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**PART II - CONSTRUCTION MATERIALS AND METHODS**

**SECTION 25.**

**SANITARY SEWER AND STORM DRAINAGE LINES**

**25.1. GENERAL**

Piping for all newly constructed sanitary sewer mains, sewer service lines, storm and irrigation drainage to be installed in easements or public right-of-way under the jurisdiction of the City, shall be installed in accordance with approved engineered plans and as hereinafter specified. These Specifications shall apply to all new construction within the City of Arvada.

All excavation, bedding, backfill and surface restoration required for the installation of any pipe covered by this section of the Specifications shall be performed in accordance with Section 20 of these Specifications.

The Contractor shall be properly licensed with the City of Arvada, obtain a permit and notify the Project Engineer in writing, twenty-four (24) hours before the planned construction is to commence or when work is to be resumed following a delay.

**25.2. MATERIALS**

Materials; other than bedding, backfill and trench resurfacing; which are to be placed within the trench limits, shall conform to the minimum standards hereinafter referred to.

Applicable Specifications for material as set forth by the American Society for Testing Materials (ASTM), the American Association of State Highway and Transportation Officials (AASHTO) and the Colorado Department of Transportation (CDOT) are made a part of these Specifications. Referenced standards are the latest edition or revision thereof.

**25.2.1 Pipe**

The pipe shall conform to the type indicated on the construction plans and to the specification noted in Table 25-1 of this section for the indicated type and application. All sanitary sewer mains shall be minimum eight inch (8") diameter. All sanitary sewer pipe joints within casing pipes shall be restrained. This may require the use of C900 PVC for sanitary sewer mains through casing pipes.

**25.2.2. Concrete**

See Section 10 of these Specifications.

**25.2.3. Mortar**

Freshly made uniform mix consisting of one (1) part Portland Cement, two (2) parts mortar sand and sufficient water to provide a workable paste.

**TABLE 25.1  
PIPE MATERIAL, SPECIFICATION AND BEDDING TYPE**

<b>SANITARY SEWER PIPE (NON-PRESSURE)</b>				
<b><u>MATERIAL</u></b>	<b><u>SPECIFICATION</u></b>	<b><u>DIAMETER (INCHES)</u></b>	<b><u>NOTES</u></b>	
(PVC) POLYVINYL CHLORIDE	ASTM D3034	4-15	(A)(B)	
(PVC) POLYVINYL CHLORIDE	ASTM F949	8-36	(A)(C)	
(PVC) POLYVINYL CHLORIDE	ASTM F679	18-27	(A)(B)(C)	
(PVC) POLYVINYL CHLORIDE	ASTM F1803	21-54	(A)(C)	
(PP) POLYPROPYLENE	ASTM F2736	12-30	(A)(C)	
(A) See Section 20 for Bedding Type, Limits, Gradation, and Compaction				
(B) SDR-35 Minimum				
(C) Minimum pipe stiffness of 46 psi				

<b>STORM SEWER PIPE (NON-PRESSURE)</b>				
<b><u>MATERIAL</u></b>	<b><u>SPECIFICATION</u></b>	<b><u>DIAMETER (INCHES)</u></b>	<b><u>NOTES</u></b>	
(HDPE) POLYETHYLENE	AASHTO M252	3- 10	(A)(B)	
(HDPE) POLYETHYLENE	AASHTO M294	12- 60	(A)(B)	
(NRCP) NONREINFORCED CONCRETE ROUND CLASS III	ASTM C14	12-24	(A)(H)	
(RCP) REINFORCED CONCRETE ROUND CLASS III	ASTM C76,C361,C655 AASHTO M170, M242	12-144	(A)(H)	
(RCA) REINFORCED CONCRETE ARCH	ASTM C506,C655	15-132(E)	(A)(H)	
(RCE) REINFORCED CONCRETE ELLIP.	ASTM C507,C655	18-144(E)	(A)(H)	
(RCB) REINFORCED CONCRETE	ASTM C789	Box	(A)(C)(H)	
(RCB) REINFORCED CONCRETE	ASTM C850	Box	(A)(D)(H)	
(PVC) POLYVINYL CHLORIDE	ASTM F794, F1803	21-48	(A)(F)(I)(J)(K)	
(ASP) ALUMINIZED STEEL TYPE 2	ASTM A760,A796,A891 AASHTO M274, M36	12-60	(A)(G)(L)	
(PE) STEEL-REINFORCED POLYETHYLENE	AASHTO MP20-10 ASTM D3212	12-60	(A)(N)	
(PP) POLYPROPYLENE	ASTM F2736	12-30	(A)(J)	

Note: Storm sewer or culvert pipe type shall be as designated on construction plans. If no designation, use of reinforced concrete pipe shall be required.

- (A) See Section 20 for Bedding Type, Limits; Gradation, and Compaction
- (B) Profile Wall - Type S, 2 ft. min. bury, 10 ft. max bury, bell and spigot joint with ASTM D3212 rubber gasket. Maximum overall deflection 5% after installation. Contractor shall submit deflection test results prior to acceptance.
- (C) Reinforced Box - Minimum cover 2 feet
- (D) Reinforced Box - Cover less than 2 feet
- (E) Equivalent round size
- (F) Closed profile wall
- (G) Existing soil must be tested to verify adequate service life of pipe before use
- (H) Rubber gasketed joints in accordance with ASTM C443 must be used. 1 ft. min bury. 11 ft. max bury thru 42" dia., 12 ft. max bury thru 78" dia., 13 ft. max bury thru 144" dia. Mastic joints shall only be used on projects where specifically approved by the Engineer.
- (I) Bell and spigot joints with ASTM D3212 rubber gasket
- (J) Minimum pipe stiffness of 46 psi
- (K) Minimum cover 2 feet or one pipe diameter (which ever is less) as determined by ASTM D2321
- (L) Coupling bands shall conform to AASHTO M36 and allow the use of o-ring gaskets as required
- (M) 1 ft. min bury, 16 ga., sizes 54-60 require 1.5 ft. min bury and 14 ga.
- (N) Minimum stiffness in accordance with ASTM F2562/F2562M, Class 1

**TABLE 25-1  
PIPE MATERIAL, SPECIFICATION AND BEDDING TYPE**

<b>UNDERDRAIN PIPE</b>				
<b><u>MATERIAL</u></b>	<b><u>SPECIFICATION</u></b>	<b><u>DIAMETER (INCHES)</u></b>	<b><u>NOTES</u></b>	
(PVC) POLYVINYL CHLORIDE	ASTM D-3034	4- 8	(A)(B)	
(HDPE) POLYETHYLENE	AASHTO M252	4- 8	(A)(C)	
(A) See Section 20 for Bedding Type, Limits; Gradation, and Compaction (B) SDR 35 Minimum, Perforated or Solid - White Color Only (C) Profile wall –Type SP, 30 ft. max bury, bell and spigot joint with ASTM D3212 rubber gasket				

<b>LINER PIPE</b>				
<b><u>MATERIAL</u></b>	<b><u>SPECIFICATION</u></b>	<b><u>DIAMETER (INCHES)</u></b>	<b><u>NOTES</u></b>	
(HDPE) POLYETHYLENE	ASTM D-3350	6- 18	(A)	
(HDPE) POLYETHYLENE	ASTM D-3350	21- 48	(B)	
(A) SDR-26 Minimum (B) RSC = 100, Grout annular void				

### CASING PIPE

<u>MATERIAL</u>	<u>SPECIFICATION</u>	<u>DIAMETER (INCHES)</u>	<u>NOTES</u>
(S) STEEL	ASTM A-53 Grade B	18-42	(A)

(A) Coal Tar Epoxy Coated (open cut installation), Welded Joint, Grout annular void to 10 psi

### JACKING PIPE

<u>MATERIAL</u>	<u>SPECIFICATION</u>	<u>DIAMETER (INCHES)</u>	<u>NOTES</u>
(RCP) REINFORCED CONCRETE	ASTM C76,C361,C655	36-84	(A)(B)

(A) Joint – Steel Bell & Spigot or External Steel Bell Band  
(B) Grout annular void to 10 psi

25.2.4. Manholes

Manholes for sanitary, storm and irrigation systems:

- A. Bases shall be cast in place or precast using Class "A" concrete.
- B. Risers, cones, bases and flat-tops shall be precast in accordance with ASTM C-478, and combined as follows:

Riser ID Ft.	Normal Top	Cone Opening
4	Eccentric Concrete (1)	24" Diameter
5	Eccentric Concrete (1)	24" Diameter
6	Flat-Top (2)	24" Diameter

- 1. Use flat-top when the distance between the top of the bench to the top of the manhole ring is less than six (6) feet.
  - 2. Reduce the ID to five (5) feet approximately 6'6" above the manhole bench.
- C. Interior concrete surface protective coating – The interior concrete surface of all exterior drop manholes and the adjacent upstream and downstream manholes shall be coated with one coat of 30 mil minimum thickness Sikadur 31 Hi-Mod Gel coating and two coats each 5 mil minimum thickness Sikagard 62 Epoxy coating over the Sikadur 31. Manhole base including bench and invert to be coated with two coats of Sikagard 62 Epoxy coating only. First Sikagard 62 coat shall be red color. Second coat to be gray color.

Also allowed is a minimum ½" thickness spray applied coating of Sewpercoat Calcium Aluminate Cement as manufactured by LaFarge Calcium Aluminates, Chesapeake, Virginia. Coatings shall be applied by coating manufacturer's certified applicators only.

25.2.5. Adjustment Rings

Leveling course and set ring adjustment; reinforced CI "A" concrete rings or HDPE Adjusting Rings. Maximum height of adjustment rings shall be twelve inches (12") total.

25.2.6 Rings, Covers, Grates and Frames

Gray cast iron conforming to ASTM A 48 Class 35 B as noted in section 3.1 of AASHTO M306. Ductile iron castings shall conform to ASTM A536. All castings shall be unpainted with machined metal bearing surfaces. Manholes, rings and covers may also be aluminum alloy A-132 and A-142 secondary furnished with positive lock down mechanisms. Covers shall be cast showing designate use (sanitary, storm, or water) and City of Arvada logo as shown in standard drawings. All castings for manhole rings and covers and storm sewer inlet grates and frames shall be manufactured in the United States of America. The following types have been approved for the application indicated.

RINGS & COVERS				
APPLICATION	Deeter	Neenah	East Jordan Iron Works	Castings, Inc.
Sanitary Sewer/ Storm Sewer 24"	1258	R-1706	2420 or 2408 with 2420 Z1 ring or 3624	550-31 (aluminum only)
Sanitary Sewer/ Storm Sewer 30"	1197	R-1798	2500	N/A
Type R Inlet	2018-A	R-1706-1S	2416	N/A

INLET FRAMES AND GRATES			
APPLICATION	Deeter	Neenah	East Jordan Iron Works
Type 16 Inlet	2502 - L	R-3362-1 (L) R-3363-1 (L)	7567 w/back (M Vane)

Note: Vane Grates shall be installed on all Type 16 Inlets unless otherwise approved by the Engineer.

