unit price bid for connecting new water services up to 2 inches in diameter to the new water main, including fittings necessary to connect the water service line to the corporation stop. The cost of connecting water service lines 2 inches or greater shall be included in the unit price bid for the fitting required to connect the water service lines to the water main. Payment for Water Service New Connection shall include Right to Work permit, New Account Setup/Inspection permit (tap permit) and tapping fees, unless otherwise specified in the Detailed Specifications.
- N. Water Service Reconnection:** Payment will be made at the unit price bid for reconnecting existing water services up to 2 inches in diameter to the new water main, including fittings necessary to reconnect the water service line to the corporation stop. The cost of reconnecting water service lines 2 inches or greater shall be included in the unit price bid for the fitting required to connect the water service lines to the water main. On City projects, all permits and tapping fees will be waived. On non-City projects the New Account Setup/Inspection permit will be waived, however the Right-to-Work permit and tapping fees are still applicable.
- O. Thrust Blocks and Joint Restraints:** No separate payment will be made for thrust blocks or joint restraint devices, such work will be incidental to the pipe.
- P. Polyethylene Bond Breaker:** No separate payment will be made for polyethylene bond breaker such work will be incidental to the pipe and fittings.
- Q. Tapping Sleeves and Valves (Includes Tee, Valve, and Thrust Block):** Payment for Tapping Sleeves and valves will be at the bid price per each including sleeve and valve, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item. Exploratory excavation to determine the existing pipe material and outside diameter of the pipe being tapped shall be considered as incidental to this bid item. The Contractor shall include payment for the "right to work" Permit, (tap permit), if applicable, and tapping fees in this bid item.
- R. Adjust Valve Box:** Payment for adjust valve box will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- S. Adjust Curb Stop Box:** Will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- T. Abandonment of Water Main and Appurtenances:** No separate payment will be made for abandonment of water mains and appurtenances, when called for on the

construction plans; such work will be incidental to the project unless otherwise specified.

- U. Abandonment of Water Main and Appurtenances, Water Main Branch Connections:** Shall be paid for under the per each entitled "Abandonment of Water Main and Appurtenances Branch Connection".
- V. Salvaging Fire Hydrants, Valves and Valve Boxes:** No separate payment will be made for salvaging and delivering salvaged materials including fire hydrants, auxiliary valves, valves and boxes; such work will be incidental to the project unless otherwise specified.
- W. Removal and disposal of Pipe:** No separate payment will be made for the removal of pipe materials to facilitate the progression of the work; such work will be incidental to the project unless otherwise specified.
- X. Abandonment of Water Services and Appurtenances, 2 Inches and Smaller:** Will be paid for under the per each entitled "Abandonment of Water Services and Appurtenances, 2 inch and smaller".
- Y. Abandonment of Water Services and Appurtenances, Larger than 2 Inches:** Will be paid for under the per each entitled "Abandonment of Water Services and Appurtenances, Larger than 2 inches".
- Z. Reuse of Water Tap Hole, 2 Inches and Smaller:** Reuse of Water tap hole, 2 inches and smaller will paid for as "Reuse water tap hole, 2 inches and smaller".

END OF SECTION

SECTION 8B

CORROSION PROTECTION – PLASTIC PIPE SYSTEMS

8B.1 DESCRIPTION

A. General: This work consists of furnishing and installing cathodic protection for all water mains, service lines, and appurtenances. This includes all equipment, tools, materials, labor and other incidentals to provide a complete system ready for immediate and continuous use. The work includes, but is not limited to the following:

1. Coatings on all ferrous metal (steel, ductile iron, cast iron) piping and fittings;
2. Galvanic anodes, joint bonds, insulating joints, test stations, and tracer wire to form an electrically continuous piping network;
3. Labeling, marking, and testing of cathodic protection system.

B. Related Work:

Section 7	General Conditions
Section 8A	Water
Section 9	Sanitary Sewer
Section 11	Utility Excavation and Backfill
Section 41	Utility Trench Resurfacing
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 92	Temporary Traffic Control
Section 112	Select Granular Backfill
Section 200	Controlled Low Strength Material
Section 203	Submittals

C. Reference Standards: The latest revision of the following minimum standards shall apply to the materials and installation included in this specification, except where more stringent standards are applicable. In case of conflict, the most stringent requirements shall apply.

1. American National Standards Institute (ANSI):

- a) C80.1-90, Rigid Steel Conduit-Zinc Coated
- b) ANSI/NSF Standard 61 Drinking Water System Components – Health Effects

2. American Society for Testing and Materials (ASTM):

- a) ASTM A380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems
- b) ASTM A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

- c) ASTM B418, Standard Specification for Cast and Wrought Galvanic Zinc Anodes
- d) ASTM B843, Standard Specification for Magnesium Alloy Anodes for Cathodic Protection
- e) ASTM G97, Laboratory Evaluation of Magnesium Anode Test Specimens for Underground Application

3. American Water Works Association (AWWA):

- a) AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
- b) AWWA C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- c) AWWA C210, Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipelines
- d) AWWA C213, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
- e) AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines
- f) AWWA C216, Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- g) AWWA C217, Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- h) AWWA C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe
- i) AWWA C550, Protective Epoxy Interior Coatings for Valves and Hydrants

4. Association for Materials Protection and Performance (AMPP):

- a) National Association of Corrosion Engineers (NACE) Standard Practice (SP), SP0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- b) NACE Standard Practice, SP0286, Electrical Isolation of Cathodically Protected Pipelines

5. National Electrical Manufacturers Association (NEMA):

- a) I-10, Type 3R and 4X Enclosures
- b) TC 2, Electrical Polyvinyl Chloride (PVC) Conduit
- c) WC 70-09 / ICEA S-95-658-09, Power Cables Rated 2000V or Less for the Distribution of Electrical Energy

6. National Fire Protection Association (NFPA), National Electrical Code (NEC), NFPA 70
7. Occupational Safety and Health Administration (OSHA)
8. Underwriters Laboratories (UL) ANSI/UL 467 "Grounding and Bonding Equipment."

D. Submittals:

1. Provide catalog cuts and other information for all proposed products proposed for use that shows compliance of those materials with these Specifications. Contractor submittals shall be made in accordance with Section 203 - Submittals. In addition, the following specific information shall be provided.
2. Submittal information shall clearly show manufacturer's name and model number of specified item to be provided, not just supplier name, if only supplier name is provided, then entire submittal shall be rejected and a new resubmittal will be required. Materials provided with only supplier's name shall be relabeled with original manufacturer's name, model number, etc., or be returned at Engineer's discretion at no additional cost to Owner.
3. Contractor shall submit required information on a system-by-system basis with items clearly marked for specific products or models to be used. Indiscriminate submittal of manufacturer's literature only is not acceptable.
4. Contractor shall submit installation, material, and safety requirements for thermite weld wire or pin brazing type connections.
5. Contractor shall submit a list of test equipment (make and model) to be provided. Test equipment shall be approved and at project site prior to start of pipe installation.
6. Contractor shall submit tracer wire continuity test equipment (make and model) and proposed tracer wire continuity test procedure.
7. **Quality Assurance Submittals:**
 - a) Manufacturer's Certificates of Compliance
 - b) Field Test Reports
 - c) Certificate of Compliance for Galvanic Anodes (Independent laboratory analysis required.)
 - d) Record Drawings shall include RECORD location of all cathodic protection test stations and tracer wire access box locations moved during construction and buried wire splices in either Station-Offset or x- and y- coordinates consistent with the project horizontal datum.
8. Submit Certificate of Compliance from fitting and appurtenance manufacturer and supplier verifying that bolting, fasteners, nuts, and washers proposed for the project meet the specifications provided herein.
9. **Contract Closeout Submittals:** Special guarantees as specified hereinafter:

- a) Submit record drawings and field test report information to the Engineer at end of project.
- b) The cathodic protection system and corrosion control monitoring systems including but not limited to joint bonding, test stations, insulators, galvanic anodes, etc. shall be fully operational upon completion of pipe installation and a functional test performed prior to acceptance of the project.
- c) The tracer wire system including tracer wire access boxes and continuity testing shall be fully operational upon completion of pipe installation. A functional test shall be performed prior to acceptance of the project.
- d) Test station and junction box wire labeling, color coding and Contractor functional testing results shall be submitted to the Engineer upon completion of functional testing and prior to acceptance of the project.

E. Quality Assurance:

- 1. The Contractor shall provide at all times a thoroughly experienced and competent field foreman, who will be present to supervise this portion of construction at the site. This person shall be responsible for the field test reports and have the authority to represent the Contractor and shall be the point of contact with the Engineer for this section of the specifications.
- 2. Functional testing shall be completed by the Contractor only in the Engineer representative's presence on the installed cathodic protection, corrosion protection items and tracer wire continuity.
- 3. The final testing shall be completed by the Engineer.

F. Observation Of Work:

- 1. Provide access to the project site for Owner, Engineer, and manufacturer at all times during installation and to observe finished work.
- 2. All materials and installations shall be subject to observation for suitability as the Engineer may elect, prior to, during, or after incorporation into the work. Observation or testing by the Engineer or the waiver of observation or testing of any particular portion of the work shall not be construed to relieve the Contractor of his responsibility to correctly perform the work and testing required in accordance with these specifications and the product manufacturer's recommendations.
- 3. The Contractor is in charge of and solely responsible for all of the quality control and final inspections required. Observation of or spot testing by the Engineer or product manufacturer does not meet the quality control inspection requirement or relieve the Contractor from doing the quality control testing required by the product manufacturer, this specification, or the Contractor's quality control program.
- 4. The Engineer reserves the right to reject all work that does not meet the minimum requirement of this specification. This may be done either during or after completion of the

work, during subsequent observations or testing, warranty inspection testing, or at any time when discovered during the warranty period.

- G. Record Drawings:** Contractor shall maintain an accurate record of the cathodic protection devices, tracer wire access boxes, and field-coated and/or repair coated pipe segments in redline fashion on a project plan set. Items on redline plans shall include, but are not limited to:
1. Galvanic anode type, size and as-constructed location to each fitting, valve or other metallic pieces;
 2. Test station and tracer wire access box locations;
 3. Tracer wire color coding for each wire segment within the project if different than that provided in this Specification;
 4. Record drawings shall include RECORD location of all cathodic protection test stations and tracer wire access box locations moved during construction and buried wire splices in either Station-Offset or x- and y- coordinates consistent with the project horizontal datum.
- H. Special Guarantee:** The Contractor, corrosion subcontractor, and product manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of two (2) years or longer if required by the General Conditions commencing on the date of final acceptance of the work.
1. Functional and final testing and warranty inspection(s) of the corrosion protection systems shall be made at the end of the project and within the warranty period, respectively. The Contractor, subcontractor, and/or product manufacturer's representatives at their option may be present during the functional or final testing or warranty inspections by the Engineer and Owner.
 2. Any construction defects identified by the Engineer during energizing and testing or during warranty inspections shall be located and corrected by the Contractor at his sole expense including all additional Engineering time, full time inspection, and re-testing time.
 3. Any defects in the corrosion protection system discovered at or during the functional, final, and/or warranty inspection(s) shall immediately be repaired and retested in a timely manner (repairs starting within 30 days and completed, tested, and approved within 60 days of notice) by the Contractor. All repairs shall be in accordance with the written product manufacturer's instructions as reviewed and approved by the Engineer. Provide the Engineer with a minimum of five (5) days advance notice before beginning repairs.
 4. All repairs or any damage to other work caused by such defects or repairing of the defects including additional Engineering, full-time observation during repairs, and retesting or re-warranty inspections shall be at sole cost to Contractor.

8B.2 MATERIALS

A. General:

1. All materials specified within this specification shall meet the requirements of this specification section as well as Section 8A. Materials referenced within Specification Section 8B do not necessarily imply that the stock material item is in compliance with Section 8A. The supplier and contractor are responsible for complying with Specifications 8A and 8B collectively and in their entirety unless modified by project specific requirements.
2. The use of a manufacturer's name and model or catalog number is solely for the purpose of establishing the standard of quality and general configuration desired. Products of other manufacturers of equal standard and quality will be considered in accordance with the General Conditions.

B. Material Suppliers: Suppliers listed below can usually supply the types of materials specified in this section. Alternate suppliers will be considered, subject to approval of the Engineer. Address given is that of offices in the Western United States; contact these offices for information regarding the location of their representative nearest the project site:

1. Farwest Corrosion Control, Denver, CO (888-532-7937) www.farwestcorrosion.com
2. Hoff Company, Denver CO (800-736-4546) www.pipelinesupplies.com
3. MESA Products, Inc., Tulsa, OK (888-800-6372) www.mesaproducts.com
4. Total Corrosion Solutions, Inc., TCS, Billings, MT (406-248-6985)

C. Wires:

1. All cathodic protection wires, joint bond wires, bonding cables, leads, and cables provided shall be insulated **STRANDED** copper wire. Wire size, type, and insulation type as specified in this section. Wire shall conform to applicable requirements of ANSI/NEMA WC 70-09 / ICEA S-95-658-09.

a) Tracer wire materials specification is included under TRACER WIRE.

b) All wire, including test leads, anode leads, joint pigtail bond wires, etc. associated with the cathodic protection system outlined in these specifications shall have a high molecular weight polyethylene (HWMPE) insulation rated for 600 volts. Minimum thickness shall be 45-mil for No. 10 American Wire Gauge (AWG) and smaller wires and 110-mil for No. 8 AWG and larger wires, as outlined in this specification.

2. Joint Bonds:

a) **General:** Type of joint bonds shall depend on pipe joint coating and shall be either:

- 1) Insulated copper joint bond wires for all pipe joint bond locations.

- 2) Metallic Fitting Pigtail Bond Wires shall be No. 12 AWG single conductor, stranded copper wire with 600-volt rated HMWPE insulation.
- I. Provide with a sleeve on each end of No. 12 AWG metallic fitting pigtail bonding wire used for bonding of metallic fittings including but not limited to fittings, valves, couplings, mega-lugs, metallic fitting glands or restraint rings, etc. for metallic and plastic pipe.
 - II. Two-piece or split fittings, restraints, couplings, etc. require a No. 12 AWG bonding wire between the individual pieces of the fitting for 10-inch diameter and smaller pipe. Two No. 12 AWG bonding wires are required for fittings 12-inch pipe and larger; the two wires may not utilize the same welds.
- b) **Insulated Joint Bond Wires:** Provide joint bond wires consisting of single-conductor, stranded insulated copper wire. Supply all joint bonds complete with a formed copper sleeve on each end of the wire. Wire conductor for field-applied sleeves shall extend 1/4 inch beyond end of copper sleeve. End of factory formed copper sleeves shall be angled to allow end of wire to be exposed to thermite weld material.
- c) **Bond Lengths:** Length of bond strap and joint bond wire may have to be increased for different pipe size and joint type per pipe manufacturer's recommendations to provide sufficient slack (one (1)-inch minimum on each end or two (2)-inches total) for pipe or joint movement between each thermite weld connection.

1) For Pipe Diameters larger than 16-inch:

- I. For Push-on, Mechanical, or Flanged Joints: No. 2 AWG wires, 18-inches long minimum.
 - II. For Flexible Coupling Joints: No. 2 AWG wires, 24-inches long minimum, with two 12-inch long minimum insulated No. 12 AWG wire pigtails.
 - III. Smaller couplings than 24-inch outer diameter (OD) pipe may allow shorter lengths. Contractor shall confirm that bond wire length supplied provides a minimum of one-inch of slack on each end for a total of two inches of slack.
 - i. Bond wires with pigtail wires can be utilized at flexible couplings, fitting or valve locations. The pigtail wires shall be bonded to the fitting or valve body.
 - ii. For multiple piece fittings, No. 12 AWG pigtail wires shall be utilized to bond different pieces to pipe. Pigtail wire length shall be as required.
 - IV. For Insulated Flexible Coupling Joints: No. 2 AWG insulated copper wire, 18-inch long minimum, with one 12-inch long minimum No. 12 AWG wire pigtail.
- 2) For pipe smaller than 15-inch diameter, Contractor may utilize No. 4 AWG wire size instead of No. 2 AWG wire size.
- 3) Acceptable pre-made insulated copper joint bond wires are available from:
- I. Hoff Company, Inc., (800-736-4546), Denver, CO, www.pipelinesupplies.com;

II. nVent Erico, (800-753-9221), Cleveland, OH;

III. Continental Industries, Inc. (ThermOweld®), A Hubbell Company), 800-558-1373, Tulsa, OK;

IV. Or approved equal.

3. Pump Station, Vaults, Test Station, and Cross Bond Pipe Connecting Wires:

- a) Single-conductor, No. 2 AWG, No. 4 AWG, No. 6 AWG, and No. 8 AWG cathodic protection cables shall be single conductor, stranded copper wire with 600-volt high molecular weight polyethylene (HMWPE) insulation.

Insulation shall be 7/64-inch (110-mil) minimum thickness in accordance with ASTM D 1248, Class C, Grade 5.

- b) Bonding of buried and above grade appurtenances may be required to minimize stray current, safety hazards, and corrosion effects (e.g., bonding through a vault).

4. Test Wires:

- a) No. 12 AWG wire for prepackaged galvanic anode and No. 12 AWG test leads and No. 12 AWG and No. 14 AWG reference electrode lead wires shall be single conductor, stranded copper wire with 600-volt rated HMWPE insulation.

- b) No. 2, No. 4, No. 6, or No. 8 AWG leads shall be single-conductor, stranded copper wire with 600-volt rated HMWPE insulation.

5. Wire Identification:

- a) Wire insulation color shall indicate the function of each wire and shall be as follows:

1) Pipeline test wires:

I. Water Pipeline: Blue

- i. Test wires for water systems of different pressure zones shall be uniquely identified by the following color combinations on transmission mains and at zone separation valves only:

I) **High Level:** Blue with 1 strip of Blue tape.

II) **Low Level:** Blue with 1 strip of White tape.

II. Foreign Pipeline: White or as requested by Foreign pipeline company.

III. **Unprotected Pipe (not cathodically protected):** Black (e.g., pump station side of metallic pipe).

2) Casings: Orange

- 3) **Anode Lead Wires:** Black
- 4) **Reference Electrode Wires:** Yellow
- 5) **Coupon Wires:** Green
 - I. Pair of leads to protected coupon (one strip of white tape)
 - II. Pair of leads to unprotected coupon (one strip of black tape)
- 6) **Tracer Wires on Plastic, Concrete, or Non-metallic Pipe:**
 - I. Blue with two strips of black tape.
 - II. Color code tracer wire by project pressures and direction with tape strip(s) as noted below:
 - i. **Project Pressures (for transmission main projects and at zone separation valves only):**
 - I) **Higher Pressure:** One strip of BLUE tape
 - II) **Lower Pressure:** One strip of WHITE tape
 - III) Or as directed in the plans.
 - ii. **Direction:**
 - I) North (1 Strip) and West (2 Strips) PURPLE tape.
 - II) South (1 Strip) and East (2 Strips) GRAY tape.

D. THERMITE WELD MATERIALS:

1. Electrical connection of copper wire or copper strap to metallic (steel, ductile iron, and cast iron) fittings, pipe, and structures shall be by the thermite weld method. The thermite weld materials shall be UL listed to ANSI/UL 467.
2. The thermite weld metal shall consist of a mixture of copper oxide and aluminum material ignited by magnesium starting powder with a spark or by an electronic type ignition. Thermite weld materials shall be designed for connection of copper to steel or ductile iron and cast iron surfaces. The materials and exothermic process shall provide a completed permanent type connection that will not loosen or develop high resistant connection points and have a resistance equal to or lower than the strap or wire, be durable, be corrosion resistant, and have a high adhesion connection to both the surface and strap or wire.
3. Supply the proper size and type of wire sleeves, cartridges, and welder molds as required for each type of connection and pipe material in accordance with the thermite weld manufacturer's written recommendations.

- a) Material and equipment shall be from the same manufacturer and utilized throughout the entire project.
 - b) Weld materials from different manufacturers shall not be interchanged.
4. The individual thermite weld metal charges shall be sealed in a moisture-resistant plastic container (tube or cartridge) with tight fitting caps with the separate steel disks in a prepackaged sealed container. The starting (ignition) material shall be packed in the bottom of the tube with the weld material on top or for the electrical ignition type intermixed as required. The individual plastic containers shall be packed in sealed boxes to protect the individual containers and keep their contents dry. The size (weight in grams) and type of the charge shall be clearly marked on the plastic package and individual sealed containers.
5. Provide type of charges required for each pipe, fitting, or structure base material.
- a) Provide steel charges for steel materials. Charge (cartridge) size shall be minimum of 15-grams and maximum of 25-grams for steel materials.
 - 1) Cadweld F-33 (Green Top) or Thermoweld P Standard Powder;
 - 2) **Electronic Ignition Materials:**
 - I. Cadweld Plus CA15PLUSF33 with black top or CA25PLUSF33 with red top, or
 - II. ThermOweld EZ Lite Remote with suitably sized Thermoweld P Standard Powder Charges,
 - III. Or approved equal.
 - b) Provide cast iron charges for all ductile iron and cast iron materials. Charge (cartridge) size shall be a minimum of 15- or 25-grams and maximum of 32-grams for ductile and cast iron materials.
 - 1) Cadweld XF-19 or Thermoweld CI Cast Iron Powder;
 - 2) **Electronic ignition materials:**
 - I. Cadweld Plus CA15XF19, CA25PLUSXF19 or CA32PLUSXF19;
 - II. ThermOweld EZ Lite Remote with suitably sized Thermoweld CI Cast Iron Powder Charges;
 - III. Or approved equal.
 - c) Minimum cartridge size for strap bonds shall be 25 grams for 1/2-inch and 5/8-inch diameter hole sizes to steel and 32-grams for 5/8-inch diameter holes for ductile iron pipe per manufacturer's recommendations.
6. Welder molds shall be graphite molds sized for each type and size of charge and pipe size and type to be used as recommended by the thermite weld manufacturer. Each mold shall

have permanent identification showing manufacturer's name, mold part number, wire size, and weld metal type and size.

- a) Ceramic "One Shot" molds will not be acceptable.
 - b) Special welders and materials are required for copper strap, formed joint bond wires, and flexible coupling bonds.
 - c) Vertical type connections require special welders and materials as recommended by the weld manufacturer.
7. For horizontal type connections to smaller pipe and fitting sizes, different molds to match the different pipe curvature are required according to the manufacturer's recommendations. These molds for small pipe sizes shall be identified by each pipe diameter.
- a) For steel pipe and fittings, different molds are required for pipe up to 3-1/2-inch diameter. Different steel mold sizes are required for 4-inch and 6-inch to 8-inch pipe sizes. For steel pipe 10-inch or larger, flat steel molds can be used.
 - b) For ductile iron or cast iron pipe and fittings, different size of molds are required for different pipe diameters up to 24-inch. The molds must be obtained for each pipe size to be welded.

8. Electronic Ignition Connections:

- a) Cadweld Plus Exothermic or ThermOweld's EZ Lite Remote: Connections with prepackaged containers with electronic type ignition can be substituted for standard thermite weld spark type ignition connections provided that equal or better low resistance, durability, adhesion, and performance characteristics are proven.
 - b) Electronic type ignition materials shall be able to be used in standard graphite molds for wire and strap type connections for each structure type and size.
 - c) Manufacturer shall provide a reference table with corresponding molds and charge sizes and types.
 - d) Spark type and electronic ignition type materials from different manufacturers shall not be intermixed.
9. Weld mold sealer shall be heavy duty, clay-like, mold sealer putty material, specially designed for that use.

Acceptable sealer putty brands include:

- a) Electrical Duct Seal manufactured by Ideal Industries;
- b) Duct Seal Compound manufactured by Gardner Bender;
- c) CADWELD® Mold Sealer by Erico® Products, Inc.;

- d) Or approved equal.
10. Cleaning wheels shall be self-cleaning and leave no resin or residue on surface to be bonded to as recommended by the weld manufacturer.

The use of resin, rubber, or shellac-impregnated type grinding wheels are not recommended by the weld material manufacturers and shall not be used.

11. Mold cleaner shall be type and size recommended by weld manufacturer for each type of graphite weld mold being used.

12. Adapter Sleeves:

- a) Install adapter sleeves for all No. 10 AWG and No. 12 AWG wires. Provide sleeve type as recommended by thermite weld manufacturer and attach in the field.
- b) Install adapter sleeves for all No. 4 AWG and No. 2 AWG wires. Premade factory sleeved wires or wires with sleeves made in the field with the appropriate sized sleeves and hammer die are acceptable.
- 1) Factory formed sleeves shall be beveled to allow molten thermite weld material to directly contact wire.
 - 2) Field formed sleeves shall be attached with the appropriate sized and type of hammer die with method as recommended by the thermite weld manufacturer. Wire conductor for field installed adapter sleeves shall extend ¼-inch beyond end of the sleeve to allow molten thermite weld material to directly contact wire.

Table 8B.1. Sleeved Thermite Weld Materials – Horizontal Connections

STRANDED TEST LEAD OR BOND WIRE SIZE	CADWELD®		ThermOweld®	
	SLEEVE MODEL No.	HAMMER DIE MODEL No.	SLEEVE MODEL No.	HAMMER DIE MODEL No.
No. 12 AWG	CAB-133-1H	Crimped	38-0200-00	Crimped
No. 10 AWG	CAB-133-1K	Crimped	38-0201-00	Crimped
No. 4 AWG	CAS-20-F	CAD-11	38-0204-00	38-4859-00
No. 2 AWG	CAS-09-F	CAD-09	38-0203-00	38-0310-00

Table 8B.1 presents sleeve and hammer die information for Cadweld® and ThermOweld® products.

13. Thermite weld materials are available as specified from:

- a) Erico Products Inc. (CADWELD 800-248-9353), Cleveland, OH;
 - b) Continental Industries, Inc. (ThermOweld®), A Hubbell Company, 800-558-1373, Tulsa, OK;
 - c) Or approved equal.
14. Thermite Weld Mold, Charge and Size for pipes LARGER than 8-inches in diameter are provided in Table 8B.2.

CONDUCTOR SIZE	CADWELD®			ThermOweld®		
	SLEEVE #	MOLD #	MAXIMUM CHARGE TYPE AND SIZE	SLEEVE #	MOLD #	MAXIMUM CHARGE TYPE AND SIZE
No. 12 AWG	CAB-133-1H	CAHBA-1G-PS	CA15XF-19 CA25XF-19	38-0200-00	M-156	15CI or 25CI
No. 10 AWG	CAB-133-1H	CAHBA-1G-PS	CA25XF-19	38-0201-00	M-7351-PS	25CI
No. 8 AWG	N/A	CAHBA-1G-PS	CA25XF-19	38-0201-00	M-7351-PS	25CI
No. 6 AWG	N/A	CAHBA-1G-PS	CA25XF-19	38-0202-00	M-7352-PS	25CI
No. 4 AWG	CAS-20-F	CAFCA-1L-PS	CA32XF-19	38-0204-00	M-154-PS	32CI
No. 2 AWG	CAS-09-F	CAFCA-1V-PS	CA32XF-19	38-0203-00	M-175-PS	32CI

Table 8B.2.**Thermite Weld Mold, Maximum Charge Size and Type for Diameters Greater than 8 Inches****E. Thermite Weld Repair Coating:** One Hundred Percent (100%) Epoxy Repair Coating

- 1) Field repair material shall be fast cure, high build, low temperature (cure down to 0 degrees (°) Fahrenheit (F)), moisture tolerant (cure underwater), 100-percent epoxy material that can be distributed in a two component repair cartridge tubes with a dispensing gun.
- 2) Repair coating shall be compatible with original pipe or fitting coating and exhibit minimum 2,000 pounds per square inch (psi) adhesion values.
- 3) Acceptable field epoxy repair type coatings are:
 - a) Denso North America Protal 7125 Repair Cartridge;
 - b) CANUSA-CPS HBE-95 WG high build epoxy;
 - c) Or approved equal.

F. Easy Bond Pin Brazing:

1. Pin Brazing for joint bond and test wire connection to dielectric lined pipe offers lower temperature, less weather restrictions, and greater versatility in connection locations.

Only direct type pin brazing connections to pipe or fitting shall be utilized, no threaded bolt and nut type connections shall be allowed. Direct type pin brazing connection shall be sized as required to meet specified test wire or joint bond wire and strap size. Consult pin brazing manufacturer for recommended direct metal type connection sizes.

2. Wire ring tongue terminal pin brazing connectors to bond or test lead wires shall be crimped and silver-soldered for all pin brazing type wire connections.
3. Pin brazing connections can be made directly to suitable sized punched copper straps.

4. Pin brazing system for cathodic protection connections shall consist of direct type pin brazing pins connected with a BAC pin brazing system are available from:

- a) Farwest Corrosion Control Company;
- b) GMC Electrical, Inc.;
- c) Hoff Company, Inc.;
- d) Mesa Products;
- e) Or approved equal.

G. Ground Clamps: Heavy duty all bronze ground clamps for wire connections to copper service pipe shall be sized to fit the pipe and wire and UL 467 listed for direct burial in earth or concrete. All parts of the clamp shall be bronze including bolts and nuts, as manufactured by:

- 1. Burndy, LLC;
- 2. EMERSON Industrial Automation;
- 3. Thomas and Betts;
- 4. Or approved equal.