25.2.7. Steps

Copolymer polypropylene plastic over 1/2" diameter Grade 60 steel, PS2-PFS as manufactured by M.A. Industries, American Step Company, or equal installed on non-staggered, fifteen (15) inch vertical centers.

25.2.8. Joint Sealant for Manhole Sections, Tongue and Grooved Pipe

Preformed water repellent sealant conforming to federal specification SS-S-210A superseding Interim Federal Specification SS-S-00210 headed "Sealing Compound, Preformed Plastic for Pipe Joints". Rub'r Nek LTM preformed gaskets as manufactured by the Henry Company or equivalent are acceptable.

25.2.9. Watertight Joint Seals for Manhole and Pipe Sections

Type M or O rubber gasket as recommended by the pipe or manhole manufacturer is required below groundwater level.

25.2.10. Chemical Joint Sealant

Acrylamide base gel grout, urethane effectiveness requirements set forth in the Environmental Protection Agency publication entitled, "Chemical Sealants for Elimination of foam grout or an approved equal. Grout shall exceed or meet the I/I". When handled and mixed in strict accordance with the manufacturer's recommendations the chemical grout sealant must: be able to react in moving water, withstand submergence in water without degradation and be impervious to water penetration over the life of the grout, be flexible after curing and be able to withstand freeze-thaw and wet-dry cycles; be biodegradable and resistant to concentrations of acids, alkalis and organics found in normal sewage.

25.2.11. Reinforcing

Deformed intermediate grade 40 or 60 steel.

25.2.12. Diapers

Burlap or cotton fabric type with two (2) longitudinal metal ribbon tie anchors.

25.2.13. Plugs

Watertight compression plug as recommended by the pipe manufacturer.

25.2.14. Dead End and Wye Marker

Nine (9) gauge steel wire attached to the dead end or wye on one (1) end and extended vertically to within twelve (12) inches of finished grade and attached to the equivalent of a 2" x 4" x 24" section of timber.

25.2.15. Storm Drain Inlets

- A. Curb inlets conforming to Colorado Department of Transportation Standard M-604-12.
- B. Valley Inlets conforming to Colorado Department of Transportation Standard M-604-13.
- C. Curb Inlets conforming to City and County of Denver (WMD) Standards S-616.1 through S-616.3.
- D. Precast Inlets for use in (A), (B) or (C) above are subject to the individual manufacturers obtaining written approval from the City Engineer for their specific design and fabrication procedures.

25.2.16. Transition Between Unlike Materials or Inline Size Changes

Prefabricated adaptors that are water tight, structurally sound and will provide a smooth continuous invert. Fernco or Calder strong back repair coupling or equivalent.

25.2.17. Concrete and Metal End Sections and Joint Fasteners

Conforming to the Colorado Department of Transportation Standard M-603-10.

25.2.18. Steel Casing for Bores

Welded steel casing pipe shall be ASTM A-53 Grade B steel and shall have an inside diameter as shown in detail W.-13, Bore Casing Details. Casing pipe installed by open cut methods shall be coal tar epoxy coated. Casing pipe that is bored shall not require epoxy coating but shall have 32 lb. anode bags cad welded to each end. The minimum wall thickness of the tubing shall be:

<u>Wall Thickness</u>	<u>Casing O.D.</u>
3/8"	30" and smaller
1/2"	32"-42"

25.2.19. Jacking Pipe

Reinforced concrete pipe of the class specified in Table 25-1 and having Steel Bell & Spigot or External Steel Bell Band joints. Joint bearing plates and longitudinal steel bars, to properly transmit the jacking thrust, shall be cast in place when specified in the special conditions.

25.2.20. Carrier Pipe Supports

Redwood skids (4" x 4" x 36") steel banded 15 to 30 degrees each side of the carrier pipe invert, at a maximum center to center spacing of twelve (12) feet.

25.2.21. Carrier Pipe Chucks

Redwood or plastic chucks banded 7 to 10 degrees each side of PVC carrier pipe crown, extended to clear the casing pipe by no more than three quarter (3/4) inch.

25.2.22. Casing Spacers and Insulators

APS Model SSI or SI with fusion bonded epoxy or PVC coating as manufactured by Advance Products and Systems, Inc., Lafayette, LA or equal, installed at a maximum center to center spacing of ten (10) feet along the carrier pipe invert with an additional spacer placed within 6" of each end of the casing pipe. Spacers shall be 8" width for carrier pipe 6" to 14" diameter, 12" width for carrier pipe 16" diameter or larger.

25.2.23. Tunnel Liner Plate

Liner plate shall be hot rolled carbon steel conforming to ASTM A-569. All plates shall be punched for bolting and fabricated as to permit complete erection from the inside of the tunnel. Two (2) inch diameter grout holes shall be tapped at the spacing and locations shown on the plans. Tapped holes shall be provided with a pipe plug screwed in place.

Plates shall be hot-dip galvanized in conformity with ASTM A-123 to provide a zinc coating of 2.5 oz. per square foot for both sides. Bolts and nuts shall conform with ASTM A-153 and be hot-dip galvanized.

25.2.24. End Seals for Casing Pipe

1/8" thick synthetic rubber wrap around water tight end seals with stainless steel bands shall be installed on casing pipe after carrier pipe insertion. End seals shall be APS Model AW Wrap Around End Seal as manufactured by Advance Products and Systems, Inc. Lafayette, LA or equal.

25.2.25. Sewer Service Saddles

Molded, gasketed "Wye" saddles shall be installed and manufactured to ASTM D3034, SDR 35, ASTM F679 and F1336 Specifications. Saddle shall be banded to the sewer main with stainless steel straps. Saddles shall be as manufactured by GPK Products, Inc. or equal. Inserta Tee fittings by Inserta Fittings with SDR 35 gasketed bell are also allowed. Also allowed are elastomeric flexible saddles as manufactured by DFW/HPI.

**25.3. INSTALLATION**

The installation of pipe material and appurtenances shall be performed in accordance with the acceptable practices set forth by the American Society for Testing Materials (ASTM), the manufacturer's recommendations, these Specifications and approved plans.

25.3.1. Interruption of Sanitary Service

The Contractor must in writing, advise affected users twenty-four (24) hours prior to performing work on a service or collector line which will interrupt a customer's wastewater line. Contractor prepared notices shall be hand delivered to each customer or occupant. If the occupant cannot be contacted, the written notice shall be left attached to the door knob or screen.

In addition, the Contractor must notify Arvada's Wastewater Division (720-898-7770) of the schedule for plugging and bypassing manholes necessary to isolate the line on which work is to be performed.

The Contractor shall provide all labor, materials and equipment to properly handle and divert all sewage flow when required for construction.

If sewage backup occurs and enters buildings, private property, irrigation ditches, streams or storm drains during Contractor's bypassing operations, the Contractor shall be responsible for clean-up, repair, property damage and all costs and claims.

A normal outage shall be a maximum of four (4) hours and between the hours of 8:00 a.m. and 2:00 p.m. If the outage will be greater than four (4) hours, the work shall be done in a manner to minimize the inconvenience to users, such as working at night in a continuous operation until service is restored. A connection which will require an outage longer than four (4) hours shall be subject to review by the City as to the appropriate time for performing the work.

If in the process of installing a connection, there exists an industry or building in the area that cannot be out of sanitary service such as a hospital, school, etc., the Contractor shall provide wastewater disposal service to them at all times during the performance of the work.

25.3.2. Excavation, Bedding and Backfill

See Section 20 of these Specifications.

25.3.3. Alignment and Grade

Sanitary and storm sewers, underdrains, irrigation ditches and their appurtenances shall be constructed to the line and grade specified on the approved plans.

The grade and alignment of the pipe or ditch being installed shall be controlled by means of laser beams or offset grade stakes, set in the field by professional survey parties. The Contractor shall be responsible to accurately transfer said grade and alignment to the trench and construct thereto.

25.3.4. Service Line Grades

Sanitary sewer services between the main and a point located seven (7) feet into the property or ten (10) feet behind and back of the sidewalk, whichever is the greater, shall be installed according to the following minimum grades:

<u>Pipe Diameter</u>	<u>Minimum Gradient Ft./100 Ft.</u>	<u>Minimum Fall In./Ft.</u>
4"	2.08'	1/4"
6"	1.04'	1/8"

25.3.5. Pipe Installation

Construction shall start at the low point in elevation or at an existing structure. Bedding and pipe shall be installed laying uphill to controlled grade and alignment.

Voids shall be created by hand excavation at each pipe joint to provide room for the pipe bell or grouted diaper, and prevent beam support at the joints.

Surfaces of the joints shall be clean and dry prior to installing Rub'r Nek LTM or O-ring gasket. After the jointing material is in place, the pipe section shall be carefully pushed home using approved methods of leverage. Care shall be exercised so that there is no damage to the ends of the pipe or the joint material so that a water tight joint is assured.

Tongue and groove concrete pipe shall be set to line and grade and the joint sealed by means of Rub'r Nek LTM or O-ring gasket. Diapered and grouted joints shall not be encased by bedding material until the grout has obtained its initial set along and under the haunches and up to springline of the pipe. Once the pipe sections have been joined and adjusted to line and grade, the section shall be secured in place by tamping bedding material along and under the haunches and up to springline of the pipe.

Pipe installed shall be maintained dry and free of gravel, dirt, animals and debris. Whenever work ceases for any reason, the unfinished end of the line shall be securely closed with a temporary watertight plug. No pipe sections shall be covered with bedding or backfill material until they have been inspected by a representative of the Engineering Department.

#### 25.3.6. Underdrains

Piped underdrains, when called for on construction drawings, shall be installed laying upgrade, the same as specified for pipe installation, except the pipe shall be encased in a free draining material (3/4" to 1 1/2" washed rock) and the vertical distance between the bells of the underdrain pipe and the carrier pipe to be installed shall not be less than six (6) inches. The lowest point on the underdrain line shall be daylighted and free draining.

The underdrain pipe shall be entirely encased with washed rock to the top of the pipe and then a layer of Mirafi 140N or equivalent shall be installed for the full width of the trench. Squeegee may be used to encase the underdrain pipe if the underdrain pipe is wrapped with a geotextile sock. All underdrain pipe including individual service line pipe shall be white in color.

Underdrains shall be continuous under each manhole or structure on the line. However, underdrains shall be connected to a double sweep wye with risers and threaded caps or compression plugs as shown in Drawing #SS-6 in each manhole to provide a cleanout access. Underdrain access shall be placed on opposite side of manhole steps. Underdrain access may also come into the side of the manhole thru the manhole wall where elevations dictate that the underdrain must be higher than the sanitary sewer. In these instances, no bends greater than 45 degrees will be allowed in order to pipe the cleanout into the manhole.