H. Galvanic Anodes:

1. **Magnesium Anode:**

- a) High-Potential Magnesium Composition for buried soil applications shall be cast of primary magnesium and meet or exceed ASTM B843 Grade with Alloy M1C chemical requirements as shown in Table 8B.3.

Table 8B.3 High-Potential Magnesium Anode Composition

ELEMENT	CONTENT
Aluminum (Al)	0.010% maximum
Manganese (Mn)	0.500% to 1.300%
Copper (Cu)	0.020% maximum
Silicon (Si)	0.050% maximum
Iron (Fe)	0.030% maximum
Nickel (Ni)	0.001% maximum
Total Others	0.050% each or 0.300% maximum total
Magnesium (Mg)	Remainder

- b) **Prepackaged Magnesium Anode Dimensions:** The anode size and weight may differ slightly because of variations in casting and mold shapes, but shall be the manufacturer's standard and should approximate the characteristics in Table 8B.4.

Table 8B.4 High-Potential Magnesium Anode Dimension Characteristics

BARE ANODE SIZE	17 POUND ANODE	32 POUND ANODE
Shape	17D3	32D5
Bare Anode Nominal Dimensions	3 inches by 25 inches long minimum	5 inches by 20 inches long minimum
Packaged Weight	42 pounds minimum	68 pounds minimum
Nominal Package Size	6 inch diameter by 29 inches long minimum	7 inches by 28 inches long minimum

- c) **Magnesium Anodes:** Shall be verified with a third party ASTM G97 tests for quality control and meet the following minimum requirements:

- 1) Minimum Open Circuit Potential shall be -1.7 volts or more negative to a copper/copper sulfate reference electrode.
- 2) Minimum current efficiency shall be 50-percent (50%) efficiency or higher or a minimum 500 amp hours or higher.
- 3) Anode suppliers (distributors) shall provide anode manufacturing certificates, manufacturing quality control testing results, and supplier's own third party ASTM G97 test results for each batch of anodes supplied for project.
- 4) If any anodes provided for the project do not pass the minimum criteria specified ASTM G97 requirements, then all anodes supplied in that batch or lot shall be rejected and replaced at no cost to the Owner.

- d) **Acceptable High Potential Magnesium Anodes are:**

- 1) MAXMAG by Interprovincial Corrosion Control Company (ICCC), Lewiston, NY, 800-699-8771, www.rustrol.com;
- 2) MESA High Potential Magnesium Anodes, MESA Products, 888-800-6372, www.mesaproducts.com;
- 3) UltraMag High Potential Magnesium Anode, Farwest Corrosion Control Company, 888-532-7937, www.farwestcorrosion.com;
- 4) Or approved equal.

2. Zinc Anode:

- a) Zinc anodes for buried soil conditions shall meet the requirements of ASTM B 418, Type II, as shown in Table 8B.5.

Table 8B.5 Zinc Anode Composition

ELEMENT	CONTENT
Aluminum (Al)	0.0050% maximum
Cadmium (Ca)	0.0030% maximum
Iron (Fe)	0.0014% maximum
Lead (Pb)	0.0030% maximum
Copper (Cu)	0.0020% maximum
Zinc (Zn)	Remainder

- b) **Prepackaged Zinc Anode Dimensions:** The anode size and weight may differ slightly because of variations in casting and mold shapes, but shall be the manufacturer's standard and should approximate the characteristics provided in Table 8B.6.

Table 8B.6 Zinc Anode Dimension Characteristics

BARE ANODE SIZE	18 POUND ANODE	30 POUND ANODE
Shape	ZUR-18	ZUR-30
Bare Anode Nominal Dimensions	1.4 inches by 36 inches long minimum	2 inches by 30 inches long minimum
Nominal Package Dimensions	5 inch diameter by 42 inches long minimum	5 inches by 38 inches long minimum
Packaged Weight	70 pounds minimum	70 pounds minimum

3. Prepackaged Galvanic Anode General Requirements:

- a) **Anode Wire:** Supply each anode with No. 12 AWG stranded copper wire with HMWPE insulation. Provide anode lead lengths as required for test stations to extend splice free from anode to test station location. Lead wire shall be coiled and bound.
- b) **Wire-to-Anode Connection:** The anode connection shall be stronger than the wire. The galvanic anode material shall be cast around a galvanized steel wire, strap, or pipe core. The anode lead wire connection to the steel core shall be silver-soldered (45% silver) by the manufacturer's standard process and be stronger than the wire. Connection of lead wire to anode shall be electrically insulated with manufacturer's standard waterproof epoxy or electrical potting compound type insulation.
- c) **Prepackaged Anode Backfill Material:** Shall have a grain size so that 100-percent is capable of passing through a 20-mesh screen and 50-percent will be retained by a 100-mesh screen. The mixture shall be thoroughly mixed and firmly packaged around the galvanic anode within the cloth bag or cardboard tube by means of adequate vibration. The complete packaged galvanic anode shall weigh a minimum of 2.0 times the bare anode weight. The quantity of backfill material shall be sufficient to cover all surfaces of the anode to a depth of 1-inch.
- d) **Packaging and Shipping:** Bare anodes shall be centered in cotton bag filled with specified backfill material. Provide anode packaged in and shipped and stored in waterproof plastic or heavy multi-walled paper bag of sufficient thickness to protect the anode, wire, backfill material, and cloth bag.

- e) **Compliance Statement:** Furnish an independent laboratory analysis certifying that all anode and backfill material supplied meets the requirements of this Specification and specified laboratory testing.
- f) **Field Verification:** At the Engineers option, if an anode is supplied by a manufacturer other than the manufacturers listed in the specifications, a galvanic anode may be selected at random for Contractor to provide an independent laboratory analysis on to demonstrate that both the anode and backfill material supplied meets the requirements of this Specification.
- g) Prepackaged Galvanic Anode Backfill material Composition is provided in Table 8B.7.

Table 8B.7 Prepackaged Galvanic Anode Backfill Material Composition

ELEMENT	CONTENT
Ground Hydrated Gypsum	75 Percent
Powdered Wyoming Bentonite	20 Percent
Anhydrous Sodium Sulfate	5 Percent

I. Cathodic Protection Test Stations:

1. Flush Mounted Test Stations:

- a) Flush mounted test stations shall be standard unless specifically indicated on the plans.
- b) **Test Station Box:** Traffic H-10 load rated concrete body cast with a cast iron ring, with a minimum weight of 55 pounds and minimum dimensions of 10-inch inside diameter and 12-inches long.
 - 1) Furnish with locking metallic ring extensions as required to penetrate concrete or pavement surfaces by 4-inches minimum.
 - 2) Furnish with a minimum 12 pound cast iron lid with the letters "TS" or words "CP Test", "Test Station" or similar words cast into the lid.

3) Test Boxes shall be:

- I. Model 3RT Traffic Valve Box by Brooks Products, www.brooksproducts.com;
 - II. Model G3 Traffic Valve Box by Christy Concrete Products, www.oldcastleprecast.com;
 - III. Or approved equal.
- c) **Terminal Block:** Plastic or glass-reinforced, ¼-inch thick laminate terminal board with minimum dimensions of 3-inches by 4-inches.
 - 1) Furnish terminal block with a minimum of seven (7) terminals. Terminal nuts and studs shall be ¼-inch with double nuts for securing the studs to the terminal board.

- 2) Terminal nuts, studs, flat and lock washers shall be nickel plated brass, bronze, or Series 300 stainless steel.
- 3) Terminal block shall not be connected to flush test station cap or be constructed in a manner that will accidentally allow wires to be shorted together through terminal board.
- 4) **Manufactured seven terminal test boards shall be:**
 - I. CP Test NM-7 by Bingham & Taylor;
 - II. Flush Fink 7 by COTT Manufacturing;
 - III. Or approved equal.

2. Shunts:

a) Shunts for test stations shall be:

- 1) Holloway Type RS 0.01 ohm manganin wire shunt with 6-amp capacity by Holloway Shunts;
- 2) Yellow CP Shunt (0.01-ohm shunt with 8-amp capacity) by M.C. Miller Company;
- 3) Yellow CP Shunt (0.01-ohm shunt with 8-amp capacity) by COTT Manufacturing;
- 4) Or approved equal.

J. Miscellaneous Reference Monitoring Equipment and Materials:

1. **Reference electrodes:** Shall only be used at locations specifically indicated in the plans or as directed by the Engineer.
2. **Prepackaged Copper/Copper Sulfate (CU/CUSO4) Reference Electrodes:**
 - a) Permanent reference electrode for buried piping locations shall be a copper/copper sulfate reference electrode. Reference electrode dimensions shall be approximately 1.5-inches in diameter by 6-inches long. Reference electrode shall be suitable for permanent installation and designed for a 15-year minimum life expectancy with an accuracy of plus or minus 5-millivolts.
 - b) Electrodes shall be supplied prepackaged in a permeable cloth bag containing manufacturer's special low-resistivity backfill mixture formulated to retain moisture and maintain electrode stability. Outside dimensions of electrode package shall be approximately 6-inches in diameter by 14-inches long.
 - c) Supply electrode with a lead wire attached and electrically insulated with the manufacturer's standard connection. The connection shall be stronger than the wire. Lead wire shall be single conductor No. 14 AWG or larger stranded copper wire insulated as specified under WIRE, this section. Lead wire shall be of sufficient length

(minimum 50 feet) or longer as required to reach splice free from reference electrode to test station. Lead wire shall be coiled and bound.

- d) Package cloth bag with reference electrode in and shipped and stored in waterproof plastic or heavy paper bag of sufficient mil thickness to protect the electrode, wire, backfill, and cloth bag.

e) **Acceptable CU/CUSO₄ reference electrodes can be obtained from:**

- 1) STAPERM Model CU-1-UGPC by GMC Electrical, Inc.;
- 2) Model UL CUG LongLife Reference Electrode by Electrochemical Devices, Inc.;
- 3) Or approved equal.

- 3. **Plastic Reference Monitoring Pipe:** Shall be a 3-inch minimum diameter Schedule 40 PVC plastic pipe with a threaded pipe cap provided at test stations as shown on the Drawings or called out in the test station schedule. Plastic reference monitoring pipe at flush test stations shall not require a threaded cap.

K. Conduit, Lockouts, And Straps:

- 1. The minimum conduit size shall be 1-inch diameter unless otherwise indicated on drawings or specified.
- 2. Use intermediate metal conduit, including couplings, elbows, nipples, and other fittings, hot-dipped galvanized and meeting the requirements of UL and the NEC.

Do not use setscrew type couplings, elbows, and nipples unless approved by the Engineer.

- 3. Heavy wall rigid PVC conduit shall be Schedule 40, UL listed for concrete encasement, underground direct burial, concealed and direct sunlight exposed use.

Use conduits, couplings, elbows, nipples, and other fittings meeting the requirements of NEMA TC and TC 3, Federal Specification W-C-1094, UL, NEC, and ASTM specified tests for the intended use.

- 4. Flexible metal conduit shall be UL listed, liquid tight flexible metal conduit consisting of galvanized steel flexible conduit covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.
- 5. Locknuts, two hole straps, and other miscellaneous hardware shall be galvanized steel.
 - a) Galvanized items shall be hot dipped galvanized in accordance with ASTM A153.
 - b) Galvanized hardware shall not be used underground or in immersion service.
- 6. Conduit bushings shall be threaded plastic or plastic-throated galvanized steel fittings.

L. Wire Connections And Splice Materials:

1. Compression Connectors:

- a) Compression connectors for in-line, multi-splices, and tap splices shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced.
 - b) Compression connectors shall be applied with the crimp tool and die recommended by the manufacturer for the wire and tap connector size.
 - c) **Acceptable Type "YC" wire compression connectors as manufactured by:**
 - 1) Burndy, LLC;
 - 2) Thomas and Betts;
 - 3) Or approved equal.
 - d) Inline "butt" type wire splice connectors or wire nuts are **NOT** acceptable.
 - e) Split bolts are acceptable only if silver soldered after a physical connection is made and both the wires are equal to or smaller than No. 10 AWG size.
 - f) **Silver Brazing Alloy:**
 - 1) Brazing Alloy with minimum 15-percent silver content, 1185° to 1300° F melting range.
 - 2) Provide suitable silver brazing alloy and flux recommended by manufacturer for materials being connected (i.e. copper to stainless steel, copper to steel, and/or copper to copper, etc.).
2. Splices shall be made with suitably sized copper compression connectors and insulated with either a hand tape system, with a specially formulated splicing kit, or with an epoxy splice kit depending on wire size.
- a) Smaller wires (equal to or smaller than No. 8 AWG) can be repaired with tape, or insulated with a specially fabricated splicing kit, or made with an approved epoxy insulated splice kits.
 - b) Insulation damage or splices to large cathodic protection cables (No. 4 AWG or larger) shall only be made with an approved epoxy type splice kit.
 - c) **Electrical Splicing Tapes and Sealers:** Tape for wire splice insulation shall be UL and CSA approved, cold and weather resistant, highly elastic, with a high dielectric strength and highly resistant to sun, water, oil, acids, alkalis, and corrosive chemicals.
 - d) Tapes and electrical sealers shall be suitable for moist or wet environments and may include the following:

- 1) Rubber High Voltage Electrical Tape: Linerless 30-mil rubber high voltage splicing tape suitable for splicing cables through 69k;
 - 2) VScotch Professional Grade Linerless Rubber Splicing Tape 130C by 3M Products;
 - 3) Plymouth L969 Plyvolt Linerless EPR High Voltage Tape by Plymouth Bishop;
 - 4) Or approved equal.
- e) **High Voltage Vinyl Electrical Tape:** All weather, minimum 7-mil thick, vinyl electrical tape suitable for cable splices up to 600 volts.
- 1) Scotch Super 33+ Vinyl Electrical Tape as 3M Products;
 - 2) Plymouth Premium 111 Black Vinyl Plastic Electrical Tape by Plymouth Bishop;
 - 3) Or approved equal.
- f) **Filler Tapes:** Low voltage rubber filler tapes or putties that can be wrapped, stretched or molded around irregular shapes for quick, smooth insulation build-up to insulate connections up to 600 volts for topcoating with vinyl electrical tapes.
- 1) Scotchfill by 3M Products;
 - 2) Plymouth 125 Electrical Filler Tape by Plymouth Bishop;
 - 3) Or approved equal.
- g) **Electrical Coating Sealer:** Electrical coating for sealing tape insulation on splices in severe conditions, suitable for direct burial, direct water immersion, and above grade applications.
- 1) Scotchkote Electrical Coating by 3M Company;
 - 2) Or approved equal.
- h) Specially formulated splicing kit shall consist of an elastomeric insulating compound that seals and waterproofs connection area with a resin-impregnated, moisture-cured fabric bandage shell such as Royston SpliceRight Splicing Kit available from Chase Industries.
- i) **Epoxy Splice Kits:** Epoxy splice kit shall be type suitable for above grade and buried applications and rated for non-shielded cables up to 5 kV and multi-conductor cables through 1,000 volts.
- 1) Splice kit shall consist of snap together plastic mold sized to fit around splice, funnels, tape for sealing ends of mold, and two-part epoxy resin in a single pouch for mixing.

- 2) Epoxy resin shall be electrical insulating low viscosity type that will harden (cure) quickly with time.
- 3) In-Line type splice insulating kit for insulation repair shall be epoxy resin, 3M Company Scotchcast Series 82; Plymouth Bishop Plycast Splicing Kit 2638; or approved equal.
- 4) Wye type splice insulating kit for insulation repair shall be epoxy resin, 3M Company Scotchcast Series 90B1; Plymouth Bishop Plycast Splicing Kit 2636; or approved equal.

3. Terminal and Connection Coating and Electrical Sealers:

- a) **Electrical Insulating Spray:** Electrical insulating spray for sealing tape insulation on splices, or on terminals to minimize external corrosion.
 - 1) Scotch 1601 Insulating Spray by 3M Company;
 - 2) Royston Protective Coating Product Data No. 614 Royston Laboratories;
 - 3) Or approved equal.
 - b) **Oxidation Inhibiting Compound:** Oxidation inhibiting compound shall be non-water soluble, non-petroleum based and suitable for aluminum, copper, steel and rubber and polyethylene type insulating materials.
 - 1) Penetrox A-13 by Burndy Products;
 - 2) Contax Inhibiting Compound Type CTB by Thomas and Betts (T&B);
 - 3) Or approved equal.
4. **Wire Connector Terminals:** A ring tongue terminal or single hole solderless lug type connector shall be installed on the end of all stranded wire before connecting it to test station, terminal box, or junction box terminal studs.
- a) Wire connector terminals shall be sized to fit wire and stud size and be suitable for use with copper conductors.
 - b) One-piece heavy duty, tin plated copper crimp on ring tongue terminal. **Acceptable ring tongue wire connectors are manufactured by:**
 - 1) Burndy LLC;
 - 2) 3M;
 - 3) Thomas and Betts;
 - 4) Or approved equal.

- c) Single hole seamless copper Lug-it type connector rated shall be UL listed for 600-volt service with off-set tongue suitable for wire size being terminated.

Acceptable No. 4 and No. 2 AWG wire single hole solderless lugs are:

- 1) L125 by Burndy;
 - 2) BTCO208-B2 by Thomas and Betts;
 - 3) Or approved equal.
- d) Wire forked end type terminals are **NOT** acceptable.
- e) Acceptable one-hole, non-insulated copper crimp wire lug terminals sizes for ¼-inch stud sizes are listed in Table 8B.8.

Table 8B.8 Stranded Copper Wire Ring Tongue Terminal Connectors

Stranded Cable Size (AWG)	Bolt or Stud Size	MANUFACTURER AND MODEL			
		Anderson	Blackburn	Burndy	T and B
No. 14 to 20	1/4"	----	----	YAV14 Box	Series 54100 Model C10-14
No. 10 to 12	1/4"	----	----	YAV10 Box	Series 54100 Model C10-14
No. 8	1/4"	----	CTL8-14	YA8C-L Box	54130
No. 6	1/4"	VHCS-6-14	CTL6-14	YA6C-L Box	54105
No. 4	1/4"	VHCS-4-14	CTL4-14	YA4C-L Box	54106
No. 2	1/4"	VHCS-2-14	CTL2-14	YA2C-L2 Box	54107

- 5. Electrical Connectors:** Hardware used in electrical connections including bolts, studs, nuts, washers, and lock-washers shall be tin or nickel plated copper, brass, bronze, or 300 series stainless steel for electrical conductivity and atmospheric corrosion resistance.

M. Plastic Conduit Sheathing: Plastic conduit for cathodic protection cable sheathing for cathodic protection cables or wires shall be one-inch minimum diameter Schedule 40 polyethylene (PE) or polyvinyl chloride (PVC) plastic pipe.

N. Location Marking Tags:

1. Test station locations shall be identified with stamped brass or aluminum marking tags.
 - a) Minimum tag size shall be 2-inch diameter.
 - b) **Marking tags are available from:**
 - 1) Western Electromarker, Edmonton, Alberta, Canada (866-486-4250);
 - 2) Or approved equal.

2. Contractor shall supply the type and number of location marking tags sufficient for the number of test stations listed in the Test Station Schedule for the project.
 - a) One UNSTAMPED tag shall be left in each test station.
 - b) Engineer will stamp the tags with appropriate identification at the time of final acceptance testing.

O. Warning Tape:

1. Warning tape shall be used on all projects where specifically called out in the Plan General Notes.
2. Warning tape shall be heavy-gauge, 4-mil minimum thickness, plastic tape for use in trenches.
 - a) Warning tape shall be non-traceable type. Warning tape shall be resistant to corrosive soil and intended for extended direct burial service.
 - b) Tape shall meet A.P.W.A. national color code and shall be imprinted with an appropriate legend to define the type of utility. Tape shall be labeled with bold black letters for full length of tape.
 - c) Warning tape for water mains shall be blue and labeled "CAUTION: WATER LINE BURIED BELOW".
 - 1) For pipe lines of 10-inch diameter and less, the warning tape shall be 6-inches in width.
 - 2) For pipe lines of 12-inches and greater, the warning tape shall be 12-inches in width.
 - d) Warning tape for buried cathodic protection cables and conduits shall be yellow and labeled "CAUTION: CABLES BURIED BELOW" and a minimum of 3-inch width.
 - e) **Acceptable products are available from:**
 - 1) ITT Blackburn;
 - 2) Allen Systems, Inc.;
 - 3) Reef Industries;
 - 4) Or approved equal.

P. Tracer Wire:

1. **Tracer Wire:**
 - a) **Copper Tracer Wire:** No. 10 AWG wire for tracer wire shall be UL listed single conductor, **stranded** copper wire with 600-volt HMWPE insulation. **Acceptable**

single-conductor copper wire for open cut pipe trench and in-conduit type installations are:

- 1) Agave Copper PE Tracer Wire 45-mil (APUT-1019) from Agave Wire, LTD;
 - 2) 45-mil HMWPE Copper Tracer Wire from Kris-Tech (K-T) Wire
 - 3) Pro-Trace Type CU HDPE Copper Tracer Wire 45-mil (Copper PE45-Stranded) from Pro-Line Safety Products;
 - 4) Or approved equal.
- b) Bi-metallic Tracer Wire:** No. 10 AWG wire for tracer wire may be a hard-drawn, copper-clad steel conductor wire with a 45-mil high density HWMPE insulation. **Acceptable bi-metallic tracer wire is:**
- 1) Agave APCU 1001 from Agave Wire, LTD;
 - 2) Pro-Trace (HDD-CCS PE45) as manufactured by Pro-Line Safety Products;
 - 3) Copperhead High Strength Tracer Wire (1030B-HS-xx) as manufactured by Copperhead Industries, LLC;
 - 4) Copper-Clad Steel (CCS) Tracer Wire from Kris-Tech (K-T) Wire;
 - 5) Or approved equal.
- c)** Tracer wire will only be required for non-metallic pipe sections and for copper water services as detailed in 13945PS.
- d)** Tracer wire insulation shall be resistant to corrosive soil and intended for extended direct burial service.
- e)** Tracer wire color and tape markings shall be in accordance with other sections of this Specification.
- f)** Tape for attachment of tracer wire to pipe shall have an aggressive adhesive intended for direct burial service. **Standard-duty Duct Tape is not an acceptable product. Minimum tape requirements are:**
- 1) Adhesive PVC/butyl rubber (polyethylene) tape materials minimum 1- ½ to 2-inch wide 6- to 10-mil nominal thickness shall be provided to securely hold tracer wire in place on top of pipe.
 - 2) Adhesive PVC/butyl rubber (polyethylene) tape materials and adhesion to bare metal surface and to backing shall be a minimum of 22 grams per ounce/inch and meet AWWA C105 requirements.
- 3) Acceptable products are:**
- I. Gorilla Tape available from Gorilla Glue Company,

- II. No. 140 Black Pipe Wrap Tape available from Sigma Corporation,
- III. UPC Pipe Tape available from Northtown Company,
- IV. Or approved equal.

g) Tracer Wire Splices:

- 1) Compression connectors for in-line splices shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced in accordance with "Wire Connections and Splice Materials" this section. Wire compression connectors shall be supplied with tape or epoxy resin type splice insulation kits.
- 2) **Acceptable Type "YC" wire compression connectors as manufactured by:**
 - I. Burndy LLC;
 - II. Thomas and Betts (T and B);
 - III. Or approved equal.
- 3) Electrical Spring Connector (Wire Nut) Pigtail Wire Type Connectors with silicone gel insulation filled resin tube.
 - I. The electrical spring connector shall consist of a steel spring, metal shell, with a flame-retardant PVC insulator outer covering.
 - II. The plastic tube assembly shall consist of a polypropylene tube with locking fingers to hold the electrical spring connector in the bottom portion of the tube and a plastic cap.
 - III. The tube shall be prefilled with non-hardening silicone electrical insulating gel sealant.
 - IV. The electrical spring connector and plastic tube assembly shall be UL listed and CS Certified for 600 volts direct bury and submersible applications.
 - V. The electrical spring connector is suitable for copper wires only and shall be sized to fit three No. 10 AWG tracer wires.
- VI. Suitable tracer wire splice kits are:**
 - i. 3M Direct Bury Splice Kit (DBR/Y-6);
 - ii. Dryconn Waterproof Connectors Direct Bury Twist-On with Strain Relief (DBSR Aqua) from King Innovation;
 - iii. Or approved equal.

- 4) Compression Connectors or split bolts with silver solder and specially formulated splicing kit shall consist of an elastomeric insulating compound that seals and waterproofs connection area with a resin-impregnated, moisture-cured fabric bandage shell.

- I. Royston SpliceRight Splicing Kit available from Chase Industries;
- II. Or approved equal.

2. Tracer Wire Access Boxes:

a) Flush Mounted Tracer Wire Access Box:

- 1) Two different sizes of tracer wire access boxes may be used on a project. The difference in sizes is described within this specification section.
- 2) For two wire, 45-mil insulation, tracer wire access, 4-inch flush mounted tracer wire access boxes may be used unless specifically indicated on the Plans.
 - I. Plastic flush terminal box body (18" long shaft, 4" diameter minimum size) with cast iron collar and lockable cast iron lid, suitable for traffic conditions.
 - II. Lids, if colored, shall meet APWA standard color for utility.
 - III. Tracer wire access boxes shall be furnished with a lock-down lid and marked "Test", "TW", "Tracer", "TWAB" or other label approved by the Engineer. Markings shall allow easy differentiation between tracer wire access boxes and cathodic protection test stations.
 - IV. Minimum four (4) wire non-conductive terminal board with ¼-inch diameter stainless steel, nickel plated brass, or bronze hardware for wire terminations.
 - V. Terminal board shall not be connected to flush tracer wire access box cap or be constructed in a manner that will accidentally allow wires to be shorted together through terminal board.
 - VI. **Acceptable 2-wire, 45-mil insulation, flush mounted tracer wire access boxes are:**
 - i. Model No. P445 DT Test 4-inch Shaft Cathodic Protection Test Boxes by Bingham and Taylor;
 - ii. Model NM-7, 5-inch inner diameter (ID) 18-inch Shaft Cathodic Protection Test Station by C.P. Test Services – Valvco, Inc;
 - iii. Model T4, 4-inch ID 18-inch Shaft Cathodic Test Stations by Handley Industries;
 - iv. Model TWAB4PT, 4-inch Tracer Wire Access Box by Drainage and Water Solutions, Inc.

- 3) For more than two tracer wires of 45-mil insulation thickness **or** two or more tracer wires, each being 100-mil or more insulation thickness, concrete tracer wire access boxes with separate terminal board shall be utilized and shall have H-10 rated concrete body with a cast iron ring and lid.
- I. The concrete tracer wire access boxes shall have a minimum weight of 55-pounds and minimum dimension of 10-inch inside diameter and shall be a minimum of 12-inches long.
 - II. Tracer wire access boxes shall be furnished with locking metallic ring extensions as required to extend to surface of pavement greater than four inches in thickness.
 - III. Tracer wire access boxes shall be furnished with a 12-pound minimum cast iron, bolt down lid marked "Test", "TW", "Tracer", "TWAB" or other label approved by the Engineer. Markings shall allow easy differentiation between tracer wire access boxes and cathodic protection test stations.

IV. Acceptable Concrete Tracer Wire Access Box Manufacturers are:

- i. Brooks Products Model 3RT Traffic Valve Box;
- ii. Christy Concrete Products Model G3 Valve Box;
- iii. Or approved equal.

V. Tracer Wire Terminal Board:

- i. Plastic or glass-reinforced, non-conductive, ¼-inch thick laminate terminal board with 3-inch by 4-inch minimum dimensions.
- ii. Terminal board shall be furnished with a minimum of four (4) terminals.
- iii. Terminal nuts and studs shall be ¼-inch with double nuts for securing the studs to the terminal board. Terminal nuts, studs, flat and lock washers shall be nickel-plated brass, bronze or Series 300 stainless steel.
- iv. Terminal board shall not be constructed in a manner that will accidentally allow wires to be shorted together through terminal board.

v. Acceptable Manufactured Terminal Boards are:

- I) CP Test NM-4 Terminal Test Board;
- II) Bingham & Taylor 4 Terminal Test Board;
- III) Flush Fink 4 Terminal Test Board;
- IV) Handley Industries 4 Terminal Test Board;
- V) Or approved equal.

Q. Insulating Joints:**1. General:**

- a) Insulating joints shall be dielectric unions, flanges, or couplings. The complete assembly shall have an ANSI rating equal to or higher than that of the joint and pipeline. All materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.
- b) No size restrictions for monolithic type insulators in buried, submerged or above grade locations.
- c) No size restrictions for insulated flange or insulated couplings in above grade or vault type locations.