#### 25.3.7. Manholes

Construct in accordance with the City of Arvada Standard Drawings. Manholes shall be placed at maximum of 400 feet intervals along the sewer main regardless of main size and at all changes in alignment, grade or at other laterals leading into the sewer main.

The maximum interior drop through any manhole shall be 0.3 in. The main line shall be laid continuously through the manhole wherever practical and the base cast with Class "A" concrete from the pipe springline to at least eight (8) inches below the outside bottom of the pipe. The top of the base shall be shaped by sloping the manhole floor upward from the pipe springline to the manhole wall at the rate of two (2) inches per foot. Where half pipe is used or when the arch of the pipe is removed, the floor shall be finished over the exposed pipe wall to give a free draining, smooth monolithic finish. When placing concrete under the pipe to form the base, care must be exercised to prevent flotation of the pipe.

Where there are changes in alignment, grade or other laterals leading in, the base of the manhole shall be formed and the concrete placed therein. The flowlines through the base

shall be shaped to conform exactly to the lower half of the pipe to which it connects and left smooth and clean. Side branches shall be constructed with as large a radius of curvature as possible. The manhole floor shall be sloped to drain as herein above stated.

When stub-outs are required through the manhole wall or any type of structure, the bell end of the stub shall face upstream, be as close to the structure as possible and be plugged with a watertight compression seal. The barrel portion of the stub shall have Type "M" or "O" rubber gaskets around the OD of the stub placed four (4) inches back from each face of the structure wall, before dry packing and sealing in place. Where the walls of the structure are eight (8) inches or less in width, only one (1) gasket will be required.

After the manhole base concrete has been properly cured, for a period of not less than forty-eight (48) hours, the bearing area to receive a precast concrete barrel ring shall be cleaned of all laitance. Rub'r Nek LTM or equivalent shall be placed in the bearing areas and the precast section carefully lowered onto the bench so that the sealant will be forced out evenly from under the section and on all sides. Likewise, subsequent barrel sections, reducers, cones, flat-top sections and concrete riser rings installed shall be sealed. The joint between the manhole cover set ring and the cone section or riser ring it rests on shall also be sealed to prevent infiltration. Care shall be taken in setting subsequent sections to assure vertical alignment of the steps over the bench of the manhole.

Manhole cover set rings shall be set to grade in full bead of mortar over a maximum of three (3) concrete riser rings totaling no more than 12" in height above the cone or flat-top. HDPE adjusting rings are also allowed. Mortar shall be evenly placed around the exterior of the cover set ring to set the ring in place when the manhole is not in a paved area.

25.3.8 Marker Posts

When manholes are installed outside of a paved surface, a marker post shall be installed adjacent to the manhole. Marker post shall be a 5 foot tall 3 inch diameter steel post set in concrete to a depth of 2 feet. Post shall be filled with soil with a 6 inch concrete cap. Post shall be painted fire hydrant yellow.

25.3.9. Connecting to Existing Manholes

Where no existing pipe is stubbed out, the connection shall be made in such a manner that the finish work will conform as nearly as practical to that specified for a new manhole. The opening in the manhole wall shall only be made large enough to receive the new pipe barrel containing the Type "O" or "M" rubber gasket around its O.D. The existing foundation shall be chipped to the cross-section of the new pipe and a grouted smooth continuous invert shaped therein. Rub'r Nek LTM, non-setting epoxy, dry packed cement or a combination thereof shall be used to provide a watertight seal between the pipe installed and the manhole wall.

25.3.10. Alignment of Sanitary Service Lines

Sanitary service lines shall be aligned in the shortest, most direct path between the sanitary main and the house. Service line stubs shall be located five (5) feet from the low side of the lot and a minimum of ten (10) feet downstream from the water service line. The point where the line crosses under the curb shall be marked by chiseling a symbol "X" on the curb.

If necessary, the service may be constructed with no more than four horizontal 45 degree bends between the house plumbing and the sanitary sewer main. If more than two bends are used a two way cleanout must be installed in the service line between the house and the sanitary sewer main. A two way cleanout must also be installed at a maximum interval spacing of 100 feet in all residential sanitary sewer service lines over 100 feet long. House

plumbing shall come out of the house on the side paralleling the main to which the connection is to be made.

Manholes and/or cleanouts shall be installed in commercial or industrial service lines, between the building and sewer main at all horizontal changes in flow and/or at a maximum interval spacing of 100 ft. Installation shall be performed in the same manner as specified for main line installations.

Sanitary service lines are not allowed to cross property other than the property being served, unless prior approval has been obtained from the City Engineer. Except as permitted below, the underground water service pipe and the building drain or building sanitary sewer shall be not less than ten (10) feet apart horizontally and shall be separated by undisturbed or compacted earth. Under extenuating circumstances, the sanitary sewer service pipe may be placed in the same trench with the building drain or building water service pipe provided prior written approval is given by the City Engineer and the following conditions are met:

- A. The bottom of the water service pipe at all points shall be at least twelve (12) inches above the top of the sewer line at its highest point.
- B. The water service pipe shall be placed on a solid shelf excavated at one side of the common trench.
- C. The water service line is one (1) continuous section of Type "K" copper tubing, joint free.
- D. The material and joints of the sewer service pipe shall be installed in such manner and shall possess the necessary strength and durability to prevent the escape of solids, liquids and gases therefrom under all known adverse conditions such as corrosion, strains due to temperature changes, settlement, vibrations and superimposed loads.

Service crossing under existing sidewalk or curb must be bored, jacked or tunneled through the earth under the concrete.

Service stub-ins shall be extended ten (10) feet beyond property line and then be plugged or capped with a gasketed plug or cap and a dead end marker installed. Glued plugs or caps are not allowed.

#### 25.3.11. Tapping Sewer Mains

Tapping sewer mains to connect six (6) inch and larger service lines or those which serve buildings intended for industrial, manufacturing or other "process" uses, will not be allowed. This size and type of service shall be connected to the main through a manhole with a formed invert.

To connect four (4) inch service lines, where wyes have not been installed in the sewer main, the main shall be machine tapped by the Contractor using a hole saw. Molded, gasketed "Wye" saddles shall be installed and manufactured to ASTM D3034, SDR 35, ASTM F679 and F1336 Specifications. Saddle shall be banded to the sewer main with stainless steel straps. Saddle shall be as manufactured by GPK Products, Inc. or equal. Inserta Tee fittings by Inserta Fittings with SDR 35 gasketed bell are also allowed. Also allowed are elastomeric flexible saddles as manufactured by DFW/HPI. The drilling machine and method of drilling are subject to approval by the City Engineer.

The City's inspector shall inspect the main and saddle for each tap prior to backfilling. In the event the tap is covered before it is inspected, it shall be dug out by the Contractor and any

bedding material around the fitting shall be removed to allow visual inspection of the tap and the main. If the main sewer line is cracked or broken during the process of locating and tapping, it shall be repaired immediately by replacing the broken section with a section of new PVC sewer main.

25.3.12. Sewer Service Connection Wyes and Riser Stubs

Cap with a gasketed watertight plug or cap and install a 2" x 4" timber which extends vertical from the stub to a minimum of twelve (12) inches above finish grade.

Wyes shall be angled upwards so that the upper invert of a one-quarter (1/4) bend connected to the fitting will have an elevation equal to or higher than the inside crown of the main line.

Riser connections will be required to be installed on deep lines so as to extend from the wye fitting on the main line to an elevation of not less than ten (10) feet below finish grade.

25.3.13. Curb and Valley Inlets

Form and cast in place in accordance with the City of Arvada Standard Drawings, using Class "A" concrete. Precast inlets shall be placed on compacted subgrade to correct line and grade.

25.3.14. Contamination and Dilution

During construction and until such time that the new lines have been tested and accepted for warranty, the point of connection to the existing system shall remain plugged. Dilution of normal sewage flows with ground water or debris from the new lines will not be allowed.

25.3.15. PVC Pipe Storage

Pipe stored outside and exposed to sunlight for more than 30 days shall be covered with a solid canvas to block the light. Clear plastic is not allowed as a cover. Air circulation shall be maintained under the covering.

**25.4. REHABILITATION OF SEWER MAINS, LATERALS AND MANHOLES**

Rehabilitation of sewer lines and manholes by means of sliplining, cured in place pipe, expanded in place pipe, pipe bursting, point repair or joint sealing methods shall be performed in accordance with the requirements set forth herein.

Prior to proceeding with the rehabilitation work; each section of pipe between manholes shall be cleaned, televised and the exact location of all service connections, pipe or joint failures, root intrusion and other defects documented with respect to the insertion manhole.

25.4.1. Care of Raw Sewage

Bypassing sewage around the section or sections of the system being rehabilitated shall be performed by the Contractor in a manner such that the dumping of raw sewage onto City streets or private property, into irrigation ditches, streams, or storm drains is not allowed. Bypassed sewage shall only be discharged into a downstream sanitary sewer manhole.

The Contractor shall submit in writing to the Project Engineer, prior to starting construction, a detailed outline of the method he proposes to use in handling and bypassing raw sewage. The pumps and bypass lines shall be of adequate capacity and size to handle all sewage flows.

No service or trunk line is to be plugged and left for a period of time during rehabilitation which would cause backup into buildings.

Diversion of sewage by means of diesel or gasoline pumps will only be allowed during working hours. No pumps, except city approved electrical pumps, are to be operated during non-working hours.

If sewage backup occurs and enters buildings, private property, irrigation ditches, streams or storm drains, the Contractor shall be responsible for clean-up, repair, property damage and all costs and claims.

25.4.2. Sewer Line Cleaning

Designated sewer pipe sections to be rehabilitated, between consecutive manholes, shall be cleaned by means of approved mechanically powered, hydraulically propelled or high velocity cleaning equipment. The equipment selected for cleaning shall be capable of removing dirt, grease, rocks, sand and other deleterious materials or obstructions from lines and manholes. Equipment used shall also provide a high-velocity gun for washing and scouring manhole walls and floors.

- A. Precautions: During cleaning operations the Contractor shall take all necessary precautions to protect the lines from damage that could result by the improper use of cleaning tools and equipment. Whenever hydraulically propelled cleaning tools, which depend upon water pressure to provide their cleaning force or any tools which retard the flow of water in the sewer are used, precautions shall be taken to ensure that the water pressure or surcharging does not cause damage or flooding of private or public property.

Water required to construct or maintain capital improvement projects may be obtained from the City, at no cost to the Contractor, providing the following conditions are adhered to:

1. Contractor must pay a deposit in accordance with Section 102-69 of the Arvada City Code with the Utility Division of the Public Works Department and obtain a designated fire hydrant permit, valve and meter. Deposit will be refunded, subject to the valve and meter being returned in equal condition as obtained.
2. Water consumption is reported to the Utility Division, on no more than seven (7) day intervals.
3. No water is drawn from the designated fire hydrant during fire demand in the immediate area.

- B. Root Removal: Roots shall be removed in the designated sections where root intrusion is a problem. Special precautions should be exercised during removal to assure complete removal of visible roots from the pipe joints. Any extensive visible roots which could impede installation of a liner pipe shall be removed. Procedures may include the use of mechanical devices such as expanding root cutters and porcupines, hydraulic procedures such as high pressure jet cleaners or chemical foaming.

- C. Material Removal and Disposal: Sludge, dirt, sand, rocks, grease, roots and other solid or semi solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from manhole section to manhole section which may cause service plugging or line

stoppage will not be permitted. Solids and semi solids collected in each manhole shall be removed and disposed of at a site approved by the Colorado Department of Health. Under no circumstances will the Contractor be allowed to accumulate debris, etc. on the site for more than four hours, except in totally enclosed containers. Obnoxious smelling materials shall be immediately removed from the site.

25.4.3. Flow Control

Sewer line flows, at the upstream manhole of the pipe section being worked, shall not exceed those shown below for the respective pipe line size as measured in the manhole for performing television inspection, joint testing or sealing tasks.

Maximum Line Flow		
Pipe ID Inches	Television Inspection % Full	Joint Testing/Sealing % Full
6-10	20	-
6-12	-	25
12-24	25	-
15-24	-	30
24 & larger	30	35

Control of flows in lines may be accomplished by pumping and by-passing, plugging or blocking methods. Providing, however, sufficient precautions are taken to prevent flooding or damage to private property, contamination of irrigation ditches or streams and surcharged lines. Should flooding, surcharging, contamination of streams and/or damage to property occur, the Contractor shall be held responsible to make all repairs and pay all claims at his expense. Also, all engines shall be equipped in a manner to keep pump noise at a minimum. Pump discharge of sewer flows in streets, storm sewer inlets or streams will not be allowed.

25.4.4. Television Inspection

Immediately following line cleaning, each pipe section between manholes shall be visually inspected under controlled flow conditions by means of closed circuit television. The camera and equipment used shall be one specifically designed and constructed so as to provide a clear photograph and/or video picture for the entire periphery of the pipe, while operating in 100% humidity conditions.

During inspection of the line the exact location of service taps, defective pipe joints, cracked pipe, roots, intrusion, infiltration, sagging line, obstructions etc. shall be documented with respect to the metered distance from the insertion manhole. Documentation so developed shall be reviewed with the Project Engineer to determine the type and extent of the repair necessary to rehabilitate the line.

25.4.5. Point Repair

Point repair of a sanitary sewer line shall be the removal and replacement of a defective section or joint of pipe at a specified location in the line, including removal, replacement and reconnection of any sewer services found connected thereto.

- A. Service Lines: Service line wyes or tees, connected to the defective pipe, shall be reconnected. The service line, if also found defective shall be replaced with ASTM D-3034 PVC pipe to the first solid section of the existing service line pipe or to

property line, whichever is the lesser. Portions of existing service lines, determined to have been broken by the Contractor shall be replaced at no cost to the City.

- B. Exposing Defective Pipe: Excavation shall expose the area of defective line and at least five (5) feet of solid pipe on either side of the proposed repair area. Excavation, bedding, backfill, resurfacing etc., shall be performed in accordance with the applicable section of these standard Specifications.
- C. Defective Joints and Pipe: Excavations that reveal defective pipe joints, collapsed or cracked pipe shall be repaired or replaced as directed by the City Representative. The defective pipe section shall be removed and replaced with ASTM D-3034 PVC pipe of equal diameter to that being removed. Reconnection of the new pipe, to the pipe allowed to remain, shall be made using Calder or Fernco adaptors providing the ends of the section to be connected have been severed smooth and at 90 degrees to pipe centerline.
- D. Sewage Handling: Handling sewage flows while making a point repair shall:
  - 1. Be the responsibility of the Contractor.
  - 2. Not cause flooding or damage to private property or contamination of ground water, irrigation ditches or streams.

#### 25.4.6. Sliplining

Sliplining of a pipe shall be the insertion of a polyethylene resin liner pipe into an existing sewer line section, between specified manholes, including reconnecting service lines connected thereto.

- A. Excavation: Excavation for access shafts and at all service reconnects shall be made prior to insertion of the liner. Excavations shall create a void sufficient in size to provide ample working room to install all seal clamps and saddles with sufficient clearance to encase same with cement stabilized sand.

Access shafts are to be located at intermediate points where the liner is to be inserted into the existing system. Where possible, the shafts should coincide with a building service connection, an existing manhole or at critical deviations in line or grade. The distance between access shafts shall be not less than 300 feet or more than 900 feet, unless waived in writing.

- B. Obstruction in Existing System: Obstructions such as protruding service connections, solids, tree roots, etc., that might prevent the entry or damage to the liner pipe shall be removed prior to commencing insertion of the liner.
- C. Jointing of Liner Pipe: Jointing of liner pipe section shall be by the heat and butt fusion method and in strict conformance with the manufacturer's recommendations.

Sections of the plastic liner shall be joined and assembled in insertion lengths, above ground and on the site, in accordance with ASTM D-2657. Joints between liner sections shall be smooth on the inside and external projection beads shall not be greater than 0.10 inches.

- D. Care of Raw Sewage: By-passing sewage around the section or sections of the system being lined shall be performed in a manner such that the dumping of raw sewage onto City streets or private property, into irrigation ditches, streams, or storm drains is not allowed.

The Contractor shall submit in writing to the Project Engineer, prior to starting construction, a detailed outline of the method he proposes to use in handling raw sewage.

No service or trunk line is to be plugged and left for a period of time which would cause backup into buildings.

- E. Liner Insertion: Insertion shall be made through an access shaft. The top of the existing main shall be exposed in the shaft to springline for its full length, prior to the cutting and removal of any portion of the existing pipe arch.

A cable from the drum of a power winch shall be strung through an existing manhole and line to the access shaft and then attached to a manufacturer furnished pulling head which has been securely anchored to the insertion liner. The power winch shall then be engaged and cause the cable to pull the liner section back through the existing line from the point of feed.

Precautions shall be taken during insertion so as not to over stress or damage the liner or cause the butt-fused joints to rupture.

As soon as the liner is in place, reached static equilibrium, and pressure tested, in the event there is reason to believe the liner was damaged, it shall be secured to the manhole walls by filling the annular space with a mechanical seal, chemical seal or combination of both. The method selected must be approved in writing by the City Engineer prior to starting construction.

- F. Service Connections: Service reconnects shall be made as soon as the inserted liner reaches static equilibrium following the insertion of the liner.

A portion of the existing sewer around each service connection shall be removed to expose the new liner pipe and a prefabricated polyethylene saddle installed between the liner and the service. Care shall be exercised to assure the four (4) inch or six (6) inch stub-out attached to the saddle protrudes into the polyethylene liner a distance equal to the wall thickness of the liner pipe. The stub-out shall then be attached to the service lateral and the liner pipe with a CAM-TEX fitting and secured to both with stainless steel bands. The fitting, service line and liner pipe shall then be encased in twelve (12) inches of cement stabilized sand.

Cement stabilized sand shall be placed in a dry void around the connection in six (6) inch lifts. Each lift shall be hand tamped and care shall be exercised at all times to prevent damage or collapse to the liner, service connection or lateral.

- G. Liner Connection in Trench: Liner pipe connections between manholes shall be made immediately following the reconnection of services to the line. The liner shall be trimmed in the trench so that the abutting ends are within one (1) inch of each other and then connected with a watertight stainless steel seal clamp.

The exposed liner and clamp shall then be encased in cement stabilized sand, placed in the same manner and limits as specified for service connections.

- H. Existing Manholes Used for Access Shafts: Manholes used as access shafts shall be rebuilt to conform with these standard Specifications. Material from an existing manhole which is salvaged in good condition may be reused.

- I. Exfiltration: Exfiltration tests shall be performed prior to reconnecting services when difficulties are encountered during pulling operations, indicating obstruction in the line may have caused damage to the liner.
- J. Resurfacing: Backfill and resurfacing at points of excavation shall be performed in accordance with Section 20 of these standard Specifications.
- K. Slip Liner Pipe - Polyethylene resin conforming to ASTM D-1248 and classified as Type III, CI C, Category 5, Grade P-34. Pipe and fittings after extrusion and fabrication shall conform to ASTM D-3035 so that when measured in accordance with ASTM D-2122, it will meet the following dimensions:

Sewer ID Inch	Liner Min. OD Inch	Minimum Wall Thickness Inches	
		SDR 32.5	SDR 21
6	5.375	0.166	0.256
8	7.125	0.220	0.340
10	8.625	0.266	0.411
12	10.750	0.331	0.512
15	13.380	0.416	0.634
18	16.000	0.493	0.762
21	18.700	0.576	0.891
24	22.047	0.679	1.050
27	24.803	0.764	1.182
30	27.953	0.861	1.332

Tolerances: OD + (.004 + .001 Diameter)  
Wall Thickness + .12% Minus 0%

Pipe wall thickness conforming to SDR-21 shall be used when ground water elevation is found to be two (2) feet or more above the pipe centerline.

- L. Liner Pipe Joints shall be joined by thermal butt-fusions conforming to ASTM D-2657 and provide a tensile strength at the fused joint equal to the parent material when tested in accordance with ASTM D-638.
- M. Service connections to liner pipe shall be made using a prefabricated neoprene gasketed polyethylene CAM-TEX saddle with two (2) stainless steel bands and then encased with cement stabilized sand.  
  
Heat fused saddles or shrink sleeves may be used, subject to request and approval by the City Engineer in writing, prior to starting construction.
- N. Manhole sealant shall be a mechanical seal or chemical seal as recommended by the manufacturer.
- O. Seal clamp for joining plastic liner pipe in access shafts shall be a circle stainless steel seal clamp, furnished by the manufacturer. Length of said clamp shall be one and one-fourth (1-1/4) times the OD of the liner pipe or fifteen (15) inches, whichever is the greater.
- P. Cement Stabilized Sand shall consist of equal parts of Portland Cement and fine aggregate, as specified in Section 10 of these Specifications, mixed dry and then hand tamped in place in six (6) inch lifts.

25.4.7. Joint Sealing and Testing

Joint sealing and testing of a pipe line shall only be performed after the line has been thoroughly cleaned. Work shall be performed in one continuous operation after initial insertion of the equipment into the line. The order of work to be performed shall be:

Progressive televising of line to locate each pipe joint or point of line failure.

Air testing of each joint or failure.

Chemically grout sealing of the joints or area that fail the air test.

Retest of the joint or failed area that was sealed, prior to proceeding further into the line.