2. Flange Insulating Kits for Flanges and Restrained Rod Harness Sets:**a) Gaskets:**

- 1) Low Pressure (Less than 150 psi) or Small Pipe Diameter (Less than 22-inch) - Provide full-face Type E with O-ring seal, style as recommended by manufacturer for flange face type. The 1/8-inch minimum thick flanged gasket shall be supplemented with a neoprene facing on each side to accomplish a seal. Sealing element shall be designed to seal either flat, raised face, or ring type joint (RTJ) flanges.
- 2) High Pressure (150 psi or greater) or Large Pipe Diameter (22-inch or larger) - Provide full-face Type E with O ring seal, style as recommended by manufacturer for flange face type. The 1/8-inch minimum thick flanged gasket shall be supplemented with a Nitrile (240° F maximum operating temperature) O-ring seal and a phenolic or G-10 (Pyrox) retainer facing on each side to accomplish a seal. Sealing element shall be designed to seal either flat, raised face, or RTJ flanges.

b) Insulating Sleeves: Individual full-length fiberglass reinforced epoxy, NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) or NEMA G-11 Grade material (Glass Reinforced Epoxy). Tube shall be 1/32-inch thick and extend one-half way into both of the inner steel washers next to the flange. Sleeve shall be a length sufficient to provide a small air gap between sleeve and nut when flange is tightened down in accordance with the manufacturer's recommendations.

c) Insulating Washers: Individual high-strength fiberglass reinforced epoxy NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) or NEMA G-11 Grade material (Glass Reinforced Epoxy). Size shall be 1/8-inch thick, standard SAE washer dimension.

d) Steel or Stainless Steel Washers: Plated, hot-rolled steel, Minimum 1/8-inch thick. If in area where stainless steel bolts and nuts required, provide Series 300 stainless steel materials or coated washers.

Provide two washers per bolt for flange diameters less than 36-inch diameter.

e) Flange Holes and Fasteners (Bolting):

- 1) For steel pipe flange, oversize bolt holes as recommended by insulated sleeve manufacturer. For ductile iron, provide standard bolt hole size as recommended by sleeve manufacturer.
- 2) Fasteners in accordance with AWWA C207 for steel and AWWA C110 for ductile iron and the following:
 - I. Minimum bolt length shall be a minimum 1/8-inch to 1/4-inch longer (before torquing or tightening down) than the sum of all of the materials being jointed together. This would include but not be limited to the maximum thicknesses of the mating flanges surfaces, the sealing gasket, the insulating and metal washer thicknesses, and the depth of the nut.
 - II. Provide bolts with full thread cut lengths or threaded rod as required to meet inside diameter dimension requirements of insulating sleeves. Insulated sleeves may not fit over unthreaded portions of the bolt body.
 - III. Coordinate bolt length and diameter with flange, bolt, and insulating sleeve manufacturers.
- f) Provide Single Insulating Washer Set Kits for Buried Applications.
- g) Provide Double Insulating Washer Set Kits for Above Grade Applications.

h) Acceptable Flange Insulating Kits Are Available From:

- 1) Trojan Sealing Insulating Gaskets by Advance Products and Systems, Inc., Lafayette, LA (800-335-6009), www.apsonline.com;
- 2) Type E Jock by Central Plastics Co., Shawnee, OK (800-654-3872), www.centralplastics.com;
- 3) Low Pressure Linebacker Type E Sealing Gasket and High Pressure GasketSeal Type E Sealing Gasket by GPT Industries (formerly Pacific Seal and Insulator, Inc. (PSI) and Pikotek) Houston, TX (800-423-2410), www.gptindustries.com;
- 4) Or approved equal.

3. Flexible Insulated Couplings:

- a) Insulating Couplings shall meet AWWA C219 Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe. The coupling type, size, and clearance shall be style intended by coupling manufacturer to be utilized with two insulating boots (sleeves, bands, etc.) with a small lip that fits over pipe end to keep pipe separated.

Insulated couplings shall be factory provided by coupling manufacturer and not be made with field conversion kits.

- b) Coupling Coating and Linings: Insulated fittings shall be steel and externally coated and lined with factory epoxy coating internally and externally in accordance with AWWA C210, AWWA C213, or AWWA C550.
- 1) Minimum surface preparation shall be white metal blast (SSPC SP-5) for internal surfaces and near white blast (SSPC SP-10) or better for external surfaces.
 - 2) Liquid epoxy coating shall be a minimum of two coats for 14 MDFT.
 - 3) Fusion-bonded epoxy coating shall be a minimum of 10 MDFT.
 - 4) Provide repair kits for epoxy-coated materials.
 - 5) Provide a manufacturing affidavit or certification that all coating furnished complies with AWWA standards and that all AWWA standard's inspection and tests have been completed.
- c) Buried, submerged, or immersed insulating couplings bolts, nuts, and washers shall either be Series 300 stainless steel or fusion-bonded steel coupling bolts, nuts, and washers per requirements of this specification. CorTen® bolts are not acceptable for buried, submerged, or immersed fitting or piping locations.
- d) Insulating boots shall be type and thickness as recommended by coupling manufacturer for intended service including products carried and pipe temperature. The insulating boots shall be factory fabricated and provided by coupling manufacturer. Insulating boots shall be size and type that do not interfere with correct installation and operation of the coupling.
- 1) Two insulating boots shall be provided for each coupling. Insulating boot shall be one-piece type and have an insulating shape with a lip or edge that fits over the end of the pipe. Boot shall be long enough to extend past end of coupling assembly body and be visible when coupling is assembled.
 - 2) Insulating boot material shall be neoprene, nitrile, or EPDM or approved equal per coupling manufacturer's recommendation depending on pipe size and type of service.
 - 3) **Minimum Insulating Boot Thickness Shall Be:**

1/8-inch for pipe up to 60-inch size.
- e) Insulated couplings at restrained joints shall be provided with the necessary supplemental insulated restrained joint harness assemblies as described below.
- 1) The use of field conversion kits will not be allowed except to insulate the restrained joint harness assembly.
 - 2) Insulated Flexible Coupling Restrained Harness Assembly: Where shown on the Drawings and/or as required and specified provide insulated restraint/harness assembly at insulated couplings on metallic pipelines. Harness bolts shall be of

sufficient length, with harness lugs placed so that coupling can be slipped at least in one direction to clear joint.

- 3) Provide an insulating flange conversion kit consisting of individual one-piece flange insulating sleeves and insulating washers to electrically isolate restraint harnessing assembly on both ends of harness rod.
 - I. Insulating sleeves shall be individual full-length 1/32-inch thick fiberglass reinforced epoxy, NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) sleeves of sufficient length to extend completely through harness lug assembly.
 - II. Insulating washers shall be 1/8-inch thick individual high-strength fiberglass reinforced epoxy NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) with a metallic washer at standard SAE washer dimension.
 - III. **Acceptable Products:**
 - i. G-10 One-Piece Sleeve and Washer from PSI;
 - ii. Or approved equal.
- 4) Harness lugs and harness bolts shall be sized as required to allow easy installation of insulating sleeves.
 - I. Harness assembly rods and bolts shall be stainless steel (Series 300) for buried or submerged locations, fusion-bonded epoxy coated for dry above grade conditions.
 - II. Individual rods or entire assemble shall be heat shrink coated, coated with a 100-percent moisture cure epoxy repair coating at 20-mil thickness.
 - III. Petrolatum tape coated after assembly and insulator testing.
 - IV. Bitumastic type coatings are not an acceptable option for coating of restraining rods.
- f) Insulating Flexible Couplings shall be F x E Type 1 insulated style that is electrically insulating type with two insulated boots (or bands) to be installed on the pipe under the coupling. **Acceptable insulating flexible couplings are:**
 - 1) Dresser Style 39 by Dresser Industries, Inc., Bradford, PA (814-368-3131);
 - 2) Style 416 by Smith-Blair, Inc., Texarkana, AR (501-773-5127);
 - 3) Depend-O-Lok by Victaulic, Inc., Atlanta, GA (800-841-6624);
 - 4) Series 200 couplings by Baker Coupling Company, Los Angeles, CA (323-583-3444);
 - 5) Or approved equal.

- g) All buried or submerged flexible coupling fasteners shall be Series 300 stainless steel.

4. Copper Service Line Insulators:

- a) Insulated service fittings shall consist of brass union body that encapsulates a nylon insulator specially designed to provide electrical isolation for this type of intended use:

Insulated corporation ball valves, insulated curb ball valves, and service line insulators shall be provided to insulate copper or metallic service lines.

- b) Acceptable service line insulators are available from:

- 1) Mueller Co., Decatur, IL (800-423-1323);

- 2) Or approved equal.

- c) Consult manufacturer for model number and installation procedures for each application.

R. Insulating Floor And Wall Sleeves And Modular Seals:

- 1. **Wall Sleeves:** Pipe wall sleeves or cored openings shall be provided at all wall and floor locations in accordance with pipe and sleeve manufacturer's recommendations.

- a) The pipe wall sleeves shall be of sufficient thickness to resist any deformation. The pipe wall sleeves shall be round with a maximum plus or minus (+/-) 1/8-inch variation in diameter allowed. The wall sleeve shall be a minimum wall thickness of 0.375-inch or standard wall thickness. The minimum width of the wall sleeve shall be per the modular seal manufacturer's recommendations to meet minimum width requirements based on seal type and pipe diameter and weight.

- b) Pipe wall sleeves shall be provided with a minimum 3-inch water stop collar that evenly contacts the wall or floor opening all the way around for a minimum length of 1-inch or more if recommended by the sleeve manufacturer. The water stop (collar) shall be of the same type of material as the wall sleeve. The wall sleeve shall have a smooth continuous weld with no welding slag or rough or high welds. The water stop collar shall be continuously welded on both sides of the collar for the entire circumference of the wall sleeve.

- c) The wall sleeve and the water stop collar shall be positioned such that it is located in the center of the structure wall or floor, when the wall sleeve is positioned in place. Steel wall sleeves and water stop collars shall be coated. The wall or floor penetration diameter and width shall be sized sufficiently to allow correct installation of the wall sleeve and water stop.

- d) Wall penetrations and wall sleeves types and sizes shall be coordinated with sleeve manufacturer, modular seal manufacturer, and pipe manufacturer to provide proper type of opening to provide a liquid tight connection.

- e) Wall pipe sleeves placed around pipe and grouted in place in accordance with sleeve and pipe manufacturer's recommendations are an acceptable method of wall openings.
 - f) Coordinate wall sleeve type, model, size, and location with modular seal and pipe manufacturers.
 - g) Prefabricated Coated Steel Pipe Wall Sleeves shall be pre-primed or coated minimum Schedule 40 wall thickness with standard 12-inch length, centered type with a minimum 3-inch water stop sized to fit pipe size.
 - 1) Depending on location, wall size, and pipe size prefabricated steel pipe wall sleeves are available from:
 - I. Model WS Steel Wall Sleeves (coated steel with a welded water stop) by GPT Industries (formerly PSI), Houston, TX (800-423-2410);
 - II. Model SWS (primed steel with a welded water stop), or Model GWS (steel with a welded water stop and Galvo-Plast coating) by Advance Products and Systems, Inc., Lafayette, LA (800-335-6009);
 - III. Or approved equal.
 - 2) Consult manufacturer for specific model required.
- 2. Insulating Wall or Floor Modular Seals:** Insulating wall and floor seals shall be adjustable modular mechanical type seals able to provide a positive seal (liquid tight) and long lasting electrical insulation for wall or floor penetrations for pressures up to 40 feet of static head. Coordinate with and provide pipe and modular seal manufacturer's recommended modular seal type and size for pipe type, pipe diameter, casing or hole opening size, environmental exposure, operating temperature, and intended installation conditions.
- a) The modular seals shall consist of synthetic rubber-bolted links, heavy duty reinforced high density nylon polymer plastic pressure plates, and Type 316 stainless steel hardware (bolts, nuts, washers, etc.) for adjustment. The modular seals shall be manufactured at a plant with a current International Organization for Standardization (ISO) ISO-9001 registration which shall be included as part of the submittal.
 - b) The rubber links shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the opening. The individual links shall be colored and permanently identified with the manufacturer's name and model number. The link shall be sized per the manufacturer's recommendations. The links shall have the following properties per ASTM standards for standard type applications (minus 40 degrees Fahrenheit to positive 250 degrees Fahrenheit), (-40° F to 250° F) Model C EPDM = ASTM D2000 M3 BA510 Black.
 - c) The pressure plates shall be molded glass reinforced nylon polymer with an integrally molded compression assist boss on pressure plated top side (bolt entry side). The pressure plate shall incorporate an integral recess ("Hex Nut Interlock") to accommodate commercially available fasteners. The individual pressure plates shall

be colored and permanently identified with the manufacturer's name. The pressure plate shall be sized per the manufacturer's recommendations. The links shall have the following properties per ASTM standards for standard type applications:

- 1) ASTM D-256 Izod Impact = Minimum 2.05 foot-pound/inch
 - 2) ASTM D-790 Flexure Strength at Yield = Minimum 30,750 PSI
 - 3) ASTM D-790 Flexure Modulus = Minimum 1,124,000 PSI
 - 4) ASTM D-638 Elongation Break = Minimum 11.07%
 - 5) ASTM D-792 Specific Gravity = Minimum 1.38
- d) The modular seal hardware shall be sized according to the seal manufacturer's recommendations depending on the size and type of modular seal. The 316 Stainless Steel hardware shall have the following properties per ASTM standards for standard type applications including ASTM F593 with an average tensile strength of a minimum 85,000 PSI.
- e) **Modular Wall Seals:** Acceptable modular wall seal insulators for pipe diameters equal to or smaller than 24-inch diameter are:
- 1) Thunderline Link-Seal Model LS-300 or LS-400 by GPT Industries Houston, TX (713-747-6948);
 - 2) Pipe Linx by Calpico, Inc. South San Francisco, CA (650-588-2241);
 - 3) Innerlynx by Advance Products and Systems, Inc., Lafayette, LA (800-315-6009);
 - 4) Or approved equal.
- f) Wall sleeves passing through walls of structures containing liquids shall be provided with double sets of modular wall seals to provide pipe support at the penetration and protection against leakage.

S. Coating And Lining For Fittings, Incidental Piping And Valves:

1. Supply incidental pipe, valves, fire hydrants and fittings with linings and coatings of the same type as adjacent pipe, except where shown on the Drawings. Coat incidental pipe and fittings installed as specified in this specification section.
2. Coat and line all buried metallic (steel, ductile iron, and cast iron) valves, fittings, miscellaneous piping, and hydrants internally and externally. Supply factory coated valves and fittings with linings and coatings of the same type as adjacent above grade pipe, except where shown on the Drawings or where coating or lining specified for buried main pipeline is not feasible for fabricated items or special pipe pieces (such as incidental metallic piping, valves, fittings, tees, flexible couplings, glands, hydrants, etc.).
 - a) Internal linings and coatings exposed to water shall be NSF approved for potable water service.

- b) Minimum surface preparation shall be white metal blast (SSPC SP-5) for internal surfaces and near white blast (SSPC SP-10) or better for external surfaces.
- c) Provide tight bonded coating and lining of pipe and fitting joints at maximum thicknesses shall be as recommended by the pipe or fitting manufacturer and shall not impair engagement of pipe or fitting joint or function of fitting.
- d) All ferrous interior mounting faces/surfaces shall be prepared and shop primed with a suitable rust-inhibitive holding primer applied in accordance with this specification and the coating manufacturer's recommendations. Holding rust-inhibitive primer shall be compatible with specified top coats. Apply per coating manufacturer's recommendations to a thickness that will not impair the clearances required for proper installation of the joint or fitting (valve, coupling, flange, etc.) operation.
- e) Valve bolts, nuts, and washers, (including in valve bonnet and stuffing) box) shall be Series 300 stainless steel.

3. Ductile Iron and Cast Iron Factory Coating Surface Preparation:

- a) Use Society for Protective Coatings (SSPC) SP grades as surface preparation guide only as it applies to cast iron or ductile iron in percentage cleanliness required and surface contaminants removed, not the color of the metal.
 - b) The abrasive blast cleaning operation shall remove the same percentage of all surface contaminants (including tightly adhered annealing scale) as the SSPC SP grade referenced.
 - c) The entire surface area shall be abrasive blasted. No tight rust stains shall be allowed.
 - d) Avoid overblasting, high nozzle velocities, and excessive blast times.
 - e) Cast iron and ductile iron attain a gray color when abrasive blasted due to the higher carbon content compared to steel.
 - f) SSPC SP-10 Near White Grade is specified for cast iron or ductile iron, the degree of surface cleanliness is comparable to a near white blast for steel and requires 95 percent removal of all surface contaminants including tightly adhered annealing scale. Ductile or cast iron will not be required to be near-white but will only be required to be a near-gray color.
4. At Contractor's option, factory coat or line the incidental piping, valves, or fittings with liquid epoxy or with fusion-bonded epoxy coating in accordance with these specifications and AWWA C210, AWWA C213, AWWA C116, or AWWA C550. Coating shall meet all AWWA standard requirements and tests and this specification section.

5. Liquid Epoxy:

- a) Provide factory applied liquid epoxy lining and coating in accordance with AWWA C210 and AWWA C550 and these specifications. Epoxy material shall meet the performance requirements of the referenced AWWA standards. Epoxy material shall

be the product of a coating manufacturer normally engaged in production of such material and shall be for intended service conditions.

- b) Coating in contact with potable water shall conform to NSF Standard 61.
- c) The liquid epoxy coating shall be a two part chemically cured coating or 100-percent material. Coating shall be mixed and applied per coating manufacturer's directions. Liquid-epoxy lining of metallic pipe and fittings shall be potable grade epoxy coating approved for potable water contact and this type of intended service.
- d) Abrasive blast with material and in manner as recommended by coating manufacturer to produce surface profile depth and angular shape needed. Surface preparation shall be a minimum of SSPC SP-5 (White) for immersion service and SSPC SP10 (Near White) or better for external service.
- e) Coating shall be a minimum of two or more coat system with a minimum thickness of 14 MDFT.
- f) Minimum adhesion to prepared steel shall be 400 psi per ASTM D1002 or per coating manufacturer's printed literature, whichever is higher.
- g) Acceptable liquid epoxy materials for linings in contact with potable water or buried-service metallic fittings, valves, etc. are:
 - 1) Carboguard as manufactured by Carboline®;
 - 2) DeVoe Bar-Rust 233H as manufactured by AkzoNobel;
 - 3) SherPlate PW Epoxy B62 as manufactured by Sherwin-Williams;
 - 4) PotaPox Plus Series N140 or L140 manufactured by Tnemec;
 - 5) Or approved equal.
- h) Acceptable liquid epoxy materials for above grade structures are:
 - 1) Carbothane 133 LH as manufactured by Carboline®;
 - 2) Devthane 379 UVA Polyurethane Enamel as manufactured by AkzoNobel;
 - 3) Endura-Shield II series 1074U Aliphatic Acrylic Polyurethane as manufactured by Tnemec;
 - 4) Or approved equal.
- i) Finish for above grade structures shall be high gloss with color selected by the Owner for the intended service.

6. Fusion-Bonded Epoxy:

- a) Provide factory applied fusion-bonded epoxy lining and coating in accordance with AWWA C213, AWWA C116, and AWWA C550, and these specifications.
 - b) Fusion-bonded epoxy material shall meet the performance requirements of the referenced AWWA standards.
 - c) Coating in contact with potable water shall conform to NSF Standard 61.
 - d) Fusion-bonded epoxy material shall be the product of a coating manufacturer normally engaged in production of such resin and shall be for intended service conditions.
 - e) The fusion-bonded epoxy coating shall be a 100-percent powder epoxy based thermosetting coating. Coating shall be applied by flocking, fluidized bed, or electrostatic method per coating manufacturer's directions.
 - f) Fusion-bonded epoxy lining of metallic pipe and fittings shall be potable grade epoxy coating approved for potable water contact and this type of intended service.
 - g) Abrasive blast with material and in manner as recommended by coating manufacturer to produce surface profile depth and angular shape needed. Surface preparation shall be a minimum of SSPC SP-5 (White) for immersion service and SSPC SP10 (Near White) or better for external service.
 - h) Fusion-bonded epoxy coating shall be one or two-coat system with a minimum thickness of 8 MDFT.
 - i) Minimum adhesion to prepared steel shall be 3,000 psi per ASTM D1002 or per coating manufacturer's printed literature, whichever is higher.
 - j) Acceptable fusion-bonded epoxy materials are listed below:
 - 1) Scotchkote 206N, 323 or 162 as manufactured by 3M™;
 - 2) Nap-Gard® 7-2500 pipe coating as manufactured by Axalta Coating Systems;
 - 3) Nap-Gard 7-4500 (CV Red FBE) for valves and fittings as manufactured by Axalta Coating Systems;
 - 4) Or approved equal.
7. Conduct dry film thickness measurements and 100-percent holiday inspection of all factory epoxy-coated items prior to shipment.
- a) Conduct dry film thickness measurements in accordance with SSPC PA-2 with exception that the specified thickness is the absolute minimum.
 - b) A minimum of two dry film thickness measurements shall be completed for each fitting or appurtenance.

- c) Repair all defects with approved repair material according to original coating manufacturer's directions prior to shipment.
8. Provide field repair kits for all types of coated materials.
9. Provide exterior coating for all above-grade piping, fittings, and vent pipes with two coats of polyamide epoxy coats at a minimum 2.5 MDFT per coat (MDFTPC) and with one top coat of polyurethane enamel at a minimum 3 MDFT or with a minimum 10 MDFT fusion-bonded epoxy coating system. Minimum surface preparation shall be near-white metal blast (SSPC SP-10) for external surfaces. Color specified by Engineer.
Hot dipped galvanized or plastic (PVC) type vent pipes do not require epoxy/polyurethane coating system.
10. Coating for valves, adapters, fittings and fire hydrant legs shall consist of one of the following:
- a) Liquid epoxy coating shall be a minimum of two coats or more for a minimum 14 MDFT coating thickness.
 - b) Fusion-bonded epoxy coating shall be one or more coats for a minimum coating thickness of 8 MDFT.
 - c) Nylon coating shall be one or more coats for a minimum coating thickness of 10 MDFT applied in a fluidized bed.
 - d) Polyurethane coating shall be a minimum 40 MDFT for ductile iron valves and fire hydrant legs and stub pieces (American AVK fusion-bonded epoxy interior with polyurethane coated exterior or approved equal).
 - e) Maximum coating thickness shall be as recommended by fitting manufacturer to not impair engagement of joint or function of fitting.
11. Provide a manufacturing affidavit for all factory epoxy coated or stainless steel items that list:
- a) Applicator of coating including name, address, phone number and date of Application.
 - b) Coating Material Manufacturer and Product Designation with a product data sheet.
 - c) Certification that all coating furnished complies with AWWA standards and these specification requirements and that all AWWA standard's inspection and tests have been completed and were met.
 - d) Certification that stainless steel items are provided as specified including name of stainless steel manufacturer and Series 300 grade provided.
- 12. Restraint Fitting Coating System:**
- a) Restrained fittings (casting bodies, wedge assemblies, and related parts, etc.) shall be abrasive blasted followed by a phosphate wash, rinse, and drying pretreatment process just prior to coating.

- b)** Restrained fittings (casting bodies, etc.) shall be coated immediately following the pretreatment process. The coatings shall be electrostatically applied and heat cured. Acceptable casting body coating systems shall consist of:
- 1)** A sealer prior to pretreatment drying and two coats of a thermosetting powder coating at minimum 3 to 6 MDFT.
 - 2)** Acceptable TGIC polyester powder coatings for restrained fittings (casting bodies) are:
 - I.** EBAA Iron Mega-Bond Restraint Coating System;
 - II.** Star-Bond Coating System;
 - III.** Or approved equal.
 - 3)** A fusion-bonded epoxy coating at a minimum 8 MDFT, Romac Industries Romacote Corvel Black;
 - 4)** A nylon coating system at minimum 10 MDFT Romac Industries Romac Nylon Coating;
 - 5)** Or approved equal.
- c)** Wedge assemblies and related parts shall be coated immediately following the pretreatment process with an approved coating system consisting of either:
- 1)** A thermoplastic flouropolymer type fastener coating specifically designed for that type of application at a minimum 1 to 2 MDFT.
 - 2)** The thermoplastic flouropolymer coating system shall consist of two or more coats of liquid thermoset epoxy coating with heat cure following each coat.
 - 3)** Acceptable flouropolymer coatings for the wedges and wedge actuators are:
 - I.** EBAA Iron Mega-Bond Restraint Coating System;
 - II.** Star-Bond Coating System;
 - III.** Or approved equal.
- 13.** A fusion-bonded coating system consisting of one or more coats of fusion-bonded epoxy electrostatically applied and heat cured following each coat with a total fusion-bonded epoxy coating system minimum thickness of 6 MDFT.
- 14.** Provide stainless steel materials or coat all other miscellaneous buried metallic items, (tie rods, thrust restraints, tapping saddles, harnesses, etc.). Coat tie rods and rebar when directly exposed to soil. Provide with factory applied epoxy coating, fusion-bonded epoxy coating, heat shrink sleeves, or with coating recommended by coating manufacturer for buried application and approved by the Engineer for intended exposure.

15. Bolts, nuts, and washers, for valves (including in valve bonnet and stuffing box) shall be Series 300 stainless steel.
16. Galvanized or black steel materials (piping, nipples, unions, fittings etc.) shall not be used in wet, immersed, or buried locations or vaults unless tight-bonded coated as specified.

T. Fasteners (Bolts, Nuts, Washers, Etc.):

1. All fasteners (bolts, nuts, tee bolts, and washers) type, size, and strength shall conform to this specification unless other design information is provided in the plans or detailed specifications. All nuts shall be fully seated. Nuts shall be compatible with the bolts and have a proof stress equal or greater than the tensile strength of the bolts. Minimum bolt size, lengths, and tensile shall be as designed for the application.
2. Coated fasteners (bolts, nuts, tee bolts, and washers) are allowed. Coated fasteners shall meet the following requirements:
 - a) Coated bolts shall be undersized or the nuts oversized as required to minimize damage to coatings, however, size shall still satisfy design and manufacturer's requirements for bolt strength and size in the particular application. Provide with applicator name, coating manufacturer and product number, and certification that coating was applied as specified.
 - b) Coated bolts, nuts, and washers for ductile iron pipe and fittings shall be low carbon weathering steel meeting the strength, physical, marking, traceability, and chemical requirements of AWWA C111 and coated with an approved fastener coating system.
 - c) Bolts, washers, nuts, and T-bolts shall be pretreated and coated with a thermosetting powder coating or fusion-bonded epoxy type fastener coating system.
 - 1) Thermosetting powder coatings shall be at a minimum 1 MDFT with Xylan, Type E, Flour Kote #1, or thermoplastic fluoropolymer type fastener coatings specifically designed for that type of application.
 - 2) Fusion-bonded coated steel bolts, nuts, and washers, fittings, and bodies shall be coated with a minimum 6 MDFT epoxy coating per AWWA C213. Surface preparation shall be SSPC SP-10 (near white).
3. **Stainless Steel Fasteners (bolts, nuts, T-bolts, washers, etc.):**
 - a) Stainless steel bolts, tee bolts, nuts, and washers shall be Series 304 or Series 316 for the specific environment of use.
 - b) Stainless steel bolts and nuts shall be provided with an anti-galling lubricating compound or coated with a 1-mil fluoropolymer or equal fastener coating system to aid in preventing galling.
4. CorTen® bolts are not acceptable for buried, submerged, or immersed fitting or piping locations.

5. Bolts and nuts shall be adequately labeled to provide traceability of the material and producer.
 - a) The identification mark shall be cast, forged or stamped on the bolt and nut. Painted markings are not acceptable.
 - b) The bolt and nut manufacturer shall provide information on the type of material provided and corresponding identification mark, and country of origin.
 - c) Markings and traceability requirements shall be in accordance with the Industrial Fasteners Institute and AWWA C111.
6. All bolts and nuts shall be installed according to manufacturer's requirements including the use of anti-galling lubricant compound or use of a thermosetting fluoropolymer type coating for stainless steel materials.

If galling or seizing of the nut and bolt occurs they shall be cut off and replaced with a new nut and bolt.

U. Stainless Steel Fabrication And Passivation:

1. Utilize Type L grade stainless steel for all items to be welded.
2. During fabrication, handling, and installation take necessary precautions to prevent mild carbon steel impregnation of stainless steel members.
3. Utilize brushes (stainless steel, non-metallic), grinding wheels (aluminum oxide discs), and tools intended for stainless steel and not used previously for carbon steel work.
4. Degrease and clean prior to welding with non-chlorinated solvents.
5. Weld stainless steel with approved materials and techniques.
6. Clean and remove contamination, remove weld heat tint, and repassivate welds per ASTM A380 and ASTM A967.
7. After treatment, visually inspect surfaces for compliance.
8. Pack stainless steel parts and pad mild steel fork lift forks and use straps instead of metal chains to handle stainless steel parts to avoid iron contamination of stainless steel.
9. After installation, visually inspect stainless steel surfaces for evidence of iron cross contamination, rust, oil, paint, and other forms of contamination. Repair as required and re-inspect.