A. Equipment: The basic equipment to be used shall consist of:

1. Television camera with viewing and recording attachments.
2. Combination air test and sealing packer heads, sized to the line being investigated.
3. Air pressure monitoring, metering and recording equipment accurate to one psi of differential pressure variation.
4. Cables, pumps, regulators, valves, hoses, gauges, approved chemical grout sealants, mixing chamber etc. necessary to control the volume and pressure during injection of the chemicals.

The Contractor may be required by the field representative at any time during the project to satisfactorily demonstrate the effectiveness and accuracy of his equipment. This may require system purging, gauge calibration and "zeroing" system "proof" tests in pipe barrel sections and open sewer laterals to show that the system is operating properly, and other demonstration required by the Project Engineer to ascertain the continued effectiveness of the testing and sealing equipment. At no time shall the packer-heads, when expanded, exert a pressure in excess of 25 psig against the barrel.

B. Air Test Procedure: Testing procedure shall consist of applying a precise pressure of no less than six (6) psig in excess of ground water pressure into the void area which has been formed to isolate the joint. When the pressure has been reached on the ground level meter for a sufficient time to stabilize the system, the application of pressure shall cease. The pressure recording meter shall be observed for a period of 30 seconds. Should the pressure in the void area drop one (1) psig or more, the joint will have failed the test and shall be sealed.

C. Joint Sealing Procedure: Joint sealing shall be accomplished by two separate pumping systems capable of supplying an uninterrupted continuous flow of approved chemical sealing materials at rates of between 1/4 and ten (10) gallons per minute at a minimum pressure of six (6) psig, for a continuous period of up to ten (10) minutes. Each pumping system shall include a tank for mixing additive solids and liquids which will form the final grout mixture. The system of pumps or pressure devices shall continuously maintain the exact manufacturer's ratio of the fluids contained in the mixing tanks. Jetting or driving pipes from the surface that could cause damage or cause undermining of the pipe lines shall not be allowed. The packer shall be positioned over the area of infiltration by means of a distance metering device and the closed circuit television camera in the line. This metering

device shall be checked daily or at the field representative's request. The packer sleeve so positioned shall be expanded using precisely controlled pressures not to exceed 25 psig. The packer sleeve inflation system shall be constructed so that pressure in the elements can be increased or decreased at any time during a joint sealing operation. The pneumatically expanded sleeves or elements shall seal against the inside periphery of the pipe to form a void area at the joint or point of infiltration, which is now completely isolated from the remainder of the pipeline. The thoroughly mixed sealant material shall be pumped through the hose system into this isolated area under controlled pressures which are in excess of the ground water pressures.

To insure the complete mixing of the grouting materials, the sealing device shall contain a mixing chamber which accepts sealant materials, including initiator, activator and additives from the pumps and dual hose system, and combines them into a single catalyzed liquid which is then injected from a single orifice into the void area formed by the packer and the pipe wall.

The diameter of the orifice exiting from the mixing chamber shall be no greater than the largest hose of the dual hose system. The discharge orifice and dual hose system shall be connected to a mixing chamber which enables all components of the final grout to combine into a single mixing conduit.

The mixing chamber shall combine the proportioned grouting materials from the pumps and dual hose system and discharge them into the void area formed by the pipe wall and the packer as a completely catalyzed and homogeneous grout. To insure a predictable and consistent product at all times, sealing systems which do not include a mixing chamber and/or inject the grouting fluids unmixed from more than a single discharge orifice will not be allowed.

The pumps, meters and packer shall be integrated so that the proportions and quantities of materials and pressures for sealing can be regulated in accordance with the type and size of pipe, percentage of voids being filled, type of soil surrounding the pipe, and the rate of flow of sealing solution in relation to the back pressures.

D. Sealing Verification: Each sealed area or joint shall be air tested upon completion of the sealing operation. The sequence of retesting to be performed shall be:

1. Reduce pressure in the inflatable packer bladders such that complete 360 degree contact is no longer maintained with the pipe wall.
2. Pressurize the testing system and make certain that a free flow of testing medium is allowed to pass through the testing device.
3. Move the packer forward and backward or employ other (mechanical) scraping methods to dislodge loose grouting material from the joint.
4. Reposition the packer on the previously sealed joint and test as required by the sewer line joint testing procedure.

Joints that fail to meet this test criteria shall be resealed and retested until the test criteria can be met. All joints sealed shall be required to pass a minimum air pressure test, applied at the location or joint, equal to 0.43 psig per foot of depth of the sewer, or 6 psig, whichever is greater.

- E. Residual Grout Material: Residual sealing material that protrudes into the pipe, adhere to roots or restrict the flow, shall be removed from the sealed area. The sealed areas or joints shall be left reasonably "flush" in dimension with the existing pipe surface. To insure that all grouting material has been removed from the interior of the pipe, all pipe sections which have been chemically grouted shall be cleaned with a high-velocity sewer cleaning jet.
- F. Records: Complete records shall be kept on all sealing performed between manhole sections on City of Arvada forms or equal. These records shall document the location of the manhole section in which sealing was performed, station location of each joint, amount of material used to seal the area or joint, numbers of injections required to complete the seal, test verification results, inspector's name, date, and Contractor's field representative.

25.4.8 Cured In Place Pipe (CIPP)

CIPP rehabilitation of pipelines and conduits shall be the installation of a resin-impregnated flexible tube which is inverted into the original conduit by use of a hydrostatic head. The resin is cured by circulating hot water or steam within the tube. When cured, the finished pipe (CIPP) will be continuous and tight fitting.

The work shall consist of cleaning, TV inspecting, and preparing the sewer, by-pass pumping as required, installing and curing the resin-impregnated tube, testing the installed CIPP, and reconnecting all live service lines.

The work shall consist of furnishing all labor, material, tools, equipment, and incidentals necessary to complete the project.

- A. Methods: CIPP must be constructed with a process that has been approved by the City of Arvada Engineering Division. All approved methods must meet these Specifications. Any proposed deviation from these Specifications must be submitted in writing for approval. Any and all departures from these Specifications must be pointed out and shown on the material submitted.

If an alternate process is approved, the Contractor shall accept the responsibility for the performance of the installation and if it does not meet the intent or standard of the specified process/installer, the City reserves the right to have the installation removed and reinstalled, or corrected at the Contractor's expense.

- B. Referenced standards: These CIPP Specifications reference the following American Society for Testing and Materials (ASTM) standard Specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof:

<u>ASTM STANDARD</u>	<u>DESCRIPTION</u>
F-1216	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
D-5813	Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe
F-1743	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)
D-790	Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics
D-638	Standard Test Method for Tensile Properties of Plastic

Where conflicts exist between the referenced standard and these Specifications, these Specifications shall govern.

C. Submittals: The following submittals are required prior to start of CIPP construction.

1. The Contractor shall provide documentation of a minimum of three (3) year commercial use of CIPP in city sanitary sewer systems. A minimum of 15,000 LF of successful sanitary sewer rehabilitation in the United States must be documented to assure commercial viability of the process.
2. The Contractor shall submit a tabulation of all projects completed in the past 5 years. This tabulation shall include the name of the city, sewer district or company, name of persons to contact, telephone number, address, year installed, size of pipe, length of line per size, total cost of project, and official acceptance date of the project. Failure to include this tabulation may constitute grounds for disqualification.
3. The Contractor shall certify that the CIPP shall meet the chemical resistance requirements of ASTM F-1216, appendix X2 and ASTM D-5813. Samples of testing shall be of tube and resin system similar to that proposed for actual construction. It is required that samples with and without plastic coating meet these chemical testing requirements.
4. The Contractor shall submit test results from previous field installations made within the previous 12 months in the USA of the same resin system and tube materials as proposed for the actual installation. These test results must verify that the CIPP physical properties listed in Table 1 of ASTM F-1216 have been achieved in previous field applications and shall also meet the requirements of ASTM D-5813.
5. The Contractor shall submit design calculations per ASTM F-1216, appendix X1 for each wall thickness proposed on the project.

D. CIPP Material:

1. Tube. The tube material shall meet the requirements of ASTM F-1216, Section 5.1 and ASTM D-5813.

The tube shall have a uniform thickness that when compressed at installation pressures will equal the specified nominal tube thickness. The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion.

The outside layer of the tube (before inversion) shall be translucent plastic coated with a flexible material that clearly allows inspection of the resin impregnation (wet-out) procedure. The plastic coating shall not be subject to de-lamination after curing of the CIPP.

The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials shall be included in the tube that are subject to delamination of the cured CIPP.

The wall color of the interior pipe surface of the CIPP after installation shall be white or light brown so that a clear detail examination with closed circuit television inspection equipment may be made.

2. Resin. The resin system shall meet the requirements of ASTM F-1216 and ASTM D-5813.

E. Structural Requirements: The CIPP shall be designed in accordance with ASTM F-1216, Appendix XI. The design shall assume no bonding to the original pipe wall.

The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers cleanly with a pointed probe; nor shall separation of the layers occur during testing as required by this specification. The CIPP shall conform to the minimum structural properties as listed in Table 1 of ASTM F1216 and requirements of ASTM D-5813.

The cured pipe material (CIPP) shall conform to the minimum structural standards, as listed below:

Flexural Stress (ASTM D-790) 4,500 psi

Modulus of Elasticity (ASTM D-790) 250,000 psi

Chemical Resistance (ASTM D-453) loss not to exceed values for required strength

The Proposer shall determine the actual lengths of the material needed by field verification.

F. Installation:

Except as otherwise indicated, comply with Section 7 of ASTM F-1216 (Direct inversion method).and requirements of ASTM F-1743 (Pulled in place method).

The Project Engineer and his representative shall at all times have access to the work wherever it is in preparation or progress. The Contractor shall provide proper facilities for such access and for inspection.

The Contractor shall at all times maintain a clean and sanitary work site. Any spillage of wastewater on the ground surface shall be cleaned immediately and the area thoroughly washed down with fresh water.

G. Inspection of Pipelines: Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles, and service connections by close circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the impregnated tube into the pipelines, and it shall be noted so that these conditions can be corrected. A video-tape and suitable log of the pre-insertion inspection shall be prepared by the Contractor and submitted to the Owner. The Contractor will be responsible for any by-pass pumping of sewer to perform this work.

H. Line Obstructions: It shall be the responsibility of the Contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of the line. If inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the inversion process, and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the City representative prior to the commencement of the work and shall be paid for based on the bid price for this item.

- I. Notification of Adjacent Property Owners and Managers: The Contractor shall as a minimum, be responsible for contacting each home or business connected to the sanitary sewer and informing them of the work to be done, and when the sewer will be off-line and the following:
1. Written notice to be delivered to each home or business describing work, schedule, how it affects them and a local telephone number of the Contractor they can call to discuss the project or problems.
  2. Personal contact on the day of pre-installation inspection of the sewer. Each lateral shall be verified by having the homeowner run water down their drain. If the homeowner is unavailable, other arrangements shall be made to drain water through the lateral.
  3. Personal contact and written notice shall be made 24-hours prior to beginning rehabilitation of the section of sewer to which they are connected.
  4. Personal contact with any home or business which cannot be reconnected within the time stated in the written notice.
  5. If so required by a served business or homeowner or at the discretion of the Project Engineer, portable toilets for use by the occupants will be furnished and serviced by the Contractor.
  6. All written or personal contacts shall be coordinated with the City's inspector.
- J. Resin Impregnation: The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with an additional 5% to 10% allowance for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used to uniformly distribute the resin throughout the tube.
- K. Temperature Gauges: During the curing process, gauges shall be placed to determine the temperature of the incoming and outgoing water from the heat source.
- Another such gauge shall be placed inside the tube at the remote end to determine the temperature at that location during the cure cycle.
- Installation and curing shall be accomplished by inversion utilizing water under hydrostatic pressure of a vertical standpipe.
- L. Service Connections: After the CIPP has been installed, the Contractor shall reopen/restore the existing active service connections and branch connections. It is the intent of these Specifications that active service connections and branch connections be reopened without excavation, and in the case of non-man entry pipes, from the interior of the pipeline utilizing a remotely controlled curing device, monitored by a closed circuit television camera, that re-establishes them to not less than 95 percent capacity, while conforming to the shape of the existing opening.
- The Contractor shall certify he has a minimum of two complete working cutting devices, plus spare key components on the site before each inversion.
- No service connection shall remain out of service for more than 24 hours at a time without the Contractor, at his own cost, providing some means of temporary facilities or hotel accommodations for the residents.

No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

- M. Workmanship: The finished pipe shall be continuous over the entire length of an inversion and shall be free of dry spots, lifts, and delaminations. If these conditions are present, the Contractor shall remove and replace the CIPP in these areas at no cost to the Owner.

If the CIPP does not fit tightly against the original pipe at its termination points, the space between the pipes shall be sealed by filling with a resin mixture compatible with the CIPP.

Where the CIPP passes continuous through manholes during an inversion, the top of the CIPP shall be removed cleanly and flush with the manhole shelf.

- N. Testing and Inspection:

1. CIPP Samples. CIPP samples shall be prepared and tested in accordance with ASTM F-1216, Section 8.1 using both methods 8.1.1 and 8.1.2 and also in accordance with ASTM D-5813 . The results shall be submitted to the Owner.
2. Leakage Testing. Leakage testing of the CIPP shall be accomplished during cure while under positive head. CIPP products in which the pipe wall is cured while not in direct contact with the pressurizing fluid (e.g., a removable bladder) must be tested by an alternative method of an acceptable low pressure air or water exfiltration test at 4 to 5 psi above the groundwater pressure.
3. Visual Inspection. Visual inspection of the CIPP shall be in accordance with ASTM F1216, Section 8.6 and ASTM D-5813. The Contractor will provide the City's Wastewater Division with a color video-tape. The tape will include both the before and after conditions, the restored connections with addresses each connection serves, in audio, on the video-tape.

- O. Patents: The Contractor and the Contractor's supplier shall warrant and save harmless the City against any and all claims and potential litigation involving patent infringement and copyright violations and any loss thereof.

- P. Warranty: The Contractor and the manufacturer shall warranty all materials and workmanship for a period of two (2) years. The warranty shall cover, but will not be limited to the following:

1. Defects discovered in material used in the project
2. Failure of liner to remain formed to the previously existing sewer line.
3. Lateral connections that were active but not reconnected to the line at the time of construction and any damages resulting from the same.

#### 25.4.9. Polyvinyl Chloride (PVC) Expanded-in-Place Pipe Liner (EIPP)

EIPP shall be the rehabilitation of sewer pipelines by the installation of a high strength polyvinyl chloride (PVC), folded or expanded-in-place pipe liner (EIPP) by pull through method into the original conduit. Reforming shall be accomplished by circulating hot water,

steam, or other approved method under pressure to reform the PVC into a circular pipe. When reformed, the EIPP liner shall extend over the entire length of the pipe between access points in a continuous, tight-fitting, watertight pipe-within-a-pipe.

The work shall consist of host pipe cleaning, TV inspection, video logs, host pipe preparation, sewage by-pass pumping as required, installation and testing of the EIPP, and reinstatement of all live service laterals, furnishing all labor, materials, tools, equipment, energy and other incidentals as necessary to complete the work.

A. Construction Methods: Contractors must construct the EIPP with a process that has been approved by the City of Arvada Engineering Division. All approved methods must meet these Specifications. Any and all divergence from these Specifications must be indicated on the submitted documentation.

If an alternative process is approved, the Contractor shall accept full responsibility for the performance of the installation. If the process installed does not meet the intent, standards or performance of the specified process or manufacturer, then the City of Arvada shall reserve the right to require that the Contractor remove and reinstall, or correct the installation at the Contractor's expense.

B. Referenced standards: These EIPP Specifications reference the following American Society for Testing and Materials (ASTM) standard Specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof:

<u>ASTM STANDARD</u>	<u>DESCRIPTION</u>
D-638	Standard Test Method for Tensile Properties of Plastic
D-696	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics
D-790	Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics
F-1504	Standard Specification for Folded Poly (Vinyl Chloride) (PVC) Pipe for Existing Sewer and Conduit Rehabilitation
D-1784	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
F-1867	Installation of Folded/Formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation
F-1871	Folded/Formed Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation

Where conflicts are noted between the referenced standard and these Specifications, these Specifications shall govern.

- C. Submittals: The following submittals are required prior to start of construction:
1. The Contractor shall provide documentation of a minimum of three (3) year commercial use of EIPP in municipal sanitary sewer systems. A minimum of 15,000 LF of successful sanitary sewer rehabilitation in the U.S. must be documented to assure commercial viability of the process.
  2. The Contractor shall submit a tabulation of all related projects completed in the last five (5) years. The tabulation shall include the name, address and telephone number of the city, sewer district or company, name of contact person(s), year completed, size and length of pipe, total project cost, and official acceptance date of the project. Failure to include this tabulation may constitute grounds for disqualification.

3. The Contractor shall certify, in writing, that the EIPP meets all requirements of ASTM test procedures D-638, D-696 and D-790, ASTM materials specification D-1784, and ASTM standard specification F-1504 for folded poly (vinyl chloride) (PVC) pipe for existing sewer and conduit rehabilitation. Samples of material used in testing shall be of an EIPP system similar to that proposed for actual construction on this project.
4. The Contractor shall submit test results from previous field installations completed in the U.S. within the past twelve (12) months of the same type of EIPP system as that proposed for actual construction on this project.

D. Materials:

1. PVC Pipe: The EIPP shall be made of virgin PVC material meeting the general requirements defined by ASTM F-1504, Section 6.1, or ASTM F-1871 and as further defined by ASTM D-1784.

The EIPP manufacturer shall provide certification that quality control for each coil delivered for installation has been performed on the specific product. Testing shall have been performed in accordance with ASTM D-638, D-696 and D-790.

The minimum PVC pipe thickness shall be DR35 for each specific pipe size, as defined by ASTM F-1504, table 1 and table 5 or DR32.5 as defined by ASTM F-1871.

The PVC material shall be fabricated to a size that when installed will neatly and tightly fit the internal circumference and length of the existing conduit. Allowance for longitudinal stretch during insertion shall be allowed. The minimum length shall span the distance from one access opening to the access opening of the respective pipe segment to be rehabilitated. The Contractor shall verify field lengths prior to start of construction.

The PVC compound shall be chemically resistant to domestic effluents. For sewage other than domestic effluents, an analysis shall be performed to ascertain feasibility of the process.

The Contractor shall provide, prior to use of any materials, satisfactory written certification of compliance with the manufacturer's standards and Specifications for all materials used in the EIPP system.

2. Structural Requirements: The EIPP shall conform to the minimum structural properties listed in ASTM F-1504, Section 7, and ASTM F-1504, Tables 2, 3 and 4 or the properties listed in ASTM F-1871.

EIPP conforming to ASTM F-1504 shall conform to the minimum structural standards as listed below:

<u>Physical Characteristics</u>	<u>Test Procedure</u>	<u>Value</u>
Wall Thickness	ASTM D-2122	DR 35
Flexural Modulus	ASTM D-790	280,000 psi
Impact Strength	ASTM D-2444	210 ft-lbs
Pipe Flattening	ASTM D-3034	60% deflection
Pipe Stiffness	ASTM D-2412	31-41 psi (1)
Coefficient of Thermal Expansion	ASTM D-696	.00003 in./in. □F

(1) at 5% deflection without cracking, breaking, or splitting.

The Contractor shall submit EIPP wall thickness calculations to the Project Engineer for approval prior to installation. The EIPP shall have a minimum wall thickness of DR 35.

EIPP conforming to ASTM F-1871 shall conform to the minimum structural standards as listed below:

<u>Physical Characteristics</u>	<u>Test Procedure</u>	<u>Value</u>
Wall Thickness	ASTM D-2122	DR 32.5
Flexural Modulus	ASTM D-790	145,000 psi
Flexural Strength	ASTM D-790	4,100 psi
Tensile Modulus	ASTM D-638	155,000 psi
Tensile Strength	ASTM D-790	3,600 psi

The Contractor shall submit EIPP wall thickness calculations to the Project Engineer for approval prior to installation. The EIPP shall have a minimum wall thickness of DR 32.5.

E. Property Owner/Manager Notification: The Contractor shall at a minimum, be responsible for contacting each home, apartment complex or business connected to the sanitary sewer, informing them of the nature of the work, and at what times the sewer operation will be interrupted. The following notification sequence shall be strictly adhered to:

1. Written notice shall be delivered to each home or business describing the work procedure, schedule, the affect to each homeowner, apartment manager or business owner. The Contractor's business phone number will also be provided so that he may be contacted to discuss the project and any associated problems. The Project Engineer and his representative will provide such written notice in the form of a door hanger or letter to the Contractor for distribution by the Contractor.
2. Personal contact shall be made on the day of pre-installation inspection of the sewer main. Verification of each active service lateral shall be made by asking the homeowner or business owner to run water down their drain.  
  
Should the homeowner be unavailable, other arrangements shall be made to drain water through the service lateral.
3. Personal contact and written notice with all affected property owners shall be made at least 24 hours prior to beginning rehabilitation on the sewer segment to which they are connected.
4. Personal contact shall be made with any homeowner, apartment manager or business owner who cannot be reconnected within the time stated in the written notice.
5. If so requested by a homeowner, apartment manager or business owner, or at the discretion of the Project Engineer, portable toilets will be furnished and serviced by the Contractor for use by occupants at the sole expense of the Contractor.
6. All written or personal contact with property owners shall be coordinated with the City's engineering inspector.