V. Pipe And Fitting Field Coating Repair Materials:

1. Field repair incidental pipe and fitting coatings and linings in accordance with this specification section.

2. Field repair coating shall be compatible with factory coating and linings and be approved by factory coating manufacturer for repair on their products.
3. **Field Coating Repair Materials:**
 - a) **Heat Shrink Sleeve and Sleeve Repair Materials:** Heat shrink sleeve repair materials shall consist of either heat shrink sleeve in tube form or heat shrink patch kit depending on size and shape of repair. Acceptable heat shrink products are:
 - 1) Covalence WaterWrap sleeve or PERP Repair Patch Kit available from Protection Engineering, Pittsburg, CA;
 - 2) CANUSA Aqua-Shield Aqua-Sleeve or CANUSA CRPK Repair Patch Kit available from CANUSA, Inc., Houston, TX;
 - 3) Or approved equal.
 - b) **Tape:** Cold-applied field repair polyethylene repair type coatings shall consist of suitable primer and minimum 35-mil thick patch/repair/joint tape with aggressive adhesive and release liner, 4-inch or 6-inch width. Suitable primer shall be provided with the repair coatings as recommended by the repair-coating manufacturer. Acceptable products are:
 - 1) Tapecoat H35 Gray by The TAPECOAT Company, Evanston, IL;
 - 2) Polyken 1027 primer and Polyken 934-35 tape by Tyco Adhesive (Polyken Kendall) Mansfield, MA;
 - 3) Tek-Rap 200-23 Series primer and Tek-Rap 280 tape by Tek-Rap, Inc., Houston, TX;
 - 4) Or approved equal.
 - c) **Epoxy Repair Coatings:** Provide 100-percent epoxy coatings that can cure under wet or dry conditions. Acceptable products are:
 - 1) A 788 Splash Zone Compound by Koppers, Pittsburgh, PA;
 - 2) Aquata Poxy A-6 by Raven (King Adhesive Corporation), St. Louis, MO;
 - 3) Protal 7125 Repair Coating by Denso North America;
 - 4) Tnemec FC 22 Epoxoline by Tnemec Company Incorporated, Kansas City, MO;
 - 5) HBE-95 WG High Build Epoxy, CANUSA-CPS, Inc., Houston, TX;
 - 6) Or approved equal.
 - d) Four-layer petrolatum wax-tape system (AWWA C-217) intended for burial conditions.

- 1) Completed buried system shall consist of a minimum four-layer system consisting of a primer, mastic filler, petrolatum wax tape and an outerwrap.
- 2) Acceptable petrolatum coating systems are:
 - I. Denso Pipe and Fittings Petrolatum System by Denso Products, Houston, TX;
 - II. No. 1 Wax-tape Coating Systems for buried locations by The Trenton Corporation, Ann Arbor, MI;
 - III. No. 2 Wax-tape Coating Systems for above grade and vault applications by The Trenton Corporation, Ann Arbor, MI;
 - IV. Or approved equal.

W. Corrosion Test Equipment: Obtain and furnish the following equipment and materials for corrosion and tracer wire functional testing. Arrange and have test equipment at project site before construction begins:

1. One Heavy Duty, Digital Multimeter, with case and test leads. Instrument shall be suitable for field conditions, be sealed to meet IP 67 waterproof and dust conditions, meet CAT IV minimum 600-volt rating, and comply with IEC and ANSI electrical safety standards. Acceptable digital multimeters are:
 - a) Model No. 27 II or Fluke 28 II by John Fluke Mfg. Co., Inc. Everett, WA;
 - b) Amprobe Model HD-160C by Amprobe Test Tools (formerly Wavetek Instruments, Beckman) Everett, WA;
 - c) Or approved equal.
2. Two copper-copper sulfate reference electrodes with cone shaped tip:
 - a) Model 6B by Tinker and Rasor, San Gabriel, CA;
 - b) Model RE-5C by M C MILLER Co., Vero Beach, FL;
 - c) Or approved equal.
3. One 32-oz. bottle of Copper-Copper Sulfate Anti-Freeze Solution as manufactured by Tinker and Rasor, San Gabriel, CA; M C MILLER Co., Vero Beach, FL; or approved equal.
4. One $\frac{3}{4}$ -pound bottle of Copper-Copper Sulfate Crystals as manufactured by Tinker and Rasor, San Gabriel, CA; M C MILLER Co., Vero Beach, FL; or approved equal.

The test equipment shall be stored at the project site and shall be maintained in accurate, working condition. The test equipment shall be available to Engineer and Owner for testing purposes.

- X. Manufacturer's Certifications:** Manufacturer's certifications of materials and installation are provided at the end of this specification section. Attachments A, B and C shall be completed and submitted as outlined in the attachments.

8B.3 EXECUTION

A. General:

1. All materials and equipment associated with pipe connecting wires, joint bonding, test stations, reference electrodes, galvanic anodes, insulating joints, and casing insulators as shown and specified herein shall be furnished and installed by the Contractor.
2. Coordinate installation of the specified work as necessary such that installation of the items herein specified can be completed concurrently with pipeline installation. Test leads shall be installed only during pipe installation. Items not installed before backfilling of the pipe shall be installed at the Contractor's sole expense. Additional excavation of pipe after backfilling shall be minimized to protect pipe and coating from possible damage. Galvanic anodes shall be only installed at the same time as metallic fitting installations are being constructed.
3. Nothing included or omitted in this specification shall relieve the Contractor of the obligation of providing a complete and satisfactory pipeline that is electrically continuous, electrically isolated, and provided with a functioning cathodic protection system with test stations as specified.
4. **Weather Conditions:**
 - a) Installation of the corrosion protection system components, such as splices, bonds, and wire installation shall only be allowed when ambient temperature are above ten degrees (10°) F (-12° C.) and rising to minimize wire and insulation damage.
 - b) Materials shall be stored in covered and heated storage units to maintain minimum temperatures above restricted minimum temperatures stipulated by material manufacturer.
5. Do not thermite (exothermic) weld, pin braze, weld, or utilize open flame or torches in areas of flammable vapors or air borne particles, where a fire or explosion could result.
6. Install and work around above grade and buried AC powerlines and gas pipelines with extreme care, follow minimum separation distances per foreign company requirements and regulations. Do not work next to powerlines during times of high lightning activity.
7. Installations shall be completed per the National Electrical Code (NEC), and as specified in this section.

B. Material Storage and Handling:

1. Store materials in secure, protected location in accordance with material manufacturer's recommendations. Store thermite weld materials, reference electrodes and prepackaged galvanic anodes off the ground and keep them dry at all times.

2. Equipment or materials damaged in shipment or in the course of installation shall be replaced. Immediately remove from site all mechanically damaged materials.
3. Prepackaged corrosion control items shall be handled with care to prevent loss of backfill material. Do not lift, lower, or hold anodes and reference electrodes by the lead wire.
4. Do not allow reference electrodes to freeze. Store in protected area, off the ground. Utilize before expiration of shelf life.

C. Pipe Joint and Fitting Bonding:

1. To form an electrically continuous pipeline and associated appurtenances, the joints of all buried metallic pipe, vault, and manhole piping and all appurtenances, adapters, tees, elbows, restrained joints, valves, and fittings including hydrant and blow-off piping shall be electrically joint bonded. All joints including all bolted and restrained joints shall be joint bonded, except those joints specified to be threaded, welded, or insulated. Blow off and hydrant pipe and fittings shall also be bonded. **DO NOT bond across insulating joints.**
2. Various components of metallic fittings (thrust restraint devices, follower rings or glands, etc.) on plastic or ductile iron pipelines shall be bonded together to provide an electrically continuous fitting or appurtenance.
3. Place metallic fitting bond wires on top quadrant of pipe or fitting to bolt pattern area or where flange edges are to minimize damage to internal coating or joint materials. Bonding can be completed above grade prior to fitting assembly.
4. Wire connections to pipes or fittings shall be as specified under WIRE CONNECTIONS.
5. Install one insulated joint bond wire or bond strap per joint on all pipe or fittings 10-inches in diameter or smaller. Install a minimum of two or more insulated joint bond wires per joint on all pipe or fittings 12-inches in diameter or larger for redundancy.
6. Bond wire size may be No. 4 AWG on pipe sizes equal to or smaller than 15-inch diameter. Place bond wires on top quadrant of pipe.
7. Factory Coated or Tape Coated Pipe Joints: Use insulated stranded copper joint bond wires or insulated copper strap bonds for bell and spigot locations where heat shrink sleeves are not used.

Use insulated stranded copper joint bond wires or insulated strap bonds for all other locations where joints or fittings are already coated such as for factory coated bolted fittings, where a heat shrink sleeve is not specified.

8. Bond bolted restrained type joints, multiple segmented fitting sections, and metallic gland connection pieces on fittings on plastic pipe, and metallic pipe into cathodic protected metallic fittings or pipe with single No. 12 AWG stranded insulated copper wires with sleeves. Length of pigtail bond wire as required. Bond across the joint with the specified number and larger sized bonds listed above based on pipe size and material.

9. Joint bonding of cast iron soil pipe is not required unless specifically shown on Drawings. Joint bonds for cast iron soil pipe and fittings and high silicon cast iron pipe and fittings shall be in accordance with the manufacturer's recommendations.
10. Bronze wedges, restrained joints, bolted or compression sleeved wires or copper straps, thrust restraints, or welded "Z" bars are **NOT** acceptable methods of achieving electrical continuity.

D. Wire Connections:

1. The electrical connection of copper wire or copper strap to metallic (steel, cast iron, and ductile iron) surfaces shall be by the thermite weld method. Prepare surface and make connections in accordance with the thermite weld manufacturer's recommended procedures and these specifications, which ever one is more stringent.
2. Provide adequate ventilation and safety equipment (gloves, safety glasses, etc.) and follow safety and training requirements as recommended by the thermite weld material manufacturer. Avoid contact with hot materials. Remove or protect fire hazards in the area during the thermite welding operations.
3. Assure that pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the pipe or fitting wall's integrity or damage the lining in any way. Do not use on Cast Iron Soil Pipe (ASTM 74-93).
4. Complete thermite or pin brazing weld connections at locations and in a manner that does not damage sealing materials, gaskets, plastic pipe, and/or coatings, and/or polyethylene encasement. Maintain minimum 2-inch separation from pipe O-ring gasket in accordance with the pipe or fitting manufacturer recommendations.
5. Complete thermite weld wire connections on horizontal surfaces, if at all possible. Thermite weld connections to vertical surfaces should be minimized and only completed if approved by the Engineer. Conduct horizontal type thermite weld wire connections to fire hydrant risers and pipe stubs in horizontal positions above grade prior to installation in excavations. Pin brazing type connections can be completed in horizontal or vertical positions.
6. All connections to stainless steel materials, copper, and light wall steel tubing (0.035-inch or less), shall be either with a silver soldered connection (silver brazing) or a physical type connection.
7. Connections to stainless steel fittings and appurtenances can be made with a ring tongue terminal placed under a bolt or a soldered connection as approved by the Engineer. Thermite weld connections to stainless steel are NOT allowed.
8. **Exothermic Thermite Weld Method:**
 - a) The Contractor is responsible for repair of any damage to pipe, fitting, lining, or coating that is a result of the thermite weld process.
 - b) Make thermite weld connections at locations that will not damage pipe gasket or internal linings exposed to liquid.

- c) The electrical quality and resistance of the connection is dependent on proper adhesion of the welded connection to the pipe or fitting surface. Observe proper thermite weld material selection, safety precautions, surface preparation, and welding procedures as recommended by the material manufacturer.
- d) Use cast iron type charges for all cast iron and ductile iron pipe and fitting thermite weld connections. Use steel type charges for all steel pipe and fitting thermite weld connections. Utilize correct sized mold (as shown on metal tag on graphite mold) based on wire and pipe or fitting size and type. Utilize correct type and size of charges for each connection based on wire and pipe or fitting size and type. Cartridge charge type and size in grams is shown on box and charge tube.
- e) The wire and cable to be exothermically welded shall be clean, bright, and dry. Clean all wire that is contaminated with oil and grease in accordance with the thermite weld manufacturer's recommendations. Remove all corroded cable including the individual strands.
- f) Before the connection is made, clean the surface to bare metal by making a two-inch (2-inch) by two-inch (2-inch) window in the coating, and then filing or grinding the surface with a grinding wheel to produce a bright (white) metal finish.
- g) All power grinding shall be with a vitrified type-grinding wheel. The use of resin, rubber, or shellac-impregnated type grinding wheels is not recommended by the thermite weld manufacturer and will not be acceptable.
- h) Contractor shall take appropriate actions for existing coatings with asbestos to minimize worker exposure and to contain, handle, and dispose of asbestos per regulations.
- i) After the surface is cleaned to a smooth, white metal finish, lightly tap the pipe surface with a sharp tool (back of claw hammer or metal chisel edge, etc.) to produce dimples to improve surface profile and adhesion for the weld material.
- j) In certain high humidity conditions, cold weather, or on cold or wet surfaces, preheating of the metal surface and/or molds may be required to improve successful connections and minimize porous welds.
- k) Exothermic welding should be completed immediately following preparation of the metal surface before surface flash rusting or oxidation can occur.
- l) Where specified, wire sleeves shall be firmly attached to the end of the wire before thermite welding to the metal surface. Wire and sleeve shall be clean and dry. Wire shall extend 1/4-inch out of field formed sleeves. Factory formed sleeves shall be provided with end of sleeve beveled or angled so that wire is exposed to thermite weld material.
- m) Utilize exothermic weld packing compound around mold as required on irregular or small weld surface areas to seal bottom of welder mold to prevent molten metal leakage.

- n) Replace worn molds at intervals as recommended by the thermite weld manufacturer to minimize the possibility of molten metal leakage during the thermite welding process.
 - o) The mold and base metal should always be clean and dry. Avoid moisture and contaminants in mold and materials being welded as this may result in spewing of hot molten material.
 - p) Place a metal disk in the bottom of the graphite mold and then pour in the weld material or place the prepackaged weld material cartridge in mold. Squeeze the plastic cylinder to get all of the starting powder out. Close the mold body lid.
 - q) Place the graphite mold on the prepared pipe surface and install the wire in the slot at the bottom of the mold. Confirm that the mold and wire provide a proper fit and that the mold is in intimate contact on all sides with the surface being welded to. Hold the wire and mold steady and firm on the pipeline or fitting surface.
 - r) Ignite the weld material with the spark gun or electrical starter depending on type of charge. Lightly tap the mold body during the ignition fusion process. Carefully remove the graphite mold after the exothermic fusion process is completed approximately 15 to 20 seconds later.
 - s) Care should be taken during the thermite welding process, as the exothermic process produces a molten liquid metal that is extremely hot, 2,500° F (1,400° C) and will result in a local release of smoke. Do not watch the bright light (flash) or breathe the fumes from the thermite welding process.
 - t) Do NOT sharply hit or move the graphite mold body during the thermite weld process to minimize expelling the molten metal out of the graphite mold.
 - u) The graphite mold should not be touched or allowed to come in contact with the pipe coating or other flammable or meltable materials, as it is extremely hot. Carefully clean the slag out of the graphite mold body with the mold cleaner intended for that mold size and type.
 - v) After the weld connection has cooled, remove slag, visually and physically test quality of connection by tapping with a hammer and lightly pulling on the wire. The completed weld should visually present a good appearance of a well-formed connection with a minimum loss of weld material or splatter. All portions of the wire and sleeve shall be covered with the weld material. Remove and replace all visually defective, porous, or poor welds.
- Completed thermite welds shall visually not demonstrate a porous or honeycombed appearance or have lava tubes or holes. They shall not be easy to physically remove from the pipe or fitting surface. If any of these conditions occur, Contractor shall use charges from a different batch of materials and contact the exothermic materials manufacturer immediately.
9. Narrow or Small Fitting Attachment Locations: Thermite weld connections on metallic fittings, restraint devices, sleeve type coupling rings, mechanical joint follower gland rings, or bolted restraint joint ring type joints, and couplings where only a small or narrow metallic

surface is available shall be carefully done to not damage the internal lining, O-ring, or damage the fitting.

- a) Two or more wires can be attached under the same thermite weld connection as long as the bond or pigtail wires are not being connected to the same structure under the same thermite weld.
- b) Apply approved mastic packing material around mold to keep molten thermite material in place. Do not hold mastic packing material in-place with bare or gloved hands.
- c) Completing connections prior to complete fitting assembly and installation of the fitting into the trench in a manner to allow the thermite weld connection to be made to a level surface on top of the fitting is the preferred method.
- d) Vertical connections after the fitting is assembled and in the trench are a more difficult type connection to make.
- e) Coat with epoxy repair coating as provided in these specifications.

10. Pin Brazing Method: Authorized BAC pin brazing manufacturer technical representative, or approved equal shall demonstrate and observe proper connection procedures for a minimum of ten (10) connections for each type of joint bond and test wire size and type utilized on project.

- a) Weld connection shall be cleaned to bare white metal similar to that for thermite weld type connections.
- b) Load pin brazing gun with proper sized and type of pin and ferrule. Only direct to metal type connections are allowed. No threaded bolts or nuts are allowed.
- c) Activate pin brazing unit to braze the cable and lug to the pipe or fitting surface.
- d) Visually inspect, physically test with hammer, and conduct digital low resistance ohmmeter (DLRO) electrical test of completed connection.
- e) Repair coat similar to thermite weld type connections.

11. Silver Solder:

- a) Use for electrical connection of copper wire to thin-wall steel tubing (0.035-inch wall or less), copper, or stainless steel pipe and pin brazing connectors.
- b) Silver solder connections shall be made at locations on the edge of the fitting lip at a location that will not damage the rubber gaskets.
- c) Before the connection is made, clean and flux the area around the connection with a suitable flux as recommended by the pipe manufacturer for the materials being soldered.

- d) Weld the copper sleeved wire to the fluxed area with the suitable silver brazing alloy in such a manner that the completed connection is free of cracks or crevices in accordance with the solder manufacturer's recommendations.
 - e) After the connection is completed, allow to cool, and remove the remaining flux by wire brush and solvent clean (SSPC-SP-1).
 - f) Clean and coat silver soldered connections on copper and steel appurtenances with epoxy repair coating. Stainless steel connections do not require coating.
- 12. Ground Clamps:** Wire connections to copper service pipe shall be made with a bronze clamp. Clean service pipe and wire and attach to service pipe in accordance with ground clamp manufacturer's recommendations.
- 13.** Pipe coating shall be protected during thermite welding or soldering procedures. Coating damaged by welding or weld splatter shall be repaired per this specification section. Welded area shall be allowed to cool to "warm to touch" condition prior to application of primer and field coating.
- 14.** Each bond wire shall be visually and physically tested before coating according to the "Electrical Continuity Testing" section of this specification. Remove, replace or install additional joint bonds at all locations not passing electrical or physical tests.
- 15.** All damage to pipe or fitting coatings or linings, gaskets or O-rings, and/or plastic pipe or fittings, etc., shall be repaired by the Contractor at his sole expense.

E. Wire Connection Coating:

- 1. Clean weld area and coat with epoxy repair coating per manufacturer's directions over each completed connection after testing.
- 2. In cold weather, store coating repair materials in a heated location and keep warm until use.
- 3. The pipe and factory-coating surface shall be clean and dry before application of epoxy repair coating.
- 4. **Liquid Repair Epoxy Coating Application:** Wire connection shall be completed with a liquid one hundred percent (100%) repair type coatings. All bare surfaces, including exposed wire shall be coated.
 - a) Complete surface preparation and apply one hundred percent (100%) solids, low temperature epoxy repair coating in accordance with coating manufacturer's directions.
 - b) Total minimum dry film thickness shall be 20-mil, apply in multiple coats if required by manufacturer of specific coating utilized.
 - c) Allow coating to cure to sufficient degree to prevent damage to coating, prior to handling and backfilling.

- d) Strictly follow minimum cure time recommended by coating manufacturer based on surface and ambient temperatures.
5. All exposed metallic surfaces not covered by the epoxy repair coating, shall be repaired per PIPE AND FITTING COATING REPAIR.

F. Prepackaged Galvanic Anode Installation:

1. General:

- a) Remove plastic or paper shipping wrap from prepackaged anode prior to placement. Galvanic anodes packaged in cardboard type chip-tube shall be thoroughly perforated just prior to installation.
- b) Install galvanic anodes a minimum of 1-foot below the fitting invert and 3- to 5-feet from buried metallic piping or 3-feet from metallic fittings to be protected.
 - 1) Space galvanic anodes equally around the fitting, pipe section, or appurtenance. Locate at bottom edge of pipe trench as shown on the Drawings or as specified.
 - 2) If two or more anodes installed at the same location, place on opposite sides of the pipe or fitting.
 - 3) Provide a minimum anode spacing of 5-feet from other unprotected pipelines.
 - 4) In general, the standard location for galvanic anodes shall be on the north or east side of the fitting, valve or other metallic appurtenance being protected. However, it may be necessary to adjust the location dependent upon underground obstructions. **The installed location of the anodes shall be marked on the Contractor's red line drawings.**
- c) Handle prepackaged anode with care. Damage to the anode, anode to wire connection, backfill material or prepackaged anode bag will require replacement of the entire assembly.
- d) Place anode in native earth backfill. Do not use pipe zone bedding material.
- e) Earth backfill around each anode shall be thoroughly compacted to a point 1-foot above the anode. Backfill material around each anode shall be native soil free of roots, organic matter, trash, and rocks. Stop backfill at specified grade to allow for placing of topsoil, pavement, or concrete, when required.
- f) All anode wires shall be buried a minimum of 36-inches below finish grade. Wires shall be handled with care. Splices or damage to the insulation on any wire shall be repaired in accordance with WIRE INSULATION REPAIR and be approved by the Engineer.
- g) Electrical connection of the anode wire to steel, cast or ductile iron metallic pipe or fittings shall either be directly to the pipe or fitting by the thermite weld or pin brazing type method or through a test station with shunt as shown on the Standard Details.

- h) Electrical connection of the anode wire to stainless steel fittings shall either be directly to the stainless steel fitting with a silver solder or ring tongue terminal physical type connection or through a test station with a shunt as shown on the Standard Details.
- i) Electrical connection of the anode wire to copper services shall either be directly to the copper service by a ground clamp or through a test station with a shunt as shown on the Standard Details.

2. Installation:

- a) Each buried or submerged metallic (steel, ductile, or cast iron) pipeline section, appurtenance, intermediate pipe restraint, valve, or fitting shall receive a minimum of one galvanic anode of size necessary to comply with these specifications.
- b) All metallic valves, blow-offs, air valves, or fittings located in vaults on plastic pipeline, which will be either continuously or intermittently under the water table shall be cathodic protected as if buried. Place galvanic anode inside vault and attach directly to metallic fitting.
- c) Each buried or submerged stainless steel appurtenance (tapping sleeve, coupling, service saddle, repair clamp, etc.) shall receive a minimum of one galvanic anode of size necessary to comply with these specifications.
- d) Install a minimum of one each or more 17-pound or 18-pound galvanic anode for each copper service line on each side of the curb stop or insulated coupling at the tie-in to the existing service line.
- e) Install a minimum of one each or more 17-pound or 18-pound galvanic anode for each connection to existing ductile, cast iron, steel, or prestressed concrete cylinder pipe (PCCP) piping. Type of prepackaged anodes is project specific and is specified in the general notes of the plans.
 - 1) Prepackaged zinc galvanic anodes for protection of metallic pipe and fittings in lower resistivity soils (1,500 ohm-cm or below).
 - 2) Prepackaged magnesium galvanic anodes for protection of metallic pipe and fittings in soils with higher resistivity soils (1,501 ohm-cm or above).
- f) Where two or more metallic fittings are adjacent to each other, install joint bonds as specified in WIRE CONNECTIONS, and install the specified quantity of galvanic anodes for each metallic pipe section, appurtenance, valve, or fitting used in conjunction with nonmetallic pipe.
- g) At the Contractor's option with the Engineer's approval, larger anodes may be used in place of multiple smaller anodes for a group of bonded metallic components on non-metallic piping provided the same total bare weight of galvanic anode is used. Maximum separation distance shall be 5-feet on fittings to be protected with one anode, if multiple fittings are bonded together.
- h) For metallic (steel, ductile iron and cast iron) fittings (including but not limited to include service saddles and Foster adaptors), where specified coating thickness is not

provided or specified holiday testing and/or 100-percent holiday free coatings are not completed by the fitting manufacturer, or bare fitting is coated with petrolatum tape type coating system, Contractor with Engineer's approval shall install one specified size larger anode or double the number of anodes for each fitting as listed in Table 8B.9.

If one 17-pound or 18-pound anode is required per Table 8B.9 and coating thickness is not as specified nor has the fitting been certified 100% holiday free, then at Contractor's option, install either a 30-pound or 32-pound anode or two 17-pound or 18-pound anodes.

- 1) Existing fittings that are exposed and coated with a four-layer petrolatum tape type coating system shall receive double the number of anodes specified or the next larger anode size shown in these specifications.
 - 2) For example, if a bare fitting (16-inch or less) is exposed and petrolatum tape coated, it shall receive two 17-pound or 18-pound size or one 30-pound or 32-pound anode.
- i) The minimum number of anodes to be installed on buried or submerged factory coated metallic fittings (including but not limited to include service saddles and Foster adaptors), pipeline sections, or appurtenances with non-metallic pipelines shall be in accordance with Table 8B.9.

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Table 8B.9 Minimum Quantity and Size of Galvanic Anodes

DESCRIPTION	0" TO 30" DIAMETER
Single Coated Metallic Fitting	1-17 pound(#) Magnesium (Mg) or 1-18# Zinc (Zn) Anode (Certified) 2-17# Mg or 2-18# Zn Anode (Noncertified)
Two (2) Metallic Fittings (5-foot separation MAXIMUM)	1-17# Mg or 1-18# Zn Anode (Certified) 2-17# Mg or 2-18# Zn Anode (Noncertified)
COATED Fire Hydrant or Blowoff Assembly (coated tee, valve and hydrant) with PVC main and 6-inch PVC lead less than 10 feet long	1-17# Mg or 1-18# Zn Anode (Certified) 2-17# Mg or 2-18# Zn Anode (Noncertified)
COATED Fire Hydrant or Blowoff Assembly (coated tee, valve and hydrant) with PVC main and 6-inch METALLIC lead less than 10 feet long	2-17# Mg or 2-18# Zn Anode
1-inch up to and including 2-inch copper service line	1-17# Mg or 1-18# Zn Anode
Existing metallic pipe tie-in, concrete encased stub piece or on existing metallic main at new service tap	1-17# Mg or 1-18# Zn Anode
Existing metallic pipe LEAK location	2-17# Mg or 2-18# Zn Anode

Notes: 1) **Certified** – Coating meets specified minimum thickness, has been 100% holiday tested and certified by manufacturer; 2) **Noncertified** – Coating meets specified minimum thickness, but has not been 100% holiday tested and has not been certified by manufacturer; 3) 1-30 pound (#) Magnesium (Mg) or 32# Zinc (Zn) anode may be utilized in lieu of 2-17# Mg or 2-18# Zn anodes.

G. Test Station and/or Tracer Wire Access Box Installation:

1. Cathodic protection test stations and tracer wire access boxes of the types indicated shall be installed and located as specified herein and as shown on the Drawings. Current span wires, reference electrode, coupon, plastic reference pipe, or resistance probe shall be installed only at test station locations indicated on test station schedule.
2. Install test wires to pipe and tracer wires only at time of pipe installation along with the necessary reference electrode, coupons (minimum of two each), plastic reference monitoring pipe, drain/ground anode, or resistance probes if required before the pipe is backfilled and compacted around. Install sufficient wire to reach test station final location. Test station boxes can be completed at a later date. Contractor shall protect wires from damage if not terminated in test station or junction box at the time of pipe installation.
 - a) **Test station or tracer wire access box types shall be installed on metallic pipelines or fittings as shown on test station schedule or drawings per the test station types as follows:**

Install flush-mounted test stations at specified galvanic anode installation locations on metallic fittings on plastic pipeline sections.

b) Tracer Wire Access Boxes:

- 1) Install flush-mounted tracer wire access boxes at each end of all plastic pipe runs and at specified locations on plastic pipeline sections.
 - I. Install tracer wire access boxes at each end of all plastic pipe runs whether shown on the test station and tracer wire access box schedule or drawings or not.
 - i. This includes plastic water services between the curb stop and the building being served.
 - ii. In the instance of private plastic water services, the tracer wire access box shall be placed within the street right-of-way adjacent to the curb stop or within a utility easement.
 - II. Install tracer wire access boxes at locations shown on test station and tracer wire access box schedule found in drawings at maximum of five hundred feet (500') for in-town transmission or distribution type pipelines or shorter spans.
- 2) **Cased Crossings:**
 - I. Install flush-mounted tracer wire access boxes on each side of cased crossings, if specified in the plans.
 - II. Install flush-mounted tracer wire access boxes on each side of cased crossings where anodes connected directly to casings, if specified in the plans.
3. If test stations or tracer wire access boxes are installed in locations other than those called out in the plans or if locations change, the Contractor shall record the location in the as-constructed plans using station-offset or coordinates relative to the project horizontal datum. Recorded location shall be within 0.5 feet of true location of test station or tracer wire access box.
4. Color-code wires per specifications before installation of wires in conduit or backfilling of the test station wires.
5. Wherever possible test stations or access boxes shall be located directly over the centerline of the pipeline. In locations, where pipe is in field and parallels a fence, install test station or access box next to and on parallel fence line. Desired maximum offset distance from pipe centerline shall be 15 feet or at edge of right-of-way which may be up to 50 feet as directed by Engineer for future physical protection of test station.
6. Locate next to other above-grade facilities and structures for protection, where possible. Install in protected locations that does not restrict intended use of the land, outside roadways, cultivated fields, and irrigation facilities.
7. Install at protected locations such as next to pipeline structures, fences and road crossings. The Engineer shall determine the final location. Changes in the location of any test station shall be reviewed and approved by Engineer prior to installation.