F. Cleaning of Sewer Lines: The Contractor shall be required to remove all internal

debris from the sewer line by use of water jet equipment prior to inserting the liner. The cleaning operation shall remove any and all debris so that each joint of pipe can be thoroughly inspected and successfully rehabilitated.

All sludge, dirt, sand, rocks, grease and other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from one manhole to another will not be permitted.

All such debris resulting from the cleaning operations shall be removed from the site and disposed of in the proper manner. The Contractor shall bear all costs associated with testing of debris and proper dumping. Dumping of the debris shall be in accordance with all local, state, and federal regulations. If hazardous materials are encountered during testing, the City and Contractor will negotiate the costs of handling and disposal of these materials.

All debris shall be removed from the downstream manhole and the site no less often than at the end of each work day. The Contractor shall leave no debris unattended at the site. Under no circumstances will the Contractor be allowed to accumulate debris beyond the stated time. In the event the Contractor has not removed the debris generated by the cleaning operation, the Contractor will not be allowed to proceed with the work until the debris is properly removed.

During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer lines from damage that might occur by improper use of cleaning equipment. Precautions shall be taken to ensure that the cleaning operation will not cause any damage or flooding to public or private property being served by the sewer line segment being cleaned. The Contractor shall bear all costs associated with any flooding or damage to public and/or private basements or structures.

- G. Pre-Insertion TV Video Inspection: Experienced personnel shall perform television inspection of the pipelines. Camera operators shall be trained in locating breaks, obstacles and service connections by closed circuit color television. A Pre-insertion video inspection shall be performed on all sewer lines to be rehabilitated to locate active services for reinstatement, as well as location and notation of any conditions that could prevent successful insertion of the EIPP for the purpose of correcting these conditions.

A color video-tape and suitable counter log of the pre-insertion inspection shall be prepared by the Contractor and submitted to the City. The Contractor will be responsible for any by-pass sewage pumping required to perform this work.

- H. Line Obstructions: It shall be the responsibility of the Contractor to clear the sewer line of obstructions such as solids and roots that will prevent the insertion of the EIPP liner. If the pre-insertion inspection reveals an obstruction such as a protruding service connection, dropped joint, or a separated or collapsed pipe section that will prevent the insertion process, and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a protruding tap repair or a trenchless point repair as required to remove the obstruction. Such repair shall be approved in writing by the Project Engineer or his representative prior to beginning the EIPP work and shall be paid for at the unit bid price for this item.

- I. Liner Installation: Installation shall be in strict accordance with manufacturers instructions and conform to the requirements of ASTM F-1504 Standard Specification for Folded Poly (Vinyl Chloride) (PVC) Pipe for Existing Sewer and Conduit Rehabilitation or ASTM F-1867 Installation of Folded/Formed Poly (Vinyl

Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation.

Each PVC liner shall be subject to inspection by the Project Engineer and/or his representative immediately before installation, and all defective liners will be rejected.

The liner shall be inserted into the existing pipe through the access opening without any modification to the access points, and then pulled or winched to the next scheduled access opening. There shall be no roadway excavation for sending or receiving pits, unless the pipe length between access points exceeds the manufacturer's maximum coiling length Specifications.

1. Preheating: The Contractor shall provide a suitable heat source to thoroughly heat the entire pipe segment to be inserted and such heat source shall be carefully monitored and regulated as recommended by the liner manufacturer and in accordance with ASTM F-1504 or ASTM F-1867. The entire pipe segment shall be heated both internally and externally prior to installation.
2. Pipe Insertion: Following heating of the EIPP both internally and externally, the liner shall pass through a shaping device that will form it into a "C" shape such that when the folded liner enters the lumen of the host pipe the fold is at either the three o'clock or nine o'clock position. The shaping device shall be fitted with a spray device for cooling the folded liner and locking it into the "C" shape to prevent stretching of the liner. Contractor shall pull the liner into the access point and pipe segment using a winch as recommended by the manufacturer. The winch shall have sufficient capacity to pull the PVC liner through the host pipe without exceeding values as recommended by the manufacturer.
3. Expanding In Place: After insertion of the PVC liner is completed, the Contractor shall supply a suitable heat source capable of delivering steam through the pipe segment to uniformly raise the temperature to effect the forming of the liner. The steam for processing shall be monitored and regulated as recommended by the liner manufacturer.

The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply. Another such gauge shall be placed at the remote access opening to determine the temperature at that location during the cure period.

Before the forming process begins, the minimum pressure required to hold the liner tight against the host pipe and the maximum allowable pressure so as not to damage the liner shall be provided by the liner manufacturer and submitted to the Project Engineer prior to any forming process. Once the cure has begun and dimpling for service taps is completed, the pressure shall be maintained between the minimum and maximum pressures until the cure has been completed. Should the pressure deviate from within the range of minimum and maximum pressures, as determined by the liner manufacturer, the installed liner shall be rejected and the Contractor will remove and dispose of the liner at no cost to the City. The Contractor will be responsible for its removal and disposal and replacement with new liner at no additional cost to the City. A complete log of the pressures shall be maintained on site and shall be submitted to the Project Engineer after each installation is completed.

The new EIPP shall be expanded until held against the existing host pipe wall. Following full expansion of the PVC liner, the liner shall held in that position for the required time as recommended by the manufacturer, while the steam pressure is replaced with compressed air pressure and cooled to a temperature of no greater than 100 degrees Fahrenheit.

If during this process the EIPP fails to form, the Contractor shall remove the failed PVC liner and replace it with a new PVC liner. This replacement work shall be done at no additional cost to the City.

Following forming and cooling of the EIPP, each end of the PVC liner shall be cut away from the pipe segment access points, curled and sealed at those access points.

- J. Sealing at Manholes: If the liner fails to make a tight seal against the original pipe segment at its access point(s), the space between the pipes shall be sealed by filling with a resin mixture compatible with the EIPP and as recommended by the manufacturer.
- K. Workmanship: The finished EIPP shall be continuous over the entire segment between two access points and be free as commercially practical from visual defects such as foreign inclusions and pin holes.

Any defects which will affect the integrity or strength of the EIPP shall be repaired at the Contractor's expense. Any ribs in the cross-sectional area of the pipe shall be removed or the PVC liner removed in its entirety unless allowance is made by the Project Engineer for offset joints or out of round pipe.

- L. Service Connections: After completing the EIPP, the Contractor shall restore the existing active service connections and branch connections. It is the intent of these Specifications that active service and branch connections be reopened without excavation, and in the case of non-man entry pipes, from the interior of the pipeline utilizing a remotely controlled cutting device, monitored by a closed circuit television camera, that re-establishes them to not less than 95% capacity, while conforming to the shape of the existing opening.

The Contractor shall verify he has a minimum of two (2) complete cutting devices in good working order before each insertion.

No service connection shall remain out of service for more than 24 hours at a time unless the Contractor, at his expense, has provided temporary facilities or hotel accommodations for the affected residents.

No additional payment will be made for excavations for the purpose of re-opening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

- M. Testing and Inspection: PVC liner samples shall be prepared and tested in accordance with ASTM F-1504, Section 11, ASTM D-638, ASTM D-696 and ASTM D-790 and/or ASTM F-1871. The tests will be performed by a Certified Independent Laboratory and approved by the City. Tests results shall be submitted to the Project Engineer at no additional cost to the City.

A post-construction color video tape will be made of all new EIPP to confirm the condition of the new PVC liner and the Contractor shall provide the City's Wastewater Division with video tapes of each installation. The tapes will include

both before and after conditions, as well as the counter and address locations of all restored service connections. All videos must be of adequate quality and coverage to inspect the condition of the entire new line. If in the opinion of the City's representative, the video quality is deemed too poor to inspect the EIPP, the PVC liner will be video inspected again at no additional cost to the City.

- N. Exfiltration Tests: In the absence of ground water, and if so ordered by the Project Engineer, an exfiltration test shall be performed. Leakage testing of the liner shall be accomplished while under a positive head and before any service connections are reinstated. This test is limited to pipe diameters of 36 inches or less. The allowable water exfiltration for any length of pipe between termination points shall not exceed 50 gallons per inch of internal pipe diameter per mile per day, providing all trapped air has been purged from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest point shall not exceed ten (10) feet of water or 4.3 psi and the water level inside the inversion standpipe shall be 2 feet higher than the top of the pipe being tested or 2 feet higher than the groundwater level, whichever is greater. The leakage quantity shall be gauged by the water level in the temporary standpipe placed in the upstream plug. The test shall be conducted for one (1) hour.
- O. Patents: The Contractor and the Contractor's supplier shall warrant and save harmless the City against any and all claims and potential litigation involving patent infringement and copyright violations and any loss thereof.
- P. Warranty: The Contractor and the manufacturer shall warranty all materials and workmanship for a period of two (2) years. The warranty shall cover, but will not be limited to the following:
  - 1. Defects discovered in material used in the project.
  - 2. Failure of liner to remain formed to the previously existing sewer line.
  - 3. Lateral connections that were active but not reconnected to the line at the time of construction and any damages resulting from the same.

#### 25.4.10 Pipe Bursting Technique and Materials

This specification shall cover the replacement of existing sanitary sewers using the pipe bursting technique. Pipe bursting is a system by which the pneumatic burster unit splits the existing pipe while simultaneously installing a new Polyethylene Pipe of the same size or larger size pipe where the old pipe existed, then reconnecting existing sewer service house connections, television inspection of the Polyethylene Pipe and complete installation in accordance with the contract documents. Only Pneumatically operated equipment with either front or rear expanders for the proper connection to the Polyethylene Pipe will be allowed for use. The pneumatic tool must be used in conjunction with a constant tension hydraulic twin Capstan Winch of either 20, 10, or 5 tons, the size of the winch depends on the diameter of the pipe to be replaced. In no case is the constant tension on the winch to exceed 20 tons.

- A. Qualifications:
  - 1. The Contractor shall be certified by the particular Pipe Bursting System Manufacturer that such a company is a fully trained user of the pipe bursting system. Contractor must use a Pipe Bursting System approved by the City of Arvada Engineering Division.
  - 2. Polyethylene pipe jointing shall be performed by personnel trained in the use of butt-fusion equipment and recommended methods for new pipe

connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the polyethylene pipe. Training shall be performed by qualified representative.

3. The Contractor shall hold the City of Arvada whole harmless in any legal action resulting from patent infringements. Pipe bursting licenses, royalties, etc., are the responsibility of the Contractor.

B. Submittals:

1. Shop drawings, catalog data, and manufacturer's technical data showing complete information on material composition, physical properties, and dimensions of new pipe and fittings. Include manufacturer's recommendations for handling, storage, and repair of pipe and fittings damaged.
2. Method of construction and restoration of existing sewer service connections. This shall include detail drawings and written descriptions of the entire construction procedure to install pipe, bypass sewage flow and reconnection of sewer service connections.
3. Certification that Contractor is licensed in the pipe bursting technique.