8. At test stations, where multiple metallic fittings are bonded together by No. 12 AWG bond wires on plastic pipelines, install one test lead to first fitting from the test station and second test lead to farthest fitting from the test station. This will allow the continuity between the metallic fittings to be confirmed.
9. Flush mounted test stations or tracer wire access boxes shall be located directly over pipeline, except in areas of heavy traffic conditions. Where heavy traffic conditions exist, locate to the side of the street.
 - a) Compact under, and install flat support blocking or brick under flush mounted test stations or tracer wire access boxes for support. Install supports and concrete collar around test station to prevent settlement.
 - b) Install a minimum 6-inch thick concrete collar either in a minimum 2-foot square pad or 3-foot diameter circular pad around flush mounted test stations or tracer wire access boxes as shown on Drawings. Shape selected by Engineer.

See Detail 13942FH for co-located test stations and tracer wire access boxes.

- c) When installed in roadway, rotate flush mounted test station or tracer wire access box square concrete slabs so that slab points toward traffic flow.
 - d) Concrete collar and test station lid shall be set level and flush with the top of curb, sidewalk or roadway. Concrete collar and test station or tracer wire lid shall be set level and ½-inch to 1-inch higher than finished grade in open dirt and lawn areas. Test stations and collars that settle or are set too low or high shall be replaced at Contractor's sole cost.
 - e) Provide sufficient slack in test wires to allow terminal block to extend a minimum 18-inches out of test station box or tracer wire access box.
 - f) Do not connect test or tracer wire terminal board to flush mounted test stations or tracer wire access box lids that may short wires together.
10. Test wires shall be attached to the pipe as specified under WIRE CONNECTIONS.
11. Test wires shall be provided with sufficient slack and looped or coiled at the test station and pipeline to prevent the wire from being unduly stressed or broken during backfilling operations. Install test wires to top test station terminals. Wires shall be installed in a continuous length.
12. All cathodic protection and test wires shall be buried a minimum of 36-inches below finished grade.
13. Test stations shall be located and identified by test station location tags. Contractor shall supply the type and number of location tags sufficient for the number of test stations listed in the Test Station Schedule for the project. One UNSTAMPED tag shall be left in each test station. City personnel or the Engineer will stamp the tags with appropriate identification at the time of final acceptance testing.

14. Wire connections to test station terminals shall be with crimp-on ring tongue terminals, or Lug-it connectors, except where terminal strips with tubular clamps are used.
15. Connect wires to test station terminals as shown on Drawings. Wire type, color code, and marker tag designations as shown on Drawings and specified under PRODUCTS in this section, shall be maintained throughout project.
16. Seal completed wire connection test lead terminals with electrical sealer for all buried flush mounted test stations and at above grade test station locations where high atmospheric corrosion may occur. Clean surface of all dirt, wax, grease and other surface contaminants. Protect or mask other areas from spray application, vigorously shake aerosol can before and during spray application. Apply 2-mil to 3-mil layer from a 12-inch to 15-inch distance in light even coats. Allow to dry then close test station.

H. Wire Insulation Repair:

1. Wire splices shall be made with suitably sized Type C compression connectors as specified or mechanically secured and silver soldered. Inline type butt connectors or wire nuts are **NOT** allowed. Split bolts are **NOT** allowed unless silver soldered and both wires are No. 10 AWG wire or smaller.
 2. Minor insulation damage to small cathodic protection wires (equal to or smaller than No. 8 AWG) shall be repaired by spirally wrapping (minimum of 50 percent overlap) with two layers of high voltage rubber splicing tape and two layers of vinyl electrical tape coated with an approved electrical seal coat in accordance with the tape manufacturer's installation instructions, or with a specially fabricated splicing kit, or made with an approved epoxy insulated splice kit.
 3. Insulation damage or splices to large cathodic protection cables (No. 4 AWG or larger) shall only be made with an approved epoxy insulated splice kits.
 4. Install splice kits in accordance with the product manufacturer's written directions. Allow splice kits to cool and set before moving.
 5. All wire splices and wire insulation repair locations shall be observed by the Engineer. Contractor shall record the location in the as-constructed plans using station-offset or coordinates relative to the project horizontal datum. Recorded location shall be within 0.5 feet of true location of splice or insulation repair.
- I. **Warning Tape:** Bury warning tape, if specified, above all underground cathodic protection cable and conduit. Warning tape shall be placed approximately 12-inches above pipe and structures being identified or at specified depths as required in other sections of this contract document or shown on the details. Align parallel to and within two (2) inches of the centerline of conduit or cable run.

J. Plastic Pipe Tracing Wire:

1. Insulated stranded copper or copper clad steel tracer wire shall be installed on all non-metallic pipe sections.

2. Tracer wire shall be electrically continuous between tracer wire access boxes with no accidental electrical contacts (shorts) to metallic fittings, anodes or other structures.
3. Tracer wire shall be centered on top of plastic or non-metallic pipeline and securely held in place with tape meeting requirements provided under TRACER WIRE. Tracer wire shall be taped with two full circumferential wraps, or as approved by the Engineer, at a maximum distance of every five feet (5') along the pipe and within one foot either side of each fitting. Standard-duty Duct Tape is not an acceptable product.
 - a) The first wrap of tape shall be started under the tracer wire, adhesive side down, inverted after six inches so adhesive side is up and wrap continued around pipe circumference. With tracer wire on top of first wrap, flip tape over so adhesive side is down and wrap around pipe circumference ending past the start of the initial tape wrap.
 - b) The intent is to have the tape adhere to itself with the tracer wire in between the two adhesive sides to minimize tracer wire falling from top of pipe.
4. For short sections of plastic pipe (less than 50 feet) where two No. 12 AWG wires are already used to bond the metallic fittings to the metallic main line, the No. 12 AWG bond wires can be utilized in place of the tracer wire. These No. 12 AWG bond wires are not the same as test station wires. If listed on the test station schedule, install separate wires for the test leads.
5. For plastic pipe installed by directional drilling in bores, install tracer wire in heavy duty plastic conduit bored in at the same time as the waterline. Terminate tracer wires at each bore pit in flush type tracer wire access boxes.
6. Do not attach tracer wire directly to metallic fittings or appurtenances.
7. Install tracer wire access boxes and terminate tracer wires at all fire hydrant assemblies, each end of all casings, bores, building or tank walls, and each end of a pipe run.
8. Install tracer wire access boxes at the end of all plastic pipe runs whether shown or not on the test station and tracer wire access boxes schedule and/or drawings.
9. Maximum tracer wire span distance shall be: The maximum span distance shall be five hundred feet (500') or less.
10. On private plastic water service lines, tracer wire shall extend from the curb stop to the residence. The tracer wire from the plastic service line shall be clamped to the copper service line using a brass ground clamp. A single tracer wire shall be extended up the curb stop box and terminate above ground in order to trace both to the main and to the residence.
11. Field terminate tracer wires in accordance with the drawings by:
 - a) Bring end of tracing wire leg from each pipe direction to above grade surface elevation by installing a flush tracer wire access box. One tracer wire end shall come from each pipe direction.

- b)** Terminate tracing wire above grade at tracer wire access boxes located next to pipe appurtenances (vaults, vent pipes, blow-offs, or at fire hydrant bases).
 - c)** Tracer wire shall be electrically continuous between tracer wire access boxes locations. Tracer wires shall not be terminated in valve boxes or below grade.
 - d)** Color code and connect the tracer wire for each tracer wire span to the same terminal location on the terminal board depending on wire direction (i.e., top terminal board location for north or west tracer wire directions and bottom terminal location for south or east tracer wire directions).
 - e)** Make inline splices and insulation repair as specified under section WIRE INSULATION REPAIR only when observed the Engineer.
 - f)** Terminate tracer wire in a flush tracer wire access box per test station schedule in accordance with the Engineer's direction.
 - g)** If tracer wires terminate in vault, drill vault wall or roof above maximum waterline and terminate outside vault in an access box next to the vault or vent pipe (if present). Seal penetrations to minimize entry of liquid in the conduit or vault structure. Terminate tracer were in vaults next to ladder to allow easy access for attachment only if approved by Engineer.
 - h)** Install tracer wire access boxes and terminate each tracer wire span in box with ring tongue terminals connected to the tracer wire access box terminal board.
 - i)** Provide jumper bond wires with ring tongue terminal connected across the two tracer wire span terminals on the test station terminal board for transmission-type projects. The jumper bond wire shall be installed under another nut on the front side of the terminal board to bond consecutive spans together while allowing easy temporary removal for testing.
- 12.** Test tracer wire for continuity with an approved method in accordance with the specified functional testing per this specification section, prior to final acceptance of the pipeline installation. Functional testing to be completed by Contractor, as a minimum, shall consist of the following:
- a)** Test tracer wire prior to placement of curb and gutter.
 - b)** In roads and streets, test tracer wire after placement of road base but prior to placement of pavement.
 - c)** At end of project after all excavations have been completed.
 - d)** Use of pipeline locator equipment for functional testing is not recommended.
 - e)** For transmission-type projects, bond all of the tracer wire spans together with jumper bond wires or shorting straps and conduct final round of Contractor tracer wire functional testing for the entire length of transmission main project.

K. Insulated Joints:

1. Insulated joints shall be installed to electrically isolate the pipeline from other structures.
 - a) Insulated joints shall be located at connections to existing metallic pipe, where loose bonded coated (polyethylene encased) pipe is connected to tight bonded coated pipe, where concrete encased pipe is connected to dielectric coated pipe, where cathodically protected pipe connects to pipe not intended to have cathodic protection, and where shown. Install a flush test station at each buried insulated joint.
 - b) Insulated joints shall be utilized to isolate electric motors and magnetic water meters from cathodically protected pipeline sections.
 - c) Provide electrical shields at locations where other metallic structures (pipe supports, conduit, bare ground wires, etc.) either may be in contact with piping or are in close proximity to the pipe. Install on both sides of the insulated joint to maintain electrical isolation.
 - d) Install electrical shield between pipelines at crossings or close parallels as shown on drawings or specified.
 - e) Install copper insulating joints where copper services are connected to metallic water mains and at service meters or curb stops where ownership of copper service lines changes.
2. Install insulated joints at locations listed on test station schedule or as shown on the Drawings. Coordinate and carefully follow both insulating joint and manufacturer's recommendations for large diameter insulating joint installations.
3. Allowable insulating joint type for maximum pipe diameter size for buried locations shall be 36-inches for insulating flanges.
4. Install insulated joints above grade in buildings, vaults, and manways whenever possible. Insulated joints shall be installed a minimum of 12-inches clearance above floor or from wall to allow access for testing and maintenance. Maintain clearance from other structures or provide electrical shields as required to maintain electrical isolation.
5. Insulated joints shall be provided over-voltage protection with ground cells, flange protectors, or polarization cell replacement (PCR) devices at locations as shown on the Drawings and/or listed on the test station schedule.
6. **General:**
 - a) Carefully align and install insulating joints according to the manufacturer's recommendations to avoid damaging insulating materials.
 - b) Support, backfill, and compact pipe and fitting in accordance with the insulator and pipe manufacturer's recommendations that will not cause leaks or damage to the insulating joint.

- c) Test each insulating joint as specified under FUNCTIONAL AND PERFORMANCE TESTING this specification section. Test buried insulating joints before and after backfilling.
7. **Insulated Flanges:** Install insulated flanges, sleeves, and washers according to manufacturer's recommendations.
- a) Bolts for insulated flanges and restrained couplings should be undersized or holes slightly oversized to allow installation of insulating sleeves. Bolts shall be threaded for full length. Coordinate with fitting manufacturer and insulating flange manufacturer.
- b) Clean flange surface and holes of all dirt, grease, oil, and contamination. Examine flange and bolt holes for burrs, sharp edges, or spurs. Remove any irregularities.
- c) Confirm that both flange faces are free of all pits, dents, gouges, grooves, corrosion, burrs, or other type of irregularities. Both flange faces surfaces shall be smooth with a finish no rougher than 250 RMS. Refinish flange faces if surface too rough in accordance with flange insulator manufacturer's recommendations.
- d) Align flanges so that they are concentric and parallel and carefully install flange gasket to not damage sealing element. Do not use grease, lubricant or adhesives on either the flange faces or the flange gasket.
- e) Check bolts and nuts and clean as required. Apply non-conductive lubricant to all threads and flange side of nuts.
- f) Carefully align bolt holes to minimize damage to insulating sleeves during assembly. Line up bolt holes with non-tapering drift pins at a minimum three locations with 120° between locations.
- g) Carefully measure and adjust sleeve length as required to provide an air gap (space) between end of sleeve and nut after flange is tightened down, length as recommended by the insulator manufacturer.
- h) Carefully insert sleeves over bolts and place insulating washer and metal washer over end, line up holes in fitting, install bolt with sleeve into place. Do not force bolt insulating sleeves into the flange hole. If force is required to insert the insulating sleeve, check alignment and readjust as required. Replace any damaged insulating bolt sleeves as required. Place insulating washer and metal washer on opposite end with nut.
- i) Two insulated washers, one on either side of insulator are required for all above grade applications. Insulating washers are only required on the unprotected pipe side for buried or immersed insulated flange locations.
- j) Tighten bolts a few turns at a time in sequence and procedure as recommended by insulator manufacturer until all bolts are uniformly tightened. Repeat torque sequence; repeat tightening in sequence to final torque. Do not exceed manufacturer's recommended pounds per square inch of pressure during initial torque-up. Go completely around flange rechecking all bolts for correct torque. All bolt tightening shall be done in accordance with insulating flange manufacturer's recommended sequence

with torque wrenches (mechanical or hydraulic) or with a stud tension measuring device.

For all above grade flange locations recheck bolt tightness after system has been pressurized.

- k) Visually inspect for physical damage to insulating sleeves or washers, replace if cracked or damage observed. Check flanges (visually with a flashlight, calipers, or feeler gauge, etc.) for a section that may not be aligned correctly and which may show a gap or separation. Correct in accordance with the insulating flange manufacturer.
 - l) Test for electrical isolation before top-coating.
 - 1) In above grade locations where high humidity or high contamination present, seal with rubber caulk type sealer or provide and install above grade flange protectors at insulating flange locations in corrosive or wet environments in accordance with specific product manufacturer's instructions.
 - 2) In buried locations, coat after assembly and testing as specified.
- 8. Insulated Couplings:** Install insulating boots and insulated flexible couplings in accordance with the manufacturer's recommendations and AWWA Standard C219.
- a) Clean and install insulated boot (sleeve, band, etc.) over end of each pipe, two boots required for each location. Push insulating boot into place over pipe until small insulating boot lip contacts pipe end. Clean, lubricate, and install other sealing gaskets, middle ring and follower rings according to manufacturer's recommendations.
 - b) Line up and install bolts as required. Tighten bolts a few turns at a time in sequence and procedure as recommended by insulator manufacturer until all bolts are uniformly tightened. Do not exceed manufacturer's recommended pounds per square inch of pressure during initial torque-up. For all above grade locations recheck bolt tightness after system has operated.
 - c) Insulating boot should be visible on either side of coupling when completed.
 - d) Bond buried coupling body into protected pipe side with pigtail wires.
 - e) Test for electrical isolation both before top-coating insulated couplings and after burial.
- 9. Restrained Insulated Joints:**
- a) If insulated flexible coupling is utilized electrically isolate restraining rod assembly with insulating G-10 sleeves and washers on both ends of restraining rods. Oversize restraining device bolt holes or undersize restraining rod as required to not damage insulating materials and still meet specified restraining strength and pressure requirements. For buried or submerged insulator locations, only install insulating sleeve and insulating washer on unprotected end of restraining rod assembly.
 - b) Test restrained rod installation for electrical isolation prior to top-coating or backfill. Coat per specification if not stainless steel or fusion-bonded coated rod, with heat

shrink, liquid 100-percent moisture cured epoxy repair coating, or petrolatum tape coated.

c) Test buried insulator both prior to and after backfill.

10. Buried Flange Insulator Coating: At buried insulated flange locations, Contractor shall coat exterior portion of insulating joint after assembly and testing. At Contractor's option, coating shall consist of either:

a) Four-layer petrolatum wax-tape system intended for burial conditions per AWWA C217.

b) A 100-percent solids epoxy mastic coating, filler tape top-coated with two layers of specified pipeline joint/repair tape coating, or heat shrink sleeve.

11. Copper Service Line Insulators: Install insulated corporation ball valves, insulated curb ball valves, and insulated service fittings at locations as shown on the Drawings in accordance with the service liner manufacturer's instructions.

L. Insulating Wall And Floor Sleeves:

1. Coordinate and install pipe and wall sleeve to provide a smooth uniformly round shaped opening per pipe and modular seal manufacturer's recommendations.
2. Coordinate pipe fabrications, wall sleeves and modular seal types and sizes for wall or floor penetrations to allow for the watertight sealing system used at wall or penetrations. Install pipe and wall sleeve or core wall to provide uniformly round shape, grind as required to control weld seam height per pipe and modular seal manufacturer's recommendations. Factory grind all welds at wall sleeve location and a minimum of 12-inches on either side of wall or floor opening, do not remove parent material during grinding operations. Repair coating as required.
3. Insulating wall or floor sleeves or seals shall be installed according to manufacturer's recommendations. Wall sleeves shall be positioned so that the water stop (collar) is centered in the width of the opening and the water stop (collar) contacts the opening evenly for the minimum 1-inch distance or more as recommended by the modular seal manufacturer. Center the pipe in the opening and adequately support on both sides. Make sure that the pipe, opening, and wall sleeve are clean, smooth, and round. Install the exact number of links per the manufacturer's recommendations for the size and type of opening and pipe diameter.
4. Install the links in the same direction so that the bolts can be tightened from the inside of the building or vault location. Assemble, insert, align, and evenly tighten insulating modular seal in accordance with the manufacturer's installation instructions in a manner that will not damage pipe coating or insulating modular seal. Position centering blocks for casing end seal type installations on bottom one-half of the pipeline as recommended by the modular seal manufacturer. Position the modular seal so that it is centered in the wall sleeve and that when tightened down it provides an even, uniform spacing in the wall sleeve. Take up free slack in bolts and then tighten each bolt clockwise in opposing succession at torque and sequence as recommended by seal manufacturer. Evenly tighten the individual bolts the maximum number of turns as recommended by the

manufacturer until the sealing elements bulges around all of the pressure plates. Do not use power tools to tighten stainless steel bolts. Completed installation shall provide long term insulated and sealed (liquid tight) connection between pipe and floor or wall opening, sleeve, or casing.

5. Insulating wall or floor sleeve shall be positioned to allow adjustment from interior side of building and vault locations and exterior side of water bearing structure locations.
6. For water bearing structures or for locations if shown on the drawings, install a second modular wall seal.

M. Electrical Shields: Install electrical shields between sections of cathodically-protected pipe and pipe supports connected to or sitting on unprotected supports or structures in order to maintain electrical isolation as shown on the drawings.

N. Factory And Field Repair Coatings For Piping, Fittings And Accessories:

1. Miscellaneous Incidental Metallic Pipe, Fitting, and Appurtenance Coating Field Quality Control Testing.
 - a) Conduct quality control testing in the field on miscellaneous factory coated fittings and appurtenance in accordance with this specification section. Conduct dry film thickness measurements and holiday test to confirm conformance with specifications and referenced standards.
 - b) Conduct dry film thickness measurements in accordance with SSPC PA-2 with exception that the specified thickness is the absolute minimum.
 - 1) A minimum of ten (10) dry film thickness measurements shall be completed on each 40-foot length of pipe.
 - 2) A minimum of two dry film thickness measurements shall be completed for each fitting or appurtenance.
 - c) Conduct 100-percent holiday inspection of all factory-applied coatings.
 - d) Repair with provided repair kits or repair materials recommended and approved by the original coated material manufacturer.
2. Field testing, surface preparation and coating for field coating or repair of damaged coating on new or existing pipe, piping, appurtenances, and fittings shall be in accordance with this specification section.
 - a) Inspect and repair any coating or lining damage with original manufacturer's approved repair kit.
 - b) Follow coating manufacturer's written directions for surface preparation and repair coating application.
 - c) Utilize potable water approved materials for coatings and linings in contact with potable water.

- d) Complete surface preparation and field repairs of coatings and linings in accordance with coating manufacturer's written directions.
 - e) Observe environmental (weather and surface temperature) requirements.
 - f) Allow to cure in strict accordance with coating manufacturer's recommendations based on surface and weather conditions prior to handling, burial, or exposure to liquids.
3. External incidental pipe and fitting field or repair coatings shall consist of external coating materials and repair procedures as recommended by the original pipe or fitting coating manufacturer.
- a) Fusion-bonded epoxy coated items shall be repaired with epoxy repair coating outlined in these specifications.
 - b) Epoxy coated items shall be repaired with repair coating from the original coating manufacturer.
 - c) Spot coating damage at thermite weld connections shall be repaired with a 100 percent solids epoxy repair coating that can cure in either wet or dry conditions.
 - d) Field epoxy coat, tape coat or heat shrink sleeve, short sections of buried metallic piping such as vent pipes, blow-off assemblies, and pipe stubs to be concrete encased under or next to buildings or tanks if not already coated with an approved specified factory applied coating system.
 - e) Provide epoxy coatings for pipe and fittings in vaults if not already coated with an approved specified factory applied coating system. Provide epoxy/polyurethane enamel type coating system for above grade appurtenances if not already factory coated with an approved specified factory applied coating system.
4. Repair or field coatings shall overlap intact factory coating a minimum of ½-inch in all directions from the damaged area.
5. Install coated valves, fittings, and miscellaneous metallic pieces in a manner that will not damage coating or lining.
6. Coat rebar or tie-rods where utilized as tie-downs or thrust restraints and exposed to soil or liquid with fusion-bonded epoxy, heat shrink tube, or four-layer petrolatum tape system.
7. Fitting and Appurtenance Fasteners (Bolts, Nuts, and Similar Items): Series 300 stainless steel or fusion-bonded epoxy coated depending on specified location.
- a) All bolts and nuts shall be installed according to manufacturer's requirements including the use of anti-galling lubricant compound for stainless steel materials.
 - 1) If galling or seizing of the nut and bolt occurs the bolt shall be cut off, nut and bolt discarded and replaced with a new nut and bolt.

- 2) Exercise care to assure tightening of the nut is against the flange or gland and not due to galling or seizing.
 - b) Conduct testing of Series 300 stainless steel materials with magnet to confirm Series 300 stainless steel provided prior to installation.
8. If approved by the Engineer, coat miscellaneous hard to coat items with four-layer petrolatum tape system or heat shrink repair coating.

O. Field Coating For Incidental Steel And Ductile Iron Pipe Stub Pieces And Fittings:

- 1. Field tape coat or heat shrink sleeve, short sections of buried metallic piping such as vent pipes, blow-off assemblies, and pipe stubs to be concrete encased under or next to buildings or tanks if not already coated with an approved specified factory applied coating system.

Bituminous asphaltic coating does not qualify as an approved factory tight bonded coating.

- 2. Follow the coating manufacturer's recommendations and the referenced AWWA Standards.
 - a) Acceptable products are specified under PIPE AND FITTING FIELD COATING REPAIR MATERIALS.
 - b) Solvent wipe per SSPC SP-1 if required to remove contamination.
 - c) Hand tool clean small surfaces only. Abrasive blast location areas larger than 12-square inches. Abrasive blast to SSPC SP-10 (Near White) for external surfaces and SSPC SP-5 (White) for internal surfaces.
 - d) Repair coating should overlap intact factory coating a minimum of 4-inches in all directions from the damaged area.

e) Field Tape Coating:

- 1) For hand taping, provide suitable field primer (if required) and 35-mil field applied repair tape with aggressive adhesive and release liner, 4-inches or 6-inches width. Apply with 50-percent overlap for a minimum 70-mil hand tape coating system.
- 2) Pipe shall be clean and dry prior to and during application of both primer and tape coating. Tape shall be applied in a spiral wrap with a 50-percent overlap in accordance with AWWA C209.

f) Heat Shrink Field Coating:

- 1) For heat shrink sleeve installation, provide suitable filler material and heat shrink sleeve material for pipe size required or heat shrink repair patch as required for field repair.

- 2) Pipe shall be clean and dry prior to and during installation of heat shrink sleeve. Install sleeve in accordance with AWWA C216, the coating manufacturer's recommendations and these specifications.

g) Moisture Cure 100-Percent Epoxy Repair Coating:

- 1) Spot coating damage locations and hard-to-coat fittings and appurtenance (edges, flanges, tie-rods, bolts, nuts, etc.) locations shall be coated with a moisture cure 100-percent epoxy repair coating.
- 2) Clean and prepare surface in accordance with repair coating manufacturer's directions. Wire brush and sand as required. Clean per SSPC SP-1 if required.
- 3) Mix epoxy repair coatings at ratio and for time per repair coating manufacturer's directions. Apply to repair area by hand application method (brush, trowel, spatula, etc.) and smooth out onto intact coating in accordance with repair coating manufacturer's recommendations.
- 4) Provide manufacturer recommended 25-MDFT to 30-MDFT coating thickness.

h) Petrolatum Tape Coating System:

- 1) Field apply petrolatum tape system for all restraining fittings and rods if not already coated with an approved specified factory applied coating system or stainless steel.
- 2) Provide petrolatum system coating at insulated location to existing pipe or appurtenances exposed as part of connection installation if not already coated.
- 3) Provide petrolatum system coating for brass or bronze service saddles if not protected by a galvanic anode system.
- 4) Provide petrolatum system coating for isolated copper fittings if not already protected by a galvanic anode system.
- 5) For petrolatum system tape installation per AWWA C217, provide suitable primer, filler material (mastic), petrolatum tape and outer wrap material for burial application.
 - I. Pipe or fitting shall be clean and dry prior to and during installation of four-layer petrolatum wax tape system.
 - II. Install petrolatum tape system in accordance with coating manufacturer's instructions and these specifications.
 - III. Apply primer in an even uniform manner to entire tie rod, pipe, or fitting surface area to be coated to achieve minimum primer thickness of 3-mil wet film thickness. Increase amount of primer at and work primer into threads, cavities, pits, angles, edges, and other irregular areas. Apply primer with brush or glove.

- IV. Apply mastic immediately after application of primer, drying of primer is not required. Work and mold mastic into irregular shapes to fill voids and achieve a uniform contour to provide a smooth even support for the tape coating system to avoid bridging.
 - V. Apply one or more petrolatum tape layer(s) in a spiral wrap fashion around the tie rod or fitting circumference with a 50-percent minimum overlap onto the proceeding layer.
- 6) Apply the 10-mil PVC outer wrap tape layer in a spiral fashion around the pipe or fitting with a 50-percent minimum overlap.
 - 7) The completed petrolatum coating system shall be a minimum of 40 MDFT and adhere tightly to the coated structure and present a smooth unwrinkled appearance.

P. Functional And Performance Testing:

1. **Functional Testing:** Provide the Engineer with a minimum of seven (7) calendar days advanced notice before beginning functional testing unless the Engineer is already scheduled to or already onsite doing construction observations (services during construction). At such a time as the Engineer may indicate, the Contractor, in the presence of the Engineer, shall conduct the following functional testing.

2. **Test Stations:**

- a) Test each test station wire for continuity, correct termination, and proper connection and color code to the designated structure.
- b) Test each wire for continuity with potential measurements to a copper/copper sulfate reference electrode and with an ohm-meter between wires prior to connecting together on the terminal board.
- c) Test the buried permanent reference electrode, if present, test leads and potentials to confirm correct operation. If the reference electrode does not provide equal or near equal potential measurements to a portable copper/copper sulfate reference electrode (convert if required depending on buried reference electrode type), then saturate the buried reference electrode by pouring water down the plastic monitoring pipe. Retest the buried reference electrode again several days later after the buried reference electrode is moist.

Testing results shall be recorded on Form 8B.1 and transmitted to the Engineer following completion of functional testing.

- d) Do not connect reference electrodes to pipe test lead terminals.

3. **Electrical Insulating Joints:**

- a) Test each insulated joint after assembly for electrical isolation in accordance with the insulation checker manufacturer's written instructions and by potential measurements.

- b) Test insulator with radio frequency type insulator checker prior to backfill. Utilize a radio frequency type meter that is self-zeroing such as the Model RF-IT manufactured by Tinker and Razor or approved equal.
- c) Test and provide electrical isolation as specified in accordance with NACE SP0286.
- d) Buried electrical insulating joints shall be tested both before and after burial.
- e) Test for electrical isolation at electrical shields between pipe and pipe supports and at wall or floor penetrations.
- f) All defective electrical shields, pipe supports, wall penetrations, insulating joints, and/or damaged or defective insulation parts shall be corrected or replaced by the Contractor at his sole expense.

4. Tracer Wires:

- a) Demonstrate correct installation of tracer wire access boxes and tracer wire termination and continuity by field functional tests.
- b) **Acceptable tracer wire continuity testing methods shall consist of:**
 - 1) Electrical continuity (four wire) type testing that demonstrates voltage (potential) changes at end of line from temporary connection to a DC current source at far end of the tracer wire;
 - 2) Verification of a voltage measurement to a test battery with the tracer wire as one side of the two-wire circuit; and/or
 - 3) Use of commercially-available cable continuity verification testing equipment utilized in accordance with the test equipment manufacturer's written instructions.
 - 4) Use of typical pipe locating type equipment IS NOT an acceptable continuity verification test method. This type of equipment may walk through tracer wire breaks.
- c) Contractor shall utilize Form 8B.2 for recording continuity testing results and transmit results to the Engineer following functional testing. Test data will be reviewed by the Engineer prior to acceptance of tracer wires and access boxes.
- d) **Potential Functional Testing Outcomes:**
 - 1) Similar or equal potential change observed at the far end and start of tracer wire span is an indication of an electrically continuous tracer wire with no accidental shorts.
 - 2) No change at the far end of the span being tested indicates a possible break in the tracer wire.
 - 3) A difference between the potential measurement value at the start of the test span and the measured value at the far end of the test span may be an indication of an

accidental electrical contact or short to one or more metallic fittings. The greater the potential difference, the more likelihood of a short or the larger the surface area shorted to.

- 4) Typically measured potential values at the start and end of a tracer wire span should be approximately 10-volts to 12-volts or higher at each end, if the source is a full-charged 12-volt battery. Measured potentials lower than 10-volts at either end indicate a possible accidental short to one or more metallic fittings or structures.
- 5) If potentials below 10-volts are measured, conduct additional testing with a cable-type locator and A-frame to locate and correct possible tracer wire insulation damage or accidental shorts to other metallic structures.
 - I. Operate cable locating equipment in accordance with equipment manufacturer's instructions at the lowest output settings possible in order to be more sensitive to problem locations and to minimize walk-through (jumping the discontinuity or break) or missing accidental contacts.
 - II. Carefully observe changes in signal strength and depth measurement values as likely indicators of either possible breaks or accidental contact locations.
 - III. Once discontinuity is located, test the span from the opposite direction to confirm discontinuity location prior to commencing with repair(s).
- 6) Repair all insulation damage found. Retest tracer wire span with 12-volt potential test to confirm all possible shorts have been found and corrected.

5. Galvanic Anode Energizing and Testing:

- a) Some of the galvanic anodes will be connected to the pipe or the fittings in the anode test stations with calibrated shunts after the installation of the galvanic anode cathodic protection system is completed.
- b) Test continuity of each anode lead wires and to confirm correct type of anode with potential measurements prior to connecting to test station terminal board.
 - 1) Zinc anodes shall read a minimum of -1.0 volt to a copper/copper sulfate reference electrode, and
 - 2) High potential magnesium anodes shall read a minimum of -1.6 volt to a copper/copper sulfate reference electrode.
- c) Do not connect anode and pipe or fitting leads together with a shunt in test stations until the Engineer is present.

Q. Final Testing:**1. General:**

- a) After construction is complete and all of the individual functional tests have been completed by the Contractor, the Engineer shall conduct final testing on the pipeline to ensure proper installation of the specified corrosion protection items.
 - b) At Contractor's option, he may be present during this final testing if desired.
2. **Galvanic Anodes Cathodic Protection System:** The Engineer shall make sufficient tests throughout the network of galvanic anode cathodic protected metallic pipe and fittings to determine proper installation of the galvanic anode cathodic protection system.
 3. **Tracer Wire and Access Boxes:** The Engineer shall make sufficient tests to determine proper installation of the tracer wire and access box system. The acceptance method for the final tracer wire continuity testing shall be by the potential shift method.
 4. Any construction defects or incomplete work identified by the Engineer during functional or final testing or during warranty inspections shall be located and corrected by the Contractor at his sole expense including additional Engineering, retesting, and inspection time.
 5. Any defects in the corrosion protection system, (including but not limited to fitting, valve or other metallic appurtenance coating or lining, tracer wire continuity, pipeline electrical isolation, cathodic protection system, test stations, etc.) when discovered, shall immediately be repaired and retested in a timely manner (warranty work shall be completed within 60 days of notice) by the Contractor in accordance with this specification and the written product manufacturer's instructions as reviewed and approved by the Engineer.

Contractor shall provide the Engineer with a minimum of 7 day advanced notice before beginning warranty repairs.

8B.4 METHOD OF MEASUREMENT

- A. **Galvanic Anodes:** Anodes and the attachment of lead wires to fittings, valves or other metallic components shall be incidental to each of the new metallic water system components installed. No separate measurement will be made.
- B. **Cathodic Test Stations:** Shall be counted on a per each basis for "Test Station". The cathodic test station bid item shall include all items specified and necessary to install and to make operational a complete test station.
- C. **Tracer Wire and Tracer Wire Access boxes:**
 1. Tracer wire and all accessory items necessary for the installation of an electrically-continuous tracing system shall be incidental to the pipe installed. No separate measurement will be made.

2. Tracer wire access boxes for 2-wire, 45-mil insulation shall be counted on a per each basis for "Tracer Wire Access Box – 2-wire".
 3. Tracer wire access boxes for more than two tracer wires with 45-mil insulation or wires greater than 100-mil insulation shall be counted on a per each basis for "Tracer Wire Access Box – Large".
- D. Service Line Insulators:** Shall be incidental to the service line installed. No separate measurement will be made.
- E. Coating Repairs:** Coating repairs to fittings, existing coated pipe or project specified coated pipe are considered incidental to the pipe or fittings installed. No separate measurement will be made.
- F. Functional Testing:** Functional testing of the cathodic protection and tracer wire systems shall be incidental to the water system components installed. No separate measurement will be made.
- G. Final Acceptance Testing:** Will be performed by the Engineer.

8B.5 BASIS OF PAYMENT

- A. Galvanic Anodes:** No separate payment will be made.
- B. Cathodic Test Stations:** Payment shall be made for "Test Station" and shall include all items specified and necessary to install and to make operational a complete test station.
- C. Tracer Wire and Tracer Wire Access boxes:**
1. No separate payment will be made for tracer wire and all accessory items necessary for the installation of an electrically-continuous tracing system.
 2. Payment for tracer wire access boxes for 2-wire, 45-mil insulation bid item shall be made for "Tracer Wire Access Box – 2-wire" and shall only include furnishing and installing a complete tracer wire access box.
 3. Payment for tracer wire access boxes for more than two 45-mil insulation tracer wires or tracer wire with 100-mil+ insulation bid item shall be made for "Tracer Wire Access Box – Large" and shall only include furnishing and installing a complete tracer wire access box.
- D. Service Line Insulators:** No separate payment will be made.
- E. Coating Repairs:** No separate payment will be made.
- F. Functional Testing:** No separate payment will be made.
- G. Final Acceptance Testing:**
1. No separate payment will be made.

2. If final acceptance testing shows inconsistencies in the cathodic protection or tracer wire systems, the Contractor shall be responsible for all labor, equipment and materials necessary to determine the cause and the location of the inconsistencies and the repair of the problem.

The Contractor is also responsible for the costs of subsequent acceptance testing associated with the cost of repairs incurred by the Engineer.

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**FORM 8B.1
STRUCTURE-TO-REFERENCE ELECTRODE POTENTIAL AND GALVANIC ANODE
MEASUREMENTS**

Project Name						Tested By	
Contractor						Date	
Station	Test Location Structure and Wire Size, Type & Color Code	Test Station Type	Anode Shunt (mV)	Milli-Amps	Potential (Volts) OFF	Potential (Volts) ON	Notes (1 mV = 100 mA)

Submitted By: _____ **Date:** _____

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FORM 8B.2

CITY OF RAPID CITY CORROSION PROTECTION - PLASTIC PIPE SYSTEMS	SHEET _____ OF _____ DATE: _____
---	---

TEST TAKEN BY: _____

TRACER WIRE POTENTIAL AND ELECTRICAL CONTINUITY TEST WORKSHEET

CLIENT: _____	PROJECT#: _____
PROJECT: _____	LOCATION: _____

PURPLE COLOR: _____ NORTH (1) OR _____ WEST (2) TAPE STRIPS / TOP 2 TERMINAL LOCATIONS
 GRAY COLOR: _____ SOUTH (1) OR _____ EAST (2) TAPE STRIPS / BOTTOM 2 TERMINAL LOCATIONS
 FROM STATION _____ + _____ TO STATION _____ + _____ TOTAL DISTANCE (FT) = _____

PROVIDE A SKETCH BELOW (INCLUDE TEST CONNECTIONS, DISTANCES, STATIONING, ETC.):

START TEST POINT STATION (STA)	COLOR, NUMBER & CURRENT (ON Test)	ON/OFF POTENTIAL SHIFT	COLOR, NUMBER & CURRENT (ON Test)	ON/OFF POTENTIAL SHIFT	COLOR, NUMBER & CURRENT (ON Test)	ON/OFF POTENTIAL SHIFT
END TEST POINT STA						
<i>TEST LOCATIONS AND WIRE CONNECTIONS (+ TO GROUND / - TO TRACER WIRE) AT BATTERY</i>						
AT START, TOP TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT START, TOP TERMINAL COLOR _____ POTENTIAL AT TEST (RECORD mVolt and mAmp)		V		V		V
AT START, BOTTOM TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT START, BOTTOM TERMINAL COLOR _____ POTENTIAL AT TEST (RECORD mVolt and mAmp)		V		V		V
AT END, TOP TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT END, TOP TERMINAL COLOR _____ POTENTIAL AT TEST		V		V		V
AT END, BOTTOM TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT END, BOTTOM TERMINAL COLOR _____ POTENTIAL AT TEST		V		V		V
RESULTS/NOTES:						

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FORM 8B.3

INDIVIDUAL WIRE JOINT BOND RESISTANCE TEST SUMMARY

PIPE NAME/SIZE _____ CONTRACTOR _____
 DATE _____ SHEET _____ OF _____

<i>Conduct test at DLRO min.10 A. current output 6,000 micro-ohm setting</i>							Calibration Time/By
MAXIMUM ALLOWABLE JOINT WIRE RESISTANCE							
No. 2 AWG Joint Bond Wires Structure or Bond Type and Length		Micro-Ohms					
Two (2) Joint Bond Wires (18" Long)							
Three (3) Joint Bond Wires (18" Long)							
Test No.	Pipe Joint No.	Approx. Pipe Stationing at Joint Measured	Measured Bond Resistance (Micro-Ohms)	Type of Joint & Pass Yes or No. If No Add Another	Additional Bond Micro-Ohms	Time Measured	Tested By

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**ATTACHMENT A and B
PVC PIPE AND DUCTILE IRON FITTINGS CERTIFICATION**

CONTRACT: _____ DATE: _____

CONTRACTOR: _____

PIPE MANUFACTURER: _____

DUCTILE IRON FITTINGS MANUFACTURER: _____

This certification applies to PVC pipe and Ductile Iron Fittings, as may be provided by Manufacturers as identified above. Omission of any required project certification herein does not relieve the Pipe or Ductile Iron Fittings Manufacturers or the CONTRACTOR from responsibilities of performance as may be required by the Contract Documents.

For pipe and pipe materials, joints and fittings to be supplied on the above referenced contract, the listed Pipe Manufacturer certifies as follows:

1. The PVC pipe shall be manufactured as specified in Section 8A – Water– of the Standard Specifications.
2. Ductile Iron Fitting Manufacturer shall provide required coatings and linings in accordance with Section 8B – Corrosion Protection - Plastic Pipe Systems – of the Standard Specifications.

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**ATTACHMENT A
PVC PIPE CERTIFICATION**

IN CERTIFICATION THEREOF:

Name: _____

Title: _____

Signature: _____

Company: _____

Address: _____

Phone: _____ E-mail: _____

This certification shall be sent by the Pipe Manufacturer to the CONTRACTOR, and then forwarded by CONTRACTOR to the ENGINEER. This certification shall be signed by an authorized representative (with power of attorney) of the Pipe Manufacturer.

NOTARY:

The above certification was signed by _____ of _____

in my presence on _____, 20_____

Notary Public: _____

My Commission Expires On: _____ 20_____

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**ATTACHMENT B
DUCTILE IRON FITTINGS CERTIFICATION**

IN CERTIFICATION THEREOF:

Name: _____

Title: _____

Signature: _____

Company: _____

Address: _____

Phone: _____ E-mail: _____

This certification shall be sent by the Ductile Iron Fittings Manufacturer to the CONTRACTOR, and then forwarded by CONTRACTOR to the ENGINEER. This certification shall be signed by an authorized representative (with power of attorney) of the Ductile Iron Fittings Manufacturer.

NOTARY:

The above certification was signed by _____ of _____

in my presence on _____, 20 _____

Notary Public: _____

My Commission Expires On: _____ 20 _____

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**ATTACHMENT C (Part 1)
MATERIAL HANDLING AND INSTALLATION CERTIFICATION**

CONTRACT: _____ DATE: _____

CONTRACTOR: _____

PIPE MANUFACTURER: _____

This certification applies to all plastic pipe, fittings, and materials as may be provided by Pipe Manufacturer as identified above. Omission of any required project certification herein does not relieve the Pipe Manufacturer or the CONTRACTOR from responsibilities of performance as may be required by the Contract Documents.

For pipe and pipe materials, joints and fittings to be supplied on the above referenced contract, the listed Pipe Manufacturer certifies as follows:

1. The Pipe Manufacturer has been present and observed the CONTRACTOR's work for the placement of the first feet of pipe from Station _____ to Station _____ for the dates of _____ to _____. During their observation of the CONTRACTOR, the CONTRACTOR was following the Pipe Manufacturer's recommendation for handling, storing, assembling and installing pipe, pipe joints, fittings, and repair procedures for coating and linings.
2. During the site visit, Pipe Manufacturer observed construction from Station _____ to Station _____ between the dates of _____ to _____. The Pipe Manufacturer has observed the CONTRACTOR's storage and handling of the pipe, assembly of pipe joints, fittings, and proper repair procedure for coatings and linings, where applicable, and all are in conformance with the Pipe Manufacturer's recommendations.

A trip report with summary of observations shall be attached to this certification and shall include any additional items that may be need to be addressed by the Contractor or problems resolved during site visits.

The Pipe Manufacturer has reviewed the Contract Documents and has taken into consideration the contract requirements governing pipe manufacture and installation as specified therein.

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**ATTACHMENT C (Part 2)
MATERIAL HANDLING AND INSTALLATION CERTIFICATION**

IN CERTIFICATION THEREOF:

Name: _____

Title: _____

Signature: _____

Company: _____

Address: _____

Phone: _____

E-mail: _____

This certification shall be sent by the Pipe Manufacturer to the CONTRACTOR, and then forwarded by CONTRACTOR to the ENGINEER. This certification shall be signed by an authorized representative (with power of attorney) of the Pipe Manufacturer.

NOTE: Attachment C is required to be completed by the Manufacturer for projects of any size diameter pipe when the total length of pipe is greater than 2,600 feet OR when project pipe diameters are larger than 12-inches and the total length of large diameter pipe is greater than 600 feet. Refer to Infrastructure Design Criteria Manual for further information.

SECTION 9

SANITARY SEWER

9.1 DESCRIPTION

A. General: This work consists of furnishing and installing sanitary sewer mains, manholes, service lines, and appurtenances. This includes all equipment, tools, materials, labor, and other incidentals to provide sewer mains and service lines complete and ready for use. The work also includes, but is not limited to, all necessary excavation, backfilling, compaction, testing, clean up, and restoration. All connections to the City sanitary sewer system, directly or indirectly, need to be designed and constructed in accordance with City Criteria.

B. Related Work:

Section 7	General Conditions
Section 8A	Water
Section 8B	Corrosion Protection – Plastic Pipe Systems
Section 11	Utility Excavation and Backfill
Section 18	Erosion, Sediment, and Water Pollution Control
Section 19	Incidental Work
Section 41	Utility Trench Resurfacing
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 92	Temporary Traffic Control
Section 112	Select Granular Backfill
Section 200	Controlled Low Strength Material
Section 203	Submittals
Section 205	Televising

C. Submittals: Shall be required unless otherwise specified in the detailed specifications or special provisions. The term "Submittals" includes, but is not necessarily limited to, manufacturer's product data sheets of pipe, manholes, appurtenances, and fittings. Submittals shall be submitted for the materials used on the project in accordance with the specifications and plans. All items included in Section 9.2 of this specification that are to be incorporated into the work shall be submitted to the Engineer for review.

All Submittals shall be made in accordance with Section 203.

Resubmittals shall be made in the same manner as Submittals, with changes clearly shown.

9.2 MATERIALS

A. Pipe: Sanitary sewer pipe up to and including 24 inches in diameter shall be Polyvinyl Chloride (PVC). Sanitary sewer pipe larger than 24 inches in diameter shall be

Reinforced Concrete Pipe (RCP) or Fiberglass Pipe (FRP). The use of materials other than those indicated requires the prior written approval of the Engineer.

1. **PVC Pipe and Fittings:** 4 inches through 15 inches diameter, shall conform to the requirements of ASTM D-3034, Type PSM, SDR-35 minimum. PVC pipe 18 inches through 24 inches diameter shall conform to the requirements of ASTM F679, minimum wall thickness T-1. PVC pipe shall be manufactured in a continuous extrusion process employing a prime grade of un-plasticized PVC plastic material that meets the requirements for this product as specified in ASTM D1784. The pipe shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, 12364-C, or 13364-B. SDR-35 is a minimum and the design engineer shall determine if depths and soil conditions require additional wall thickness.

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

Nominal laying lengths shall not be less than 12.5 feet, except shorter lengths may be used adjacent to manholes and for the installation of inline wyes and tees. Each length of pipe shall be marked, as a minimum, with size, SDR, "Sewer Pipe" and ASTM number.

2. **Reinforced Concrete Pipe (RCP) and Fittings:** In sizes 27 inches through 108 inches in diameter, shall conform to the requirements of ASTM C-76 and shall be manufactured using TYPE II cement. The pipe and fittings shall be manufactured at a precast facility that is certified by the American Concrete Pipe Association, is approved for supplying products to the South Dakota Department of Transportation, or as approved by the Engineer. Class of pipe shall be as shown on the plans or specified in the detailed specifications. Joints for RCP pipe shall meet the requirements of ASTM C-361 for concrete joints and confined rubber profile gaskets.
3. **Fiberglass Pipe (FRP):** The use of FRP pipe requires the design engineer to prepare a detailed specification for the material and requires the prior written approval of the Engineer to use the material specification.
4. **Sanitary Sewer Force Main:**
 - a) **Polyvinyl Chloride (PVC) Pipe and Fittings 4 Inch and larger** - Shall conform to Section 8A Water Piping Systems, subsection 8A.2 Materials and Section 8B – Corrosion Protection – Plastic Pipe Systems. PVC force main shall utilize a green dye resin for color in order to represent wastewater or a green locator ribbon with the word “sewer” stenciled shall be used.
 - b) **Ductile Iron Fittings 4 Inch and larger** - Shall conform to Section 8A Water Piping Systems, subsection 8A.2 Materials and Section 8B – Corrosion Protection – Plastic Pipe Systems and requires the prior written approval of the Engineer to use. A green locator ribbon with the word “sewer” stenciled shall be used.

- c) **High-density Polyethylene (HDPE)** - The use of HDPE pipe is allowed however the design engineer shall prepare and submit detailed specifications for the material and installation procedures. The detailed specifications shall be reviewed and approved by the Engineer prior to plan approval. The HDPE pipe shall incorporate a green stripe to indicate "sewer".

5. Sewer Service Pipe and Fittings:

- a) All gravity pipe and fittings shall conform to the requirements of ASTM D-3034, SDR-35.
- b) Service line cleanout caps shall be flush type cap. Cleanouts installed in travel surfacing shall have a frame and cover per the Standard Details.
- c) Force mains less than 4 inch diameter shall utilize HDPE. The use of HDPE requires the Contractor to submit detailed specifications for the material to the Engineer for approval of use.

B. Miscellaneous Pipe Materials:

- 1. **Pipe Couplings:** When coupling PVC pipe to PVC pipe a gasketed PVC repair coupling shall be used. A clamp style coupling shall generally be used when coupling dissimilar pipe materials or for coupling non-PVC pipes.

Clamp style couplings shall be Fernco-Strong back RC series repair couplings, or approved equal.

Nonshear reinforced banded style couplings shall be adjustable repair coupling with 300 series stainless steel shear ring as manufactured by Mission Rubber Company, Inc., PVC repair couplings, or approved equal shall be used on all pipe 6 inches in diameter or less. All couplings shall bear the manufacturer's identifying mark and size.

Increasing/reducing couplings will not be allowed.

- 2. **Caps/Plugs:** PVC caps and plugs shall be the gasketed or solvent welded sewer fitting type.

Concrete caps and plugs for non-PVC pipe shall be non-shrink grout placed continuously for a one foot or one pipe diameter, whichever is greater, into the pipe.

- 3. **Sewer Main Insulation:** Refer to Section 11 Utility Excavation and Backfill.
- 4. **Sanitary Sewer Force Main Fittings, Valves, and Ancillary Items:** Shall conform to Section 8A Water Piping Systems, subsection 8A.2 Materials and

Section 8B – Corrosion Protection – Plastic Pipe Systems. Tracer wire color shall be green.

C. Concrete Manholes:

1. **General:** Manholes shall be pre-cast reinforced concrete, manufactured using Type II cement, and shall have diameters as shown on the plans. The manholes shall be manufactured at a precast facility that is certified by the American Concrete Pipe Association, is approved for supplying manholes to the South Dakota Department of Transportation, or has been approved by the Engineer. Manholes 48 inches in diameter shall meet the current requirements of ASTM-C-478. Manholes with diameters larger than 48 inches shall have steel reinforcing that meets the requirements of ASTM C-76, Class 2. Upon request from the Engineer, the Contractor and/or supplier shall supply a test report from an independent testing laboratory showing compliance with this Specification.
2. **Manhole Bases:** Shall be precast integral (monolithic) with the barrel section and shall be cast to a minimum thickness of 6 inches.

Cast-in-place bases shall not be allowed unless pre-approved by the Engineer. When specified in the detailed specifications or shown on the plans, cast-in-place bases shall have a minimum thickness of 8 inches with concrete conforming to the requirements of Class M6, Section 56, and manufactured using Type II cement. Cast-in-place bases shall incorporate a water stop between the base slab and manhole barrel. The water stop material shall be American Colloid “Water stop – RX”, 1 inch x ¾ inch size or approved equal. The detailed specifications and use of this type of base shall be reviewed and approved by the Engineer.

3. **Cone Sections:** Shall be eccentric type with 27-inch opening.
4. **Flat Cover Slabs:** When shown on the plans or specified in the detailed specifications, shall be designed for H-20 loading and shall have an offset 27-inch diameter opening.
5. **Gasketed Joints:** Joints between manhole sections, and between manhole sections and flat cover slabs shall be rubber gasketed joints conforming to the requirements of ASTM C443. Gasket types shall be either the O-ring style, the profile style, or approved equal.
6. **Manhole External Joint Seals:** Shall meet the requirements of ASTM C877 Type III, and are required on all manhole joints. The wrap must provide a minimum seal width of 9 inches. Manhole external joint seal shall be Infi-Shield External Gator Wrap or approved equal. Manhole external joint seals shall be installed on all manholes where ground water is present and shall be installed in accordance with the manufacturer’s recommendations. Engineer will identify on the plans where external joint seals are required.
7. **Manhole Steps:** Shall not be provided.

- 8. Lifting Holes:** Penetrating through the manhole sidewalls are not permitted.
- 9. If an interior lift system is used:** Inserts shall be grouted flush with the interior of the manhole after placement, grouted with a non-shrink grout.

- 10. Non-Shrink Grout:** Shall conform to the following requirements:

Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7000 psi in 28 days. Approved manufacturers are:

“Crystex” - by L & M Construction Chemicals

“588 Non-Metallic, Non Shrink Grout” - by W.R. Meadows

“Master Flow 713” – by Master Builders

“SonogROUT 10K” – by Sonneborn

“Five Star Grout” – by US Grout Corp.

Or approved equal.

- 11. Manhole Inverts:** Shall be Class M-6 concrete per Section 56.

- 12. Pipe Connections to New Manholes:** Shall be constructed with a compression-type flexible connector cast into the manhole wall, as manufactured by A-Lok Products, Inc., or approved equal.

Alternatively, shall be constructed with a boot-type flexible connector consisting of a rubber gasket or boot, metal expansion ring, and double metal take-up clamps, as manufactured by Press Seal Gasket Corporation, or approved equal. A stainless steel “power sleeve” shall be supplied for connecting the boot to the manhole. The boots shall be type PSX as manufactured by Press Seal Gasket Corporation or approved equal. Rubber boots and gasket material shall meet or exceed ASTM C-923.

- 13. Pipe Connections to Existing Manholes:** Are not allowed unless prior approval of the Engineer has been obtained. If approved the connection shall be made by coring the existing manhole and installing a boot-type flexible connector consisting of a rubber gasket or boot, metal expansion ring and double metal take-up clamps, as manufactured by Press Seal Gasket Corporation, or approved equal. A stainless steel “power sleeve” shall be supplied for connecting the boot to the manhole. The boots shall be type PSX as manufactured by Press Seal Gasket Corporation or approved equal. Rubber boots and gasket material shall meet or exceed ASTM C-923. The existing manhole inverts shall be reconstructed to meet specifications. Refer to Section 9.3 regarding Construction Requirements and the Standard Detail for further guidance with this installation.

- 14. Coating for Concrete Manholes and Lift Station Wet Wells:** When indicated on the plans or specified in the detailed specifications a corrosion resistant interior grout liner shall be provided on manholes or lift station wet wells. This includes coating of the manhole walls and bench, unless noted on the plans otherwise. The

liner shall be Sauereisen Sewergard™ No. 210, Induron Ceramasafe 90 Ceramic Epoxy, or approved equal. These products are specifically formulated for coating the interior of concrete manholes or wet wells for corrosion protection.

Coating color shall be the Earthcoat gray for manholes and Earthcoat white for wet wells unless otherwise indicated on the plans or specified in the detailed specifications.

D. Manhole Frames and Covers:

1. **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 H2O loading conditions. The castings shall be free from cracks, blowholes, porosity, shrinkage distortion or other imperfections. They shall be true to pattern and free from warpage. The frame and covers shall fit together in a satisfactory manner. Machined bearing surfaces shall be provided to prevent rocking and rattling. Manhole frames and covers shall be as follows:
 - a) Standard frames and covers shall have a minimum casting height of 7 inches.
 - b) Standard frames and covers shall be Neenah 1733, Deeter 1260, Municipal Castings (MC) 301, or approved equal unless otherwise indicated on the plans or specified in the detailed specifications.
 - c) Extra deep frames and covers shall be installed where manholes are located in pavements thicker than 7 inches. A casting height corresponding to or exceeding the pavement thickness (up to 10 inches) shall be selected. Extra deep frames and covers shall be Neenah 1733-A; 1733-B; or 1733-C, Deeter 1261, or approved equal.
 - d) Bolt down frames and covers shall be installed as specified but will mainly be used in areas, which are without hard surfacing and are subject to flooding. Bolt down frames and covers shall be Neenah R1916-F, Deeter 1247-B, or approved equal.
2. **All Covers:** Shall be supplied with concealed pick holes as specified in the standard plates. All covers shall be marked with the letter "S" or word "Sewer" formed in the center of the cover. The cover style shall be a Neenah Type "B" Lid, indented top design, or approved equal. All covers shall be supplied with self-sealing type "T" or O-Ring gaskets as manufactured by Neenah Foundry Company, machined groove continuous O-Ring gasket as manufactured by Deeter Foundry Inc., or approved equal. The covers shall be delivered from the manufacturer with pre-installed glued-in gaskets. The gasket shall be installed in a machined groove and be continuous around the perimeter. The gasket material shall be oil resistant Nitrile (60 DURO) glued in the groove, and have a maximum swell of 90 percent when tested in accordance with ASTM D471 using ASTM No.

3 oil. The glue shall be Lock-rite Black Max as manufactured by 3M Products or approved equal.

E. Manhole Adjusting Rings:

1. Concrete Adjusting Ring Materials:

- a) **Masonry Bricks, Masonry Blocks, or Masonry Shimming Devices:** will be allowed for use in adjusting manhole castings. Wood blocking or wood shimming devices greater than one inch in thickness will not be allowed. Any blocking or shimming device, when used, will not extend to the interior of the manhole.
- b) **Adjusting Rings:** Concrete adjusting rings shall be in accordance with ASTM C478. The adjusting rings shall be sized to conform to the standard manhole 27-inch cone opening, frame, and cover.
- c) **Mortar:** Shall be "Non-Shrink Grout" as previously specified in this section.

2. Plastic Adjusting Ring Materials:

- a) **Sealant:** Butyl Rubber Sealant in trowelable form shall be used. EZ-STIK #3 as manufactured by Pre-seal Gasket Corporation or approved equal. The material must meet or exceed the requirements of Federal Specification TT-S-001657, ASTM C-990 and AASHTO M-198.
- b) **Plastic Adjusting Rings:** The adjusting rings shall be injection molded HDPE as manufactured by Ladtech, Inc. or approved equal. The adjusting rings shall be manufactured from polyethylene plastic as identified in ASTM D-1248 (Standard Specification for Polyethylene Plastic Molding and Extrusion Materials). Material properties shall be tested and qualified for usage in accordance with the ASTM Test Methods referenced in ASTM D-1248. The plastic adjusting rings shall be manufactured utilizing the injection molding process as defined by SPE (Society of Plastic Engineers).

The adjusting rings shall be tested to assure compliance with impact and loading requirements in accordance with the AASHTO Standard Specification for Highway Bridges. The adjusting rings shall meet and exceed the static load requirements of AASHTO Highway Bridge Specification HS-25 (21,280 lbs). The rings must withstand 1,000,000 plus full load cycles of 10 seconds or less duration. The rings must perform without failure to a minimum of 150 percent of these load values. The adjusting rings shall be sized to conform to the standard manhole 27-inch cone opening, frame, and cover.

3. Rubber Adjusting Ring Material:

- a) **Sealant:** Sealant shall be polyurethane, formulated specifically for use with rubber adjusting rings and shall be manufactured by GNR Technologies, or approved equal.
 - b) **Rubber Adjusting Rings:** Rubber adjusting rings shall be Infra-Riser multi-purpose rubber adjustment riser as manufactured by GNR Technologies, or approved equal.
- F. Manhole Internal Frame Seal:** Manhole internal frame seals shall be installed with all manholes, unless pre-approved by the Engineer to be installed without a chimney seal. Manhole internal frame seals shall be CRETEX Internal Manhole Chimney Seals as manufactured by CRETEX Specialty Products, NPC Flexrib Seal, or approved equal. Internal frame seals shall consist of a flexible internal rubber sleeve and extension that completely covers all rings from cone to casting and stainless-steel compression bands.
- G. Tracer Wire System:** Tracer Wire shall be a direct bury wire per Section 8B except shall be modified as having the insulation color be green.

9.3 CONSTRUCTION REQUIREMENTS

A. Wastewater Flow Modifications:

1. **Interruption of Service:** The Contractor shall provide continuous, uninterrupted sanitary sewer service to all users in and upstream of the project area.
2. **Flow Handling Plan:** Prior to beginning work on any manhole or sewer main requiring flow modifications the Contractor shall present a plan for handling wastewater flows to the Engineer for approval. The plan shall describe the methods to be used and shall identify all materials and equipment that will be required for flow handling. The Contractor's plan shall also identify a contingency plan and procedures to be implemented in the event of an equipment failure or other emergency.
3. **Methods:** Bypass pumping is required during construction hours and temporary connections between existing and new sewer mains are required during non-working hours. Wastewater flows shall not be conveyed in open ditches nor in the trench excavation, and at no time shall wastewater be allowed on the ground surface, trench, streets, gutters, storm sewers, or other places, which may constitute a health hazard. Whenever, in the opinion of the Engineer, a health hazard exists because of actions or inactions of the Contractor, the Contractor shall immediately correct the situation to the satisfaction of the Engineer. If not corrected in a timely manner, the City may cause to take any actions necessary to remove the health hazard and charge the Contractor one and a half (1 ½) times the cost incurred.

If bypass pumping is required by site conditions or as per plan note, the following shall apply.

- a) The Contractor shall furnish all labor, supervision, tools, equipment, appliances, and materials to perform all operations in connection with bypass pumping of sewage flow for the purpose of preventing interference with the televising of the sanitary sewer manholes and mainlines as well as providing reliable sewer service to the occupants of the buildings being served.
- b) The Contractor will be required to provide adequate pumping equipment and force mains in order to maintain reliable sanitary sewer service in all mains involved in the scope of the work.
- c) Under no circumstances shall the flow be interrupted or stopped, such that damage is done to either private or public property, or sewage flows/overflows into a storm sewer or natural waterway.
- d) The Contractor shall provide bypass pumping of sewage around each segment(s) of main that is to be televised and shall be responsible for all required bulkheads, pumps, equipment, piping, and other related appurtenances to accomplish the sequence of pumping. Also refer to Section 205 for bypass pumping requirements when televising.
- e) The Contractor shall be required to have all materials, equipment, and labor necessary to complete the repair or replacement on the jobsite prior to isolating the sewer manhole or line segment and beginning bypass pumping operations.
- f) The Contractor shall locate bypass pumping suction and discharge lines so as to not cause undue interference with the use of streets, private driveways, and alleys to include the possible temporary trenching of force mains at critical intersections.
- g) The Contractor shall not initiate any effort to accommodate bypass pumping piping operations until specific written approval is given by the Engineer.
- h) The Contractor shall coordinate with all property owners to ensure that no damage will be caused to their property during any and all sewer rehabilitation work.
- i) The Contractor shall complete the televising as quickly as possible and shall satisfactorily meet all requirements prior to discontinuing bypass pumping operations and returning flow to the sewer manhole or main segment.
- j) The Contractor shall ensure that no damage will be caused to private property as a result of bypass pumping operations. Ingress and egress to adjacent properties shall be maintained at all times.
- k) Ramps, steel plates, or other methods shall be employed by the Contractor to facilitate traffic over surface piping.

4. **Damages to Property:** Any damages to private or public property due to backups, overflows, or surcharging resulting from work under this section shall be the responsibility of the Contractor and shall be corrected as soon as practical and at no cost to the City. If not corrected in a timely manner, the City will take the necessary action and charge the Contractor one and a half (1½) times the cost incurred.

B. Materials Handling and Storage:

The Contractor shall be responsible for the safe handling and storage of all materials furnished, and shall replace, at their expense, all such materials found defective in manufacture or damaged in transportation, handling, or storage.

Pipe, manholes, castings, and accessories shall be loaded and unloaded by lifting with hoists or skidding to avoid shock or damage. Under no circumstances shall such materials be dropped. All material shall be stored in a neat and orderly manner. Pipe shall be stored, to the greatest extent possible, in unit packages or bundles and shall be handled to prevent stress to bell joints and prevent damage to bevel ends. In addition, materials shall be handled and stored in accordance with manufactures' recommendations.

The Contractor shall cover all PVC pipe and fittings in accordance with manufacturer recommendations. In the absence of manufacturer recommendations, PVC pipe and fittings shall be stored to minimize direct rays of sun and UV exposure. This may be accomplished with a minimum of a light opaque material covering the pipe. The covering shall be positioned to allow adequate ventilation to prevent heat buildup. The submittal for this material shall identify the proposed method of storage. Pipe material that shows signs of UV impact including impacts such as chalking, faded colors will be removed from use on the project.

- C. **Underground Obstructions:** The Contractor shall expose existing underground obstructions shown on the plans or located in the field and shall determine their elevations far enough in advance of pipe laying that the proposed sewer main can be adjusted. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere with the proposed horizontal or vertical alignment of the sewer, the Contractor shall notify the Engineer so that the Engineer may modify the plans and order a deviation in the line and/or grade, or may arrange for the removal or relocation of the obstruction(s). The Contractor shall not deviate from plan line or grade without the Engineer's approval.
- D. **Sewer Main and Water Main Crossings:** Refer to Section 11 Utility Excavation and Backfill.
- E. **Protection of Existing Sewers:** The Contractor shall take necessary precautions to ensure that dirt, debris, and foreign materials do not enter existing sewers. Where new sewer mains are to be extended from and connected to existing sewers, the Contractor shall give, the City Utility Maintenance Division 24-hour notice in order that City personnel may install a temporary plug at the terminal manhole on the existing sewer.

Contractor is responsible to ensure that the plug remains functional. Said plug shall remain in place and functional until all work on the new sewer has been completed and the Engineer is satisfied that the new sewer is free of dirt, debris, and foreign materials. Plugs shall be salvaged to City Utility Maintenance upon removal. Any costs incurred by the City due to the Contractor allowing dirt, debris, foreign materials, trench water, or storm water to enter an existing sewer shall be charged to the Contractor at one and a half (1 ½) times the cost incurred.

F. Installation of Pipe:

1. **Trenching, Bedding, and Backfill:** Shall comply with the requirements of Section 11 Utility Excavation and Backfill. Trench dewatering discharges shall not be allowed to enter the sanitary sewer collection system at any time.
2. **Alignment and Grade:** Pipe shall be laid true to the line and grade established on the plans. Pipe shall be installed within 1/2 inch (0.04 feet) of the specified alignment and within 1/4 inch (0.02 feet) of the specified grade. These tolerances apply to any point along the entire pipe length.

The Contractor shall carry line and grade into the trench by means of an approved laser beam system and by surveying level instrument. At no time shall the Contractor change the grade without approval from the Engineer. If an underground obstruction is encountered at the assigned grade, the Contractor shall notify the Engineer and wait until the revised grade for the sewer has been determined, if necessary.

As a secondary check to the laser beam device, the Contractor shall check the grade from a surveyed grade stake to the pipe invert a minimum of every 100 feet using a surveying level instrument. The Contractor shall record all grade checks and produce the grade stake record if requested by the Engineer.

3. **Cleaning:** Shall be done as necessary so that the interior of all sewer pipe is free from all dirt, cement, or other foreign material before installation. Contact surfaces shall be wire brushed immediately prior to jointing.
4. **Pipe Cutting:** Shall be done without damage to the pipe with saw or abrasive wheel and shall be smooth, straight, and at right angles to the pipe axis. Ends of pipe shall be dressed and beveled to remove roughness and sharp corners.
5. **Laying and Joining of Pipes:** Shall be in accordance with the pipe manufacturer's instructions, unless specifically required otherwise by these specifications.
 - a) Each pipe length shall be inspected for defects prior to being lowered into the trench. All pipes shall be carefully lowered into the trench to prevent damage to the pipe and/or coating.
 - b) 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.

- c) Pipe shall be carefully installed to line and grade in accordance with line and grade stakes so that the finished sewer will present a uniform grade. Any noticeable variations from true alignment or grade will be cause for rejection of the work.
- d) All pipe shall be installed upgrade with spigot ends pointing in the direction of flow. The bottom of the trench shall be free of all rocks and stones and shall be hand shaped and bedded and the pipe shall be in firm contact with the bedding material for its entire length.
- e) At every bell and spigot pipe joint, a hole shall be dug of sufficient size so that the weight of the pipe will rest on the barrel of the pipe and not on the bells, and the bell hole shall not be compacted. All pipe must be properly fitted together.
- f) During the course of construction, a suitable stopper shall be kept in the end of the pipe to prevent any dirt and 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.
- g) Standard length pipe shall be utilized for all installations. Shorter lengths will only be allowed for use at manhole terminations, except as noted in the plans and as needed for the installation of service inline tees or wyes. A full standard length pipe shall be used upstream of all manholes.
- h) Joint surfaces shall be cleaned and lubricated immediately before completing the joint. Lubricant other than that furnished with the pipe shall not be acceptable. Pipe jointing shall be accomplished in a relatively dry trench condition.
- i) At manhole connections the Contractor shall take extra care to ensure the pipe is properly bedded to prevent shifting, settlement, deflection, or other failures.
- j) Joints in PVC Sanitary Sewer Pipe:
 - 1) All PVC Sanitary Sewer Pipe shall be jointed utilizing elastomeric gaskets as specified. 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.
 - 2) 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.

- 3) 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.
- k) Joints in Pipe Material Other than Identified in the specifications: Repairs on existing pipe not otherwise specified in this Section shall be approved by the Engineer.
6. **Protection of the Work:** At the end of each day's work, or when sewer pipe is not being laid, the Contractor shall protect the end of the pipe by a close-fitting stopper to prevent soil, water, or other matter from entering the pipe, and shall take adequate precautions to overcome possible uplift. The elevation of the last pipe laid the previous workday shall be checked the next day before work resumes.
7. **Connections:** When coupling PVC pipe to PVC pipe a PVC repair coupling shall be used. A clamp style coupling shall generally be used when coupling dissimilar pipe materials or for coupling non-PVC pipes. When using the Power seal or Fernco type installation, the Contractor shall encase the coupling in six inches of concrete for one (1) foot either side of the coupling. PVC couplings do not require concrete encasement.
8. **Minimum Cover:** Depth from the top of pipe to finished grade shall not be less than 5.0 feet for Collector Sewers (sewer mains with service connections) or 4.0 feet for Interceptor Sewers (sewer mains with no service connections). In the event adequate cover cannot be achieved by alignment or grade adjustment then, with prior approval of the Engineer, the sewer pipe may be insulated. Refer to Section 11 Utility Excavation and Backfill and Standard Details for insulation requirements in cases where minimum cover cannot be provided. The use of insulation shall only be permitted in those rare instances where the pipe's grade cannot be adjusted, or the finished surfacing grade cannot be adjusted to maintain the minimum cover. Insulation shall be required in instances where less than 18 inches of separation between culverts or storm sewers cannot be achieved.
9. **Dewatering:** Shall be accomplished per Section 11 Utility Excavation and Backfill.
10. **Insulation:** Shall be accomplished per Section 11 Utility Excavation and Backfill.
11. **Sanitary Sewer Force Main:**
- a) Shall conform to Section 8A Water Piping Systems, subsection 8A.3 Construction Requirements.
- b) In addition to meeting the above requirements Tracer Wire Access Boxes shall be installed at a minimum of every 500 feet along the length of the force main and at all system valves. Each Tracer Wire Access Box shall be located as identified in Section 8B Corrosion Protection – Plastic Pipe Systems.

- c) PVC force main shall utilize a green dye resin for color in order to represent wastewater or a green locator ribbon with the word “sewer” stenciled shall be used. The green locator ribbon shall be installed with ductile iron pipe. The locator ribbon shall be placed on top of the “select bedding material” approximately 12 inches above the top of pipe and centered horizontally directly over the pipe.

G. Installation of Manholes:

1. **All Manhole Barrel and Cone Sections:** Shall be numbered and/or measured by the Contractor prior to installation to ensure that each furnished manhole component is correct for that location and that the finished manhole will be to the grade specified. External joint seals shall be installed on all manhole joints when ground water is present.

Placement of manholes shall be on a 4-inch (minimum thickness) leveling course of Type 1 Bedding Material. Manholes shall be set level and to the grade specified.

2. **Invert Channels:**

- a) **General:** Channels shall have smooth, clean surfaces and shall be semi-circular U-shaped conforming to the adjacent pipe. Changes in size and grade of the channels shall be made gradually and evenly. In no case shall the invert width through the manhole be greater than that of the outlet pipe. Changes in direction flow and side branch connections shall be made with a full, smooth, and sweeping curve with a radius meeting the requirements per the Standard Details.

Manhole inverts shall be U-shaped with a channel depth equal to the diameter of the outlet pipe and with the channel sides, above the spring line, vertical or slightly laid back at a slope not to exceed (1/10, horz./vert.). Refer to Standard Details. Manhole inverts shall be Class M-6 concrete per Section 56, manufactured using Type II cement.

The manhole invert shall be shaped and finished with a smooth steel trowel finish.

- b) **Inverts for New Manholes:** Materials for new manhole inverts and benches shall be as specified in Section 9.2 Materials. New manhole benches and inverts shall be constructed by the same manufacturer that produces the precast monolithic base and constructed at the production facility. Field cast inverts will not be allowed for new manholes unless pre-approved by the Engineer.

The manhole invert and bench shall have a smooth steel trowel finish.

- c) **Inverts for Existing Manholes:** Materials for existing manhole inverts shall be as specified in Section 9.2 Materials and as further described.

Existing manhole benches and inverts may be reconstructed with hand formed inverts and benches provided the other components of the specification are met. The manhole invert and bench shall have a smooth steel trowel finish.

All sewer flows shall be removed by bypass pumping or other approved methods from the manhole to be reconstructed. The existing invert and bench shall be demolished to the extent necessary to maintain a minimum new concrete invert thickness of 3 inches and side thickness of 8 inches throughout the manhole.

Acceptable methods for demolishing the existing invert include the use of concrete saws, core drilling, jackhammers, chisels and other hand tools. The existing concrete shall be rough and have an approved bonding agent applied to it prior to placing the new concrete. The new invert shall be constructed using a concrete mix as specified with the exception that the concrete shall be low slump.

Sewer flows will not be permitted on the concrete until 4 hours after the initial set has occurred and the Engineer has inspected and approved the reconstructed invert.

3. **Shelves/Benches:** Shall be formed from the top of the channel to the manhole wall and shall slope up from the channel at a minimum rate of 1 inch per foot and a maximum rate of 3 inches per foot.
4. **Steps:** Anytime work is done on the inside of an existing manhole with steps, steps must be removed, and grout applied over any remaining metal or holes from the old steps filled in.
5. **Pipe Connections to New Manholes:** Manhole connections to the sewer main shall be accomplished with a rubber boot or a gasket seal that insures a watertight seal. Ends of pipes, which enter manholes, shall be cut smooth, straight, and at right angles to the pipe axis. The annular space between the boot or gasket and the pipe shall be grouted flush with the inside of the manhole such that a smooth, continuous channel is formed through the manhole. The annular space above the flow channel on top of the pipe shall not be grouted.

Drop manholes shall have the lower connection and 45-degree fitting, outside the manhole, totally encased in concrete. Refer to Standard Details. The interior pipe connections shall have the annular space grouted as described above.

When a sewer main stub is provided for future extension, the sewer main stub shall be capped with a watertight cap.

6. **Pipe Connections to Existing Manholes:** Pipe Connections to existing manholes shall not be allowed unless preapproved by the Engineer. When a connection or

extension is necessary the Engineer may require the manhole be replaced with a new manhole.

If preapproved by the Engineer the manhole connections shall be made by coring the existing manhole and installing a boot-type flexible connector consisting of a rubber gasket or boot, metal expansion ring and a metal take-up clamp, as manufactured by Press Seal Gasket Corporation, or approved equal. Rubber boots and gasket material shall meet or exceed ASTM C-923. Drop manholes shall have the lower connection and 45 degree fitting, outside the manhole, totally encased in concrete. Refer to Standard Details. The interior pipe connections shall have the annular space grouted as described for "Pipe Connections to New Manholes".

The Contractor shall test the existing manhole for water tightness prior to making any modifications as required under Section 9.3.1 - Manhole Tests. If the manhole does not pass a water tightness test prior to modifications, the Contractor will not be required to pass a test after modifications are made to the manhole. Manhole must pass a visual inspection by the Engineer. If the manhole does pass a water tightness test prior to modifications, the Contractor shall test the manhole after modifications are made and if the manhole does not pass the test it shall be the Contractor's responsibility to correct the deficiencies and demonstrate a passing test. The Contractor is responsible for correcting deficiencies in the manhole.

External joint seals shall be installed on an existing manhole for all exposed manhole joints when adding a pipe connection to an existing manhole, when ground water is present and no external joint seals exist.

7. Frames and Covers:

- a) **Grade and Slope:** Manhole frames and covers shall be placed at finished grade. When placed in asphalt, concrete, or gravel surfaces, frames and covers shall match both the crown slope and profile slope of the street. The cover shall be set at an elevation and slope that it is not above the surface and no more than 1/2 inch below the surface at all points around the circumference of the cover. Decreasing the surfacing thickness around the manhole frame and cover, as a method of achieving the above tolerances, is not permitted.

Finished grade for frames and covers located outside of paved areas shall be graded such that positive drainage will be maintained away from the manhole.

Frames shall be blocked and shimmed to correct elevations and slopes prior to placing pavement. The lid shall be adjusted to match both the cross slope of the street and the profile of the street. Following paving, the frame shall be checked for correct placement and adjusted as necessary. The joint between frame and adjusting ring shall then be grouted watertight with non-shrink grout. Blocks and shims shall be placed no closer than 2 inches from the inside edge of the adjusting ring. The internal frame seal shall be installed after the manhole frame and cover has been installed in its final position and is complete.

Vertical Adjustment of manhole frames and covers:

Adjusting rings shall be installed per the Standard Details and as specified herein. Adjustments greater than those shown on the details shall be accomplished by replacing or adding additional barrel sections rather than adjusting rings.

Plastic, rubber or concrete adjusting rings may be used. The plastic or rubber adjusting rings shall be installed as recommended by the manufacturer. No shims or other leveling devices, other than leveling rings provided by the manufacturer, will be permitted with use of the plastic or rubber adjusting rings. The annular space between the adjusting rings shall be sealed using an approved sealant. The first plastic adjusting ring on existing manholes may require leveling with concrete mortar and therefore the first plastic ring may be set in mortar.

The manhole frame and adjusting rings where concrete adjusting rings are used shall be set in a full bed of mortar to the grade and slope as specified. The mortar shall be tuck pointed between rings and shall not be applied to the inside diameter surface of the adjusting rings. Smearing of mortar on the inside of the adjusting rings will be cause for rejection of the work.

- 1) **New Manholes:** New Manhole barrels and cone sections shall be manufactured to a tolerance that provides from 2 inches to 8 inches of vertical adjustment between the top of the cone and the bottom of the frame. Vertical adjustments, between the top of the cone and the bottom of the frame, greater than 8 inches shall be accomplished by installing a new appropriately sized manhole barrel section. Rings shall be vertically aligned to be straight with the top of the cone section without any offset.
- 2) **Existing Manholes:** Existing manhole frames and lids may be adjusted to grade by adding additional adjusting rings. The vertical adjustment between the top of the cone and the bottom of the frame however shall not exceed 18 inches. Vertical adjustments greater than 18 inches shall be accomplished by installing a new appropriately sized manhole barrel section or manhole cone section. Rings shall be vertically aligned to be straight with the top of the cone section without any offset.

Steel adjusting rings that are inserted into the existing frame and allow the cover to be raised are not permitted. All manhole adjustments shall be done as specified above.

External joint seals shall be installed when a vertical adjustment of a manhole occurs on an existing manhole for all exposed manhole joints, when ground water is present and no external joint seals exist.

- b) **Chimney Seal:** Unless pre-approved by the Engineer, manhole chimney seals shall be installed in all cases. Whether an existing manhole is adjusted or a new manhole is installed, the manhole chimney shall be sealed. All manhole chimneys shall be sealed using a manhole internal frame seal. The seal shall be installed according to the manufacturers recommendations and when properly installed will prevent the inflow of water between the manhole cone and the frame and cover.
8. **Coating for Concrete Manholes and Lift Stations Wet Wells:** When indicated on the plans or specified in the detailed specifications a corrosion resistant interior coating shall be provided on manholes or lift station wet wells. The coating may be field applied or applied at the manufacture's site. New manholes shall be coated prior to installation. This includes coating of the manhole walls and bench, unless noted on the plans otherwise. The material shall be applied as per manufacturer's recommendations. Manhole coating color shall be as specified in Section 9.2 Materials.
9. **Manhole Depth:** Manholes 5.5 feet and greater in depth, measured from invert to rim, shall have eccentric cone top section per Standard Manhole Detail. Manholes less than 5.5 feet in depth shall have flat concrete covers designed for AASHTO H-20 wheel loading as per Standard Shallow Manhole Detail.

H. Sewer Main Tests:

1. **General:** A visual inspection, a television inspection, a leakage test, and a pipe deflection test shall be performed as specified herein for all sewer mains and manholes as a condition of acceptance by the City. All tests shall be performed after backfill is complete but prior to any surface restoration.
2. **Pre-Cleaning:** Prior to testing newly installed sewer pipe, the Contractor shall remove all accumulated construction debris, rock, gravel, sand, silt, and other foreign matter from the sewer with an appropriately sized cleaning ball.

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 make said sewer unacceptable for final acceptance and usage. Also included is all work necessary in the manholes and all cleanup work required prior to final acceptance.

The City will not be responsible for cleaning lines prior to televising the sewer. In the event that the line is not acceptable for televising, due to the Contractor's operations, the Contractor will be notified. It will be the Contractor's responsibility to arrange to clean the sewer and make it acceptable for the television inspection work. If not cleaned in a timely manner, the City may cause to take any actions necessary and charge the Contractor one and a half (1½) times the cost incurred.

3. **Visual Tests:** All newly installed sewer main pipe shall pass a visual, or "lamping", inspection by the Engineer, and a television inspection performed by the

Contractor. Refer to Section 205 – Televising for requirements. Straight alignment shall be checked either with lamping or with the laser beam. Lamping shall be conducted by viewing the pipe from inside a manhole to determine proper alignment. The television inspection shall consist of viewing the inside of all sewer main pipe installed to determine proper alignment, joining, properly installed service connections, infiltration, etc. The Contractor shall correct, at their own expense, any defects discovered because of lamping and/or televising the pipe.

Both a visual and television inspection shall be completed unless specified otherwise on the plans or specified in the detailed specifications.

If defective workmanship of material or construction is noted, the Contractor at no expense to the City, shall correct the deficiency. Additional television inspections to review if the repairs were made properly and in accordance with the specifications shall be provided by the Contractor per Section 205. 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. The City may cause to take any actions necessary for any items not completed or repaired in a timely manner and may charge the Contractor one and a half (1½) times the costs incurred.

It is the Contractors responsibility to notify the Engineer/City Inspector that the sewer is ready for inspection and when television inspection will occur. Any surfacing started prior to the television inspection is at the Contractors own risk.

4. **Leakage Tests:** The Contractor shall conduct leakage testing of all newly constructed or reconstructed sewer mains. The Contractor shall furnish all necessary equipment and be responsible for conducting the leakage test in the presence of the Engineer and/or City Inspector.

The preferred Leakage Test method is the “Low Pressure Air Test”, provided groundwater conditions allow it. Alternative leakage tests may be the “Ex-Filtration Test” if groundwater is less than 4 feet above the top of pipe, or the “Infiltration Test” if groundwater is 4 feet or more above the top of pipe.

Leakage tests for sewer mains shall include testing of the mains and service pipe connections including inline sewer service wyes/tees.

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 Engineer.

- a) **Low Pressure Air Test:** This is the preferred testing method. The Contractor may conduct low-pressure air testing of newly installed sewer mains in lieu of ex-filtration testing if the ground water is less than 1 foot above the top of the finished sewer main at the lowest point of the test section as determined by construction records and/or test borings. The test shall conform to the

procedures outlined in Uni-Bell Specification Uni-B-6-98 or latest, Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.

The pressurizing equipment shall include a regulator or relief valve set no higher than nine (9) psig to avoid over-pressurization.

Pipeline segments between manholes shall be tested separately. Mechanical or pneumatic plugs shall be placed in the line at opposing manholes and each plug braced as a safety precaution. An aboveground air pressurizing device including shut-off valve, pressure-regulating valve, pressure relief valve, input pressure gage and a continuous monitoring pressure gage shall be provided and connected to the test plug at one end.

Separate hoses for introducing air and for monitoring air pressure shall be provided. The monitoring hose shall be equipped with two (2) accurate pressure gauges. The monitoring gauges shall read in divisions of 0.1 psi with an accuracy of plus or minus 0.04 psi.

Procedure:

- 1) Clean the section of sewer line to be tested by flushing or other means prior to conducting the low-pressure air test. This cleaning serves to eliminate debris and produce the most consistent results.
- 2) Isolate the section of sewer line to be tested by inflatable stoppers or other suitable test plugs.
- 3) Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. All plugs and caps shall be securely braced to prevent blow-out. One of the plugs or caps should have an inlet tap, or other provision for connecting a hose to a portable air control source.
- 4) Connect the air hose to the inlet tap and portable air control source. The air equipment shall consist of necessary valves and pressure gauges to control an oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section.
- 5) Low pressure air shall be introduced into the line until the internal pressure reaches four (4) psig, and the supply throttled to maintain four (4) psig for at least two (2) minutes. The supply shall then be shut off or disconnected. The pressure shall be allowed to drop to about three and one-half (3 ½) psig at which time the timing shall commence and the time accurately measured for a one (1) psig pressure drop per Table 9-1.
- 6) If the test section fails to meet these requirements, the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner

approved by the Engineer. This does not mean that the Low Pressure Air Test has to be repeated but rather a passing test has to be achieved by either the Low Pressure Air Test or the Ex-filtration Test.

- 7) The Engineer may reduce the testing time to one-half the testing time if the pressure drop is less than 0.5 psi for the first one-half the test period listed in Table 9-1.
- 8) 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.

**TABLE 9-1
LOW PRESSURE AIR TEST
ALLOWABLE LEAKAGE FOR A 1 PSIG PRESSURE DROP ***

Pipe Diameter	Time of Test (sec.'s)	Minimum Time of Test (sec.'s)
4	0.380 x L	226
6	0.854 x L	340
8	1.520 x L	454
10	2.374 x L	566
12	3.418 x L	680
15	5.342 x L	850
18	7.692 x L	1020
21	10.470 x L	1190
>21	as per plans	

* Use of Table 9-1:

The time of test shall be calculated using the formula presented in Table 9-1. Time is in seconds and L is in feet of pipe being tested. If the calculated time is less than the minimum time of test then the minimum test time shall govern. For example: 200 feet - 10 inch sewer would have a calculated time of $2.374 \times 200 = 475$ seconds. The minimum test time however is 566 seconds. Thus the minimum length of time for a 1 psig pressure drop would be 566 seconds not the calculated 475 seconds.

If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test considered.

L is the length of the sewer main. If sewer services are included in the air test, no additional time for the test is necessary beyond that needed for the sewer main.

- b) **Ex-Filtration Test:** Shall be used if groundwater is less than 4 feet above the top of pipe as determined by construction records and/or test borings. The test shall be conducted in a manner approved by the Engineer and shall provide a minimum head of 2 feet at the highest point in the test section, but no more than 10 feet of head at the lowest point, with head measured from top of pipe, except when the groundwater surface is above the pipe, in which case head shall be measured from the groundwater surface.

Unless otherwise specified, the pipe shall not allow ex-filtration of water of more than 50 gallons per inch diameter per mile of pipe (50 gallons/inch/mile) in any 24-hour period as per Table 9-2.

The minimum test period shall be for two (2) hours and the values derived from Table 9–2 will need to be adjusted for the actual test time. If the test section fails to meet these requirements the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner approved by the Engineer. This does not mean that the Ex-filtration test has to be repeated but rather a passing test has to be achieved by either the Ex-filtration Test or the Low Pressure Air Test.

It is not recommended to conduct the pipe leakage test concurrently with the manhole ex-filtration test, as the allowable parameters for head (H) in the two tests differ. However, a separate manhole ex-filtration test will not be required when manholes are tested simultaneously with the sewer pipe ex-filtration test.

The Contractor shall anticipate the need to conduct multiple tests in order to meet the above requirements and shall conduct testing in such a manner and sequence that the requirements indicated above are achieved.

Water used to test ex-filtration shall be clean potable water and will not be allowed to discharge to the sewer system. The Contractor shall be responsible for removing the water by pumping it from the system and discharging it at an approved location.

**TABLE 9-2
ALLOWABLE LEAKAGE ***

PIPE SIZE (Inches)	LEAKAGE RATE (Gallons/Feet/24 Hours.)
8	0.08 x L
10	0.09 x L
12	0.11 x L
15	0.14 x L
18	0.17 x L
21	0.20 x L
24	0.23 x L
27	0.26 x L
>27	as per plans

* Use of Table 9-2:
The length of time for the test in the table is given as a 24-hour period and will need to be adjusted for the actual test time. The allowable leakage shall be calculated using the formula presented in Table 9-2 and L is in feet of pipe being tested.

It is not recommended to conduct the pipe leakage test concurrently with the manhole ex-filtration test, as the allowable parameters for head (H) in the two tests differ.

If the Contractor wishes to concurrently test the pipe and manhole then Table 9–4 may be used to assist in measuring the pipe loss for a concurrent test.

For example the calculated loss for 350 feet - 12 inch sewer would be $0.11 \times 350 = 38.5$ gallons in a 24-hour period. To adjust this loss to the actual test time or if a manhole test is being conducted concurrently the 38.5 gallons would need to be converted, to say, two (2) hours; then $(38.5 / 24 \text{ hrs}) \times 2 \text{ hrs} = 3.2$ gallons. The 3.2 gallons would be the permitted loss or if testing concurrently would have to be added to the loss calculated for the manhole.

- c) Infiltration Test:** Shall be used if ground water is 4 feet or more above the top of the finished sewer main at the highest point of the test section as determined by construction records and/or test borings. Test methods and infiltration measurements shall be conducted in a manner approved by the Engineer.

The allowable leakage into the pipe shall not exceed that set for Ex-Filtration in Table 9-2. The minimum test period shall be for two (2) hours and the table values will need to be adjusted to accommodate for the actual test time. If the test section fails to meet these requirements, the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner approved by the Engineer. This does mean that the Infiltration Test has to be repeated as the other test methods would not be permitted because of the groundwater conditions.

- 5. Pipe Deflection Test:** Deflection tests shall be performed by the Contractor on all PVC sewers. Deflection tests will not be required for reinforced concrete pipe sanitary sewers. Deflection tests for other sanitary sewer pipe materials will be handled on a case-by-case basis by the Engineer. Deflection tests shall be conducted after the final backfill has been in place at least 30 days. Deflection tests shall be made using a deflection gauge (mandrel) device or other approved method. The diameter of the deflection gauge device shall be 95% of the undeflected inside diameter of the flexible pipe. The deflection test shall be performed without mechanical pulling devices. The Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed five (5) percent. All pipes exceeding the five (5) percent deflection within the two-year warranty period shall be re-laid or replaced by the Contractor at no additional cost to the City.

I. Manhole Tests:

- 1. General:** Manhole tests shall be performed on all newly installed manholes and on existing manholes where new sewer main connections have been made. The preferred Manhole Leakage Test method is the “Manhole Vacuum Test” rather than the “Ex-Filtration Test”.
- 2. Existing Manhole Modifications:** For existing manholes where new sewer main connections are to be made or any modifications, the Contractor shall test the manhole prior to any modifications to confirm manhole will pass test. Testing is not required when modifications are the addition of chimney seals or manhole

adjustment by use of adjusting rings. If the existing manhole passes the test, Contractor is required to pass the test after modifications are made to manhole. If the existing manhole does not pass the test, Contractor is not required to pass the test after modifications are made to manhole.

3. **Visual Test:** The Engineer/Inspector will visually inspect each manhole exterior and interior for flaws, cracks, holes, or other deficiencies, which may affect the operation or watertight integrity of the manhole. Should any deficiencies be discovered, the Contractor shall correct them to the satisfaction of the Engineer and at no cost to the City. Manhole barrels and cones that have cracks or holes that extend from the interior of the barrel or cone to the exterior shall be replaced. Manhole barrels or cones that have spalls or cracks that extend to or through the O-ring gasketed joint shall be replaced. For other deficiencies or flaws the Contractor may submit to the Engineer a written repair procedure for consideration. The Engineer may or may not permit the proposed repair method and by allowing a repair method does not, in anyway, remove or alleviate any testing requirements.
4. **Manhole Vacuum Test:** Shall be performed in accordance with ASTM C1244. The following procedure is summarized from ASTM C1244 and shall be followed in conjunction with ASTM C1244 unless modified by the Engineer. The vacuum test shall include testing the top of the manhole, excluding the adjusting rings and manhole frame and cover. Testing will be allowed after backfilling has occurred, manhole vacuum tester assembly and vacuum pumps shall be as manufactured by Cherne Industries, Inc. or approved equal. Repair of leaks may require the removal and replacement of manhole sections. Repair of leaks shall be approved by the Engineer.

Procedure:

- a) All lift holes shall be plugged.
- b) All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
- c) The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
- d) A vacuum of 10 inches of mercury shall be drawn on the manhole and then the vacuum line shall be throttled to maintain the 10 in vacuum for at least two (2) minutes. After the two minutes the valve on the vacuum line of the test head shall be closed, and the vacuum pump shut off. The time shall then be measured for the vacuum to drop to 9 inches of mercury.
- e) The 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 Table 9-3.

- f) Two (2) accurate vacuum pressure test gauges shall be installed to monitor the test. Vacuum pressure gauges shall have graduation marks, at minimum, for every 0.2 inches of mercury and be capable of interpreting pressure readings within 0.1 inches of mercury. The pressure reading deviation between the two pressure gauges shall not be greater than 0.1 inches of mercury. During the vacuum pressure test the pressure loss indicated between the two gauges shall not deviate by more than 0.05 inches of mercury between the two gauges.
- g) If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained. This does not mean that the Manhole Vacuum Test has to be repeated but rather a passing test has to be achieved by either the Manhole Vacuum Test or the Ex-filtration Test.

**TABLE 9-3
MINIMUM MANHOLE VACUUM TEST TIMES FOR
VARIOUS MANHOLE DIAMETERS PER DEPTH OF MANHOLE**

Manhole Depth (Feet)	48 inch Diam. MH (Seconds)	60 inch Diam. MH (Seconds)	72 inch Diam. MH (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
30	74	98	121
>30	as per plans		

5. **Ex-filtration Test:** The Contractor shall furnish all necessary equipment and materials and shall be responsible for conducting, in the presence of the Engineer/Inspector, an ex-filtration test on each manhole. A separate manhole ex-filtration test will not be required when the manhole is tested simultaneously with the sewer pipe during an ex-filtration test.

It is not recommended to conduct the pipe leakage test concurrently with the manhole ex-filtration test, as the allowable parameters for head (H) in the two tests differ. However, a separate manhole ex-filtration test will not be required when manholes are tested simultaneously with the sewer pipe ex-filtration test. If the Contractor wishes to concurrently test the pipe and manhole then Table 9-2 may be used to assist in measuring the pipe loss for a concurrent test.

The manhole shall not allow ex-filtration of water of more than 0.10 gallons per hour per foot diameter per foot head (0.10 gallons/hour/foot diameter/feet head) with head being measured from the top of the water surface in the test manhole to groundwater level outside the manhole or to the bottom of the manhole, whichever is less.

All pipes leading into or out of the manhole shall be plugged to provide a watertight seal and the manhole filled with water to a level 3 inches to 4 inches below the casting rim or lid. The water shall be allowed to stand for 2 hours prior to beginning the test to allow for absorption into the manhole. If the water has dropped at the end of the 2 hour stabilization period, additional water shall be added to bring the water level to at least 3 inches to 4 inches below the casting rim or lid, as initially was done. If the head is greater than 30 feet refer to the plans for ex-filtration testing requirements.

The minimum test period shall be for 2 hours and the values derived from Table 9-4 will need to be adjusted for the actual test time. If the test fails to meet these requirements, the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner approved by the Engineer. This does not mean that the Ex-filtration test has to be repeated but rather a passing test has to be achieved by either the Ex-filtration Test or the Manhole Vacuum Test.

The Contractor shall anticipate the need to conduct multiple tests in order to meet the above requirements and shall conduct testing in such a manner and sequence that the requirements indicated above are achieved.

Water used for ex-filtration testing shall be clean, potable water and will not be allowed to discharge into the sewer system. The Contractor shall be responsible for removing the water by pumping it from the manhole being tested and discharge it at an approved location.

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**TABLE 9-4
MANHOLE EX-FILTRATION TEST - ALLOWABLE LEAKAGE ***

Head (Feet)	Allowable water drop in casting and cone per hour					
	4 Foot Diam.		5 Foot Diam.		6 Foot Diam.	
	(gallons)	(Inches)	(gallons)	(Inches)	(gallons)	(Inches)
2	0.8	0.32	1.0	0.40	1.2	0.48
4	1.6	0.64	2.0	0.80	2.4	0.96
6	2.4	0.96	3.0	1.21	3.6	1.45
8	3.2	1.29	4.0	1.61	4.8	1.93
10	4.0	1.61	5.0	2.01	6.0	2.42
12	4.8	1.93	6.0	2.42	7.2	2.90
14	5.6	2.25	7.0	2.82	8.4	3.38
16	6.4	2.58	8.0	3.22	9.6	3.87
18	7.2	2.90	9.0	3.63	10.8	4.35
20	8.0	3.22	10.0	4.03	12.0	4.84
22	8.8	3.55	11.0	4.43	13.2	5.32
24	9.6	3.87	12.0	4.84	14.4	5.81
26	10.4	4.19	13.0	5.24	15.6	6.29
28	11.2	4.51	14.0	5.64	16.8	6.77
30	12.0	4.84	15.0	6.05	18.0	7.26
>30	as per plans					

* Use of Table 9-4:

Example of a concurrent manhole and pipe ex-filtration test:

Given: 370 feet of 10 inch sewer, groundwater approximately 2 feet above the pipe invert at the manhole being tested, the manhole is 5 foot in diameter and the manhole is 17 feet deep from rim to invert.

The calculated pipe loss for 370 feet – 10 inch sewer would be (from Table 9-2) $0.09 \times 370 = 33.3$ gallons in a 24-hour period. To adjust this loss to coincide with the manhole test the 33.3 gallons would need to be converted, to two (2) hours; so $(33.3 / 24 \text{ hrs}) \times 2 \text{ hrs} = 2.78$ gallons. The 2.78 gallons is the permitted loss for the pipe in 2 hours.

The calculated manhole loss for a 5 foot diameter manhole 17 feet deep with groundwater 2 feet above the invert would be (from Table 9-4) 17 feet – 2 feet = 15 feet H, round H down to 14 feet, the corresponding value from the 5 foot Diam. Column results in a manhole loss of 7.0 gallons per hour. This value then needs to be converted to a two hour test. So $7.0 \text{ gallons} \times 2 = 14$ gallons for two hours.

The combined total loss would be 2.78 gallons (pipe) + 14 gallons (manhole) = 16.78 gallons. This loss can be measured in inches of water surface drop in the cone by converting the gallons in Table 9-4 to inches. The 7.0 gals. = 2.82 inches of drop, therefore 16 gallons of loss equals $2 \times 2.82 \text{ inches} = 5.64 \text{ inches}$. The 2.78 gallons would be rounded down to 2.0 gallons, which is equivalent to a 0.80 inch drop. Therefore, the total water surface drop for a two hour test would be $5.64 \text{ inches} + 0.80 \text{ inches} = 6.44 \text{ inches}$.

Another option instead of measuring the surface water drop would be to measure the volume of water required to bring the water surface back to the original level, at the start of the test. In order to achieve a passing test the volume of water needed to fill the cone would have to be less than 16.78 gallons.

J. Abandoning Sanitary Sewer Mains and Manholes:

1. **Existing Sewer Mains:** To be abandoned between manholes shall be plugged at all open ends with concrete extending into the abandoned pipe one foot or one pipe diameter, whichever is greater. Existing sewers to be abandoned at a manhole shall be cut flush with the inside of the manhole and plugged as specified above. The pipe shall be grouted flush with the inside of the manhole and the manhole invert shall then be reconstructed. The reconstructed manhole inverts shall provide for the new flow scheme and comply with the standards for manhole inverts, as specified.
2. **Existing Manholes:** To be abandoned shall have all pipes plugged with concrete extending into the abandoned pipe one foot or one pipe diameter, whichever is greater. The upper 4 feet of the manhole shall be broken or removed and the manhole filled with compacted Select Granular Backfill Material. The floor of the manhole must be fractured to eliminate the manhole from holding water. The Contractor shall not backfill manholes to be abandoned until the Engineer/Inspector has inspected each plug and the fractured floor.

Unless shown otherwise on the plans or specified in the detailed specifications, the Contractor shall salvage manhole frames and covers and deliver to and unload them at the City Utility Maintenance Shop.

K. Service Lines:

1. **Service Line Separation:** Refer to Section 11 Utility Excavation and Backfill.
2. **Permits:** Obtainable from the City Utility Maintenance Division, are required for all connections to the City sanitary sewer system. Applicants must hold a City Sewer & Water Installer Contractor's License.
3. **Horizontal Distance:** Between a water main and a sewer service shall not be less than 5 feet, and a sewer main and a water service shall not be less than 5 feet.
4. **Service Pipe:** Shall be laid at a 2.00% slope or greater. Any service pipe less than 2.00% slope requires Engineer approval. Minimum depth of cover over service lines shall be 3-1/2 feet unless approved by the Engineer to be shallower. Shallower installations will require the use of insulation. Reconstruction of existing sewer service lines shall be laid with the greatest slope possible in order to reconnect into existing conditions.
5. **Cleanouts:** Shall be installed at all changes in horizontal alignment of greater than 45 degrees and at distances not to exceed 75 feet for 4 inch diameter pipe and 100 feet for 6 inch diameter pipe. Cleanouts shall be installed when the summation of the horizontal degree of change in a service line exceeds 135 degrees. Cleanout location and installation shall meet the more stringent of the above requirements or those of the adopted plumbing code.

- 6. Insulation:** For sewer services, when shown on the plans, shall be as specified for sewer mains. The use of insulation requires prior approval of the Engineer.
- 7. Sewer Service New Connections:** Where new service lines are to be installed for undeveloped property or future buildings, the Contractor shall furnish all materials necessary for connection of new service lines to the sewer main, and shall obtain and pay permits and tapping fees as established by Ordinance.
- a) With the construction of new mains, in-line wyes shall be used for 4 inch and 6 inch service lines when connecting to 8 inch and 10 inch sewer mains.
 - b) With the construction of new mains, in-line tees shall be used for 4 inch and 6 inch service lines when connecting to 12 inch or greater sewer mains.
 - c) In all cases when a 6 inch connection is to be made onto an existing 8 inch or 10 inch sewer main, the connection must be made with an in-line wye. If the connection is to an existing main, the in-line wye shall be cut into the existing main.
 - d) For new connections onto existing sewer mains that are not a 6 inch connection onto an 8 inch or 10 inch main, or at location determined necessary by the Engineer, the City will use tapping saddles, furnished and installed by the City.
 - e) In-line wyes, tees, and service lines bends installed at a depth of greater than 14 feet shall be SDR 26. All other in-line wyes and tees shall be SDR 35 minimum.
 - f) In-line wyes and tees shall be furnished and installed by the Contractor as the sewer main is installed.

New service connections and lines shall be, at a minimum, extended to the property line and the service line capped. If the termination point is not at a cleanout, the termination point shall be marked with a minimum 3 foot long steel fence post. The steel fence post shall be buried below the surface at least 8 inches and must be steel to facilitate location by magnetic locators.

- 8. Sewer Service Reconnections:** The Contractor shall furnish all materials necessary for reconnecting service lines existing prior to reconstruction of a sewer main.
- a) With the construction of new mains, in-line wyes shall be used for 4 inch and 6 inch service lines when reconnecting to 8 inch and 10 inch sewer mains.
 - b) With the construction of new mains, in-line tees shall be used for 4 inch and 6 inch service lines when reconnecting to 12 inch or greater sewer mains.

- c) In all cases when a 6 inch reconnection is to be made onto an 8 inch or 10 inch main, the reconnection must be made with an in-line wye. If the reconnection is to an existing main, the in-line wye shall be cut into the existing main.
- d) For reconnections onto existing sewer mains that is not a 6 inch connection onto an 8 inch or 10 inch sewer main, the City will use tapping saddles, furnished and installed by the City.
- e) In-line wyes, tees, and service lines bends installed at a depth of greater than 14 feet shall be SDR 26. All other in-line wyes and tees shall be SDR 35 minimum.
- f) In-line wyes and tees shall be furnished and installed by the Contractor as the sewer main is installed.

The Contractor shall visually inspect the inside of each existing sewer service line to be connected to the new sewer main prior to making the reconnection. When it is discovered that an existing sewer service line beyond the edge of the excavation is not in good physical condition or is plugged, full of roots, or is otherwise not operating properly, the Contractor shall notify the Engineer so they may document the condition and notify the property owner.

Connections between the new service line and existing service line shall be accomplished with a coupling. The Contractor shall encase the Fernco connection in 6 inches of concrete, 6 inches each side of the coupling.

- 9. **Abandoning of Service Lines:** Shall be accomplished by cutting and plugging the line at the sewer main unless directed otherwise by the Engineer. The service line shall be plugged in the same manner as specified for plugging sewer mains.
- 10. **Service Line Inspection and Taps:** City personnel shall inspect all sewer service connections to the City sewer main, service line installations, and service line abandonments, prior to backfilling. The Contractor shall notify the City Utility Maintenance Division a minimum of four (4) hours prior to the time of wanted inspection. Any trench backfilled without being inspected and approved by authorized City personnel shall be re-excavated by the Contractor to expose the work for the required inspection. Discrepancies shall be corrected by the Contractor and re-inspected by City personnel. City personnel shall tap all City sewer mains, at locations as identified in this Specification. The Contractor shall schedule all inspections and taps between 7:30 AM to 3:00 PM, Monday through Friday.
- 11. **Tracer Wire:** Tracer wire shall be installed and extended along with all sewer service lines. The wire shall be installed along the top of the pipe and shall be securely anchored to the pipe every four (4) feet horizontally with an adhesive tape. The tracer wire shall be brought to the surface at each clean out and shall terminate at the service connection point on the main.

At locations where the service line is not being replaced entirely, the Contractor will splice the new tracer wire to the existing tracer wire at the point of reconnection. In instances where a service line is not being replaced entirely and the existing tracer wire is not encountered, the Contractor shall coil approximately five (5) feet of wire at the reconnection location(s) to facilitate a future splice.

All tracer wire connections shall be accomplished in accordance with Section 8B. In addition to meeting these requirements the Tracer Wire specification shall be modified so that the wire insulation is green with a print line saying "SEWER".

9.4 METHOD OF MEASUREMENT

- A. Sewer Main Pipe:** Installed pipe quantities shall be measured from centerline to centerline of all manholes and special items to the nearest even foot. Depth of pipe shall be determined from top of finish grade to flow line of pipe. Standard depth is 0 - 6 feet and extra depth shall be in increments of two (2) feet.
- B. Sewer Service Pipe:** Installed pipe quantities shall be measured from edge of sewer main pipe to fittings or end of pipe to the nearest even foot.
- C. Standard Manhole, Shallow Manhole, Termination Manhole, and Drop Manhole:** 0 - 6 feet, shall be measured on a per each basis for the type and diameter of the particular manhole. Measurement for ancillary items to the manhole, including but not limited to chimney seals, castings, adjusting rings and external joint seals will not be made; such work shall be incidental to the respective bid item.
- D. Extra Manhole Depth:** per diameter of manhole being installed shall be measured to the nearest one tenth (0.1) foot from the top of finish grade to the invert of the manhole minus the nominal 6 foot depth measured under Standard Manhole, Shallow Manhole, Termination Manhole, and Drop Manhole.
- E. Abandon Sewer Mains:** No separate measurement will be made for plugging abandoned sewer mains; such work shall be incidental to the project, unless otherwise specified.
- F. Abandon Manhole:** Measurement will be made on a per each basis for each manhole abandoned.
- G. Sewer Service New Connections and Reconnections with In-Line Sewer Service Wye or Tee:** Sewer service reconnections and sewer service new connections with in-line service wye or tee will be counted on a per each basis. When applicable, saddles will be furnished and installed by the City. The pipe used for connections and reconnections shall be measured and paid for under the bid item for sewer service pipe. Pipe couplings are incidental to the connection to the sewer service. All fittings and appurtenance required for change in direction of the sewer service pipe are incidental to the length of sewer service pipe.

- H. Adjust Manhole Frame and Cover:** Measurement will be made on a per each basis for each manhole frame and cover adjusted and includes adjusting rings for a complete installation. If there is an existing chimney seal the reinstallation of the chimney seal and extensions as necessary for a complete installation shall be considered as incidental to this item.
- I. Manhole Chimney Seal and Extensions:** Measurement will be made on a per each basis for each installation. The chimney seal installation includes the chimney seal and extensions, as necessary. This item is applicable for installations where an existing manhole is being retrofitted or adjusted.
- J. Reconstruct Manhole:** Measurement will be made on a per each basis for each manhole reconstructed. Reconstruct Manhole consists of the removal of or the addition of a new manhole barrel(s) or cone for vertical adjustment. Adjustments of the frame and cover associated with the addition of or removal of a barrel or cone shall be considered as incidental to this bid item.
- K. Reshape Manhole Invert:** Measurement will be made on a per each basis for each manhole that has the invert(s) reshaped and reconstructed.
- L. Sanitary Sewer Caps/Plugs:** Are incidental to the applicable bid item.
- M. Sanitary Sewer Cleanouts:** Measurement will be made on a per each basis for each type and size of cleanout installed.
- N. Sanitary Sewer Cleanout Cover Frame and Casting:** Measurement will be made on a per each basis for each type and size of cleanout cover frame and casting installed.
- O. Connection to Existing Manhole:** Measurement will be made on a per each basis for each connection to an existing manhole.
- P. Remove Manhole:** Measurement will be made on a per each basis for each manhole removed.
- Q. Remove Sewer Main:** Measurement will be made on a linear foot basis and shall be measured to the nearest foot if sewer main to be removed is located in a separate trench of any new utility being installed with the project. If the sewer main to be removed is located in the same trench of any new utility being installed with the project, removal of the sewer main shall be incidental to the installation of the new utility.
- R. Connection to Existing Sewer Main:** Measurement will be made on a per each basis for each connection to an existing sewer main. Pipe couplings are incidental to the connection to existing sewer main.
- S. Sanitary Sewer Force Main, Fittings, Valves, and Ancillary Items:** Installed quantities shall be measured conforming with the applicable provisions of Section 8A - Water Piping Systems and Section 8B - Corrosion Protection – Plastic Pipe Systems.

- T. Bypass Pumping:** Measurement will be made on a lump sum basis for bypass pumping, diversions and/or wastewater flow modifications including pumping equipment and operation of same for a complete installation for the entire project and may be multiple setups, startups, and stops. All other appurtenances to effectuate the bypass pumping are considered as incidental to this item.

9.5 BASIS OF PAYMENT

- A. Sewer Main Pipe:** Payment will be at the unit price bid for the appropriate size and depth of sewer pipe, furnished and installed, including , trenching, excavation, Type 1 bedding material, compacting, backfilling, dewatering, sheeting or shoring, compaction, and testing.
- B. Sewer Service Pipe:** Payment will be made at the unit price bid for the appropriately sized pipe, furnished and installed, including trenching, excavation and backfilling, bedding material, compacting, dewatering, tracing wire, and sheeting or shoring. The cost for any connections between the new service line and existing service lines shall be included in the unit price bid for the appropriate sized pipe.
- C. Standard Manhole, Standard Shallow Manhole, and Termination Manhole:** 0 - 6 feet. Payment will be made at the unit price bid for each type and diameter, furnished and installed including but not limited to the following ancillary items to the manhole: adjusting rings, frame, cover and external joint seals.
- D. Drop Manhole:** 0 - 6 feet. Payment will be made at the unit price bid for each diameter, furnished and installed, including but not limited to the following ancillary items to the manhole: adjusting rings, frame, cover and external joint seals. Price bid shall include the wye and the pipe installed from the wye to the floor of the manhole, and concrete encasement of lower connection and 45 degree fitting. No separate payment will be made for this pipe, wye, bend and concrete encasement.
- E. Extra Manhole Depth:** Payment shall be made at the unit price bid for that depth, per the appropriate manhole diameter, over and above 6 foot, which is paid for as Standard Manhole, Shallow Manhole, Termination Manhole, and Drop Manhole.
- F. Abandon Sewer Mains:** Payment for plugging abandoned sewer mains shall be incidental to the project, unless otherwise specified.
- G. Abandon Manhole:** Payment will be at the bid unit price and shall include all labor, materials, including concrete plugs, and granular backfill.
- H. Sewer Service In-Line Wye or Tee:** Payment will be made at the unit price bid for each size and type of fitting, furnished and installed.
- I. Sewer Service New Connection:** Payment will be made at the unit price bid for connecting new sewer services to the sewer main, including fittings necessary to connect the service line to sewer. When applicable, saddles will be furnished and installed by the City. Sewer service pipe will be paid for separately. Sewer service in-

line wye or tee connection to the main will be paid for separately. Payment for Sewer Service New Connection shall include Right to Work permit, New Account Setup/Inspection permit (tap permit) and tapping fees, unless otherwise specified in the detailed specifications, including all labor and material.

- J. Sewer Service Reconnection:** Payment will be made at the unit price bid for reconnecting existing sewer services to the sewer main, including fittings necessary to connect the service line to sewer. When applicable, saddles will be furnished and installed by the City. Sewer service pipe will be paid for separately. Sewer service wye or tee connection to the main will be paid for separately.
- K. Adjust Manhole Frame and Cover:** Payment will be at the unit price bid for adjusting manhole frame and cover, existing chimney seals, and includes adjusting rings.
- L. Manhole Chimney Seal and Extensions:** Payment will be made at the unit price bid for each installation.
- M. Reconstruct Manhole:** Payment will be made at the unit price bid for Reconstruct Manhole including new manhole barrel(s) and cone, or removal of manhole barrel(s) and cone.
- N. Reshape Manhole Invert:** Payment will be at the unit price bid for reshaping existing manhole inverts, including all materials, labor, equipment, wastewater flow diversions, modifications, and/or pumping.
- O. Sanitary Sewer Cleanouts:** Payment will be at the unit price bid for Sanitary Sewer Cleanout furnished and installed, including all labor and materials.
- P. Sanitary Sewer Cleanout Cover Frame and Casting:** Payment will be at the unit price bid for Sanitary Sewer Cleanout Cover Frame and Casting furnished and installed, including all labor and materials.
- Q. Connection to Existing Manhole:** Payment will be at the unit price bid and shall include all labor and materials.
- R. Remove Manhole:** Payment will be at the unit price bid and shall include all labor, materials, including concrete plugs, and backfill.
- S. Remove Sewer Main:** Payment will be at the unit price bid and shall include all labor, materials, including concrete plugs, and backfill.
- T. Connection to Existing Sewer Main:** Payment will be at the unit price bid and shall include all labor and materials.
- U. Sanitary Sewer Force Main, Fittings, Valves, and Ancillary Items:** Payment will be in conformance with the applicable provisions of Section 8A - Water and Section 8B - Corrosion Protection – Plastic Pipe Systems.

- V. Bypass Pumping:** Payment will be made on a lump sum basis for bypass pumping, diversions and/or wastewater flow modifications including pumping equipment and operation of same for a complete installation for the entire project and maybe multiple setups, startups, and stops. All other appurtenances to effectuate the bypass pumping are considered as incidental to this item.

END OF SECTION