C. Materials:

1. High Density Polyethylene Plastic Pipe: HDPE shall be high density polyethylene pipe and meet the applicable requirements of ASTM F-714 Polyethylene (PE) Plastic Pipe (SDR-PR) based on outside diameter, ASTM D1248, ASTM D3550. **SDR 17 pipe shall be used.** Sizes of the insertions to be used shall be such to renew the sewer to greater than present flow capacity. All pipe shall be made of virgin material. No rework except that obtained from the manufacturer's own production of the same formulation shall be used. Material color shall be white, black or whatever is specified with interior of pipe having a light reflective color to allow easier viewing for television inspection. Tests for compliance with this specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate with this specification shall be furnished, upon request, by the manufacturer for all material furnished under this specification. Polyethylene plastic pipe and fittings may be rejected to meet any requirements of this specification.
2. Saddles: Reconnection of service laterals to installed HDPE pipe shall be accomplished by various methods that are compatible with the new sewer pipe. If a saddle is used, the saddle, once secured in place, drill a hole full inside diameter of saddle outlet in pipe liner. Mechanical saddles shall be made of polyethylene pipe compound that meets the requirements of ASTM D1248, Class C, have stainless steel straps and fasteners, neoprene gasket and backup plate. Mechanical saddles shall be Strap-On-Saddle type as manufactured by Driscopipe or approved equal. Inserta-Tee Connection by Fowler Manufacturing is also allowed.
3. Flexible Couplings: Connections to existing service laterals shall be made using flexible couplings. All flexible couplings shall conform to ASTM C-245 and shall be as manufactured by Fernco Joint Sealer Co., DFW Plastics, Inc., or approved equal.

4. Joints: Sections of HDPE pipe shall be assembled and joined on the job site. Jointing shall be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions. It is the sole responsibility of the Contractor to provide an acceptable water tight butt-fusion joint. Joint strength shall be equal to or greater than the pipe and shall indicate a ductile rather than brittle fracture when tested. If sectional HDPE pipe is used, it shall be joined in accordance with the manufacturer's recommendation for a leakproof, stab joint method using EPDM O-ring synthetic elastomer gaskets.

D. Equipment:

1. The pipe bursting tool shall be designed and manufactured to force its way through existing pipe materials by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. The bursting unit shall be pneumatic and shall generate sufficient force to burst and compact the existing pipe line. See manufacturer's Specifications for what size tool should be used in what diameter of pipe, as well as parameters of what size tool for percentage of upsize allowed.
2. The pipe bursting tool shall be pulled through the sewer by a winch located at the upstream manhole. The bursting unit shall pull the polyethylene pipe with it as it moves forward. The bursting head shall incorporate a shield/expander to prevent collapse of the hole ahead of the PE pipe insertion. The pipe bursting unit shall be remotely controlled.
3. The pipe bursting tool shall be pneumatic. The bursting action of the tool shall increase the external dimensions sufficiently, causing breakage of the pipe at the same time expanding the surrounding ground. This action shall not only break the pipe but also create the void into which the burster can be winched and enables forward progress to be made. At the same time the polyethylene pipe, directly attached to the sleeve on the rear of the burster, shall also move forward.

The burster shall have its own forward momentum while being assisted by winching. A hydraulic winch shall give the burster friction by which it can be moved forward. To form a complete operating system, the burster must be matched to a constant tension hydraulic winching system.

4. Winch unit - A winch unit shall be attached to the front of the bursting unit. The winch shall provide a constant tension to the burster in order that it may operate in an efficient manner.

The winch shall ensure directional stability in keeping the unit on line.

The winch shall be hydraulically operated providing a constant tension throughout the operation. The winch shall be of the constant tension type and shall be fitted with a direct reading load gauge to measure the winching load.

The winch must automatically maintain a constant tension at a set tonnage reading.

The constant tension winch shall supply sufficient cable on one continuous length so that the pull may be continuous between approved winching points.

The winch, cable and cable drum must be provided with safety cage and supports so that it may be operated safely without injury to persons or property. The Contractor shall provide a system of guide pulleys and bracing at each manhole to minimize cable contact with the existing sewer between manholes.

The supports to the trench shoring in the insertion pit shall remain completely separate from the winch boom support system and shall be so designed that neither the pipe nor the winch cable shall be in contact with them.

E. Construction Method:

1. Insertion or launching pits shall only be allowed at locations of existing or proposed manholes, unless otherwise approved by the Project Engineer.
2. Equipment used to perform the work shall be located away from buildings so as not to create excessive noise impact. Provide a silent engine compartment with the winch to reduce machine noise.
3. The Contractor shall install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes, and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances will the pipe be stressed beyond its elastic limit. Winch line is to be centered in pipe to be burst with adjustable boom.
4. The installed pipe shall be allowed the manufacturer's recommended amount of time, but not less than four (4) hours, for cooling and relaxation due to tensile stressing prior to any reconnection of service lines, sealing of the annulus or backfilling of the insertion pit.
5. Sufficient excess length of new pipe, but not less than four (4) inches, shall be allowed to protrude into the manhole to provide for occurrence. Restraint of pipe ends shall be achieved by means of. The couplings shall be slipped over pipe ends against manhole wall and fused in place. Installation of couplings shall be done in accordance with the manufacturers recommended procedures.
6. Following the relaxation period, the annular space may be sealed. Sealing shall be made with material approved by the Project Engineer and/or his representative and shall extend a minimum of eight (8) inches into the manhole wall in such a manner as to form a smooth, uniform, watertight joint.

25.4.11. Manhole Rehabilitation Protective Coatings

Interior manhole barrel and eccentric cone surfaces as well as benches and inverts of all manholes to be rehabilitated shall be treated with two (2) ea. 10 mil thick coatings of Aquata Pox; an approved moisture insensitive, solventless, amine cured, two component, 100% solids epoxy paint or gel as manufactured by American Chemical Corp., Menlo Park, California. Also allowed is a minimum 1/2" thickness spray applied coating of Sewpercoat Calcium Aluminate Cement as manufactured by LaFarge Calcium Aluminates, Chesapeake, Virginia. Coatings shall be applied by coating manufacturer's certified applicators only.

- A. Surface Preparation:
1. Existing interior manhole surface to be restored shall be high pressure water blasted with a minimum 2,000 psi water pressure or sandblasted to remove existing coatings and all foreign matter before application of new coating.
  2. Any new concrete interior cone and barrel surfaces shall be allowed to cure, after casting, for a minimum of ten (10) days. After curing, the surfaces to be treated shall be sweep sand blasted or high pressure water blasted to remove laitance or curing agents thereon.
- B. Repair of Concrete Surfaces: Following surface blasting the concrete surfaces shall be inspected for deterioration, i.e. exposed aggregate, spalling, holes, corroded, exposed steel, etc.
- If rehabilitated with Aquata Poxy, exposed aggregate surfaces shall be coated with Aquata Poxy gel, applied with a trowel or squeegee so that the aggregate is completely covered. Spalled areas and holes one or more inches deep shall be filled with a high strength cementitious grout. In each instance the gel or grout shall provide a finish surface level with the surrounding area prior to coating.
- Exposed steel areas, after cleaning by blasting, shall be treated with two coats of an EPA approved Dyna Bond System 1. Each coat shall be applied at 10 mils wet film thickness each. A minimum of 30 minutes shall separate the application of the first and second coat. A minimum of 36 hours cure time shall be provided between the application of the final coat of Dyna Bond System 1 and the application of the protective coating hereinafter detailed.
- C. Protective Coating: The entire interior surface shall receive a minimum of two (2) coats of aquata poxy paint. The wet film thickness for each coat shall be no more than 12 mils with a total dry film thickness for the complete coating system of 20 mils minimum. Spray applied Sewpercoat Calcium Aluminate Cement shall be minimum 1/2" thickness.
  - D. Coating Application: Mixing and application of the protective coatings shall be in strict conformance with the direction of the coating manufacturer. Application shall be by stiff brush, short nap roller (Aquata Poxy) or manufacturer approved spray system (Aquata Poxy or Sewpercoat).
  - E. Sealing of Penetration Through Coatings: Penetration through protective coatings at joints, fasteners, steps or other items installed after the coating system is complete in place shall be thoroughly sealed with Aquata Poxy gel or Sewpercoat.
  - F. Repair of Holidays: Holidays or pinholes found in the Aquata Poxy protective coating shall be repaired by applying additional Aquata Poxy Paint. Surfaces to be repaired shall be roughened with coarse sandpaper in the vicinity of the repair if the repair is to be undertaken after five (5) days have elapsed from application of the final coat of protective coating material.

## **25.5. BORING, JACKING AND THREADING OF CARRIER PIPE**

### **25.5.1. Pit Excavation**

Pits shall be excavated such that timber blocking can be installed to give an unyielding backing for the hydraulic boring machine or jacks and to prevent sloughing of the header face. Subgrade on which rails or guides are to be set shall be stabilized with washed rock

where soft and springy ground is encountered.

Excavation and casing installation shall be performed simultaneously. At no time shall advancing edge of the casing trail the excavation by more than twelve (12) inches.

25.5.2. Casing Pipe Joints

Sections of the steel casing shall be trimmed, beveled and aligned in the pit so when welded together the thrust of the boring machine will be uniformly transmitted through the casing in a horizontal plane. Welds shall be made to provide solid firm watertight connection without the use of butt straps.

Jacked concrete pipe with R-2 joints shall be made watertight by the use of O-ring rubber gaskets. 1/4" to 1/2" plywood shims may be used in the joint to provide a uniform bearing between pipe sections.

25.5.3. Casing Pipe Sections Alignment

The casing pipe shall be installed by boring or jacking upgrade from the outlet end. When the carrier pipe to be installed is for gravity flow, the horizontal and vertical alignments of the casing pipe, when in place, shall not vary from those called for on the plans by more than the following:

<b>ALIGNMENT</b>	<b>ENTRANCE</b>	<b>MIDPOINT</b>	<b>OUTLET</b>
Horizontal	0.02'	0.35'	0.70'
Vertical	0.02'	+ 0.10' - 0.05'	+ 0.20' - 0.10'

25.5.4. Grouting Casing Pipe

When excavation exceeds the advancing edge of the casing pipe such that voids are created along or above the casing, external pressure grouting of the casing pipe will be required.

Grouting shall be accomplished by pumping at between five (5) and ten (10) lbs. per square inch pressure, equal parts of Portland Cement and mortar sand mixed with sufficient water to provide slump of less than two (2) inches through grout holes in the casing until all voids are filled. Grout holes (1"-2" in diameter) shall be provided or drilled in the casing on four (4) foot centers along the pipe arch and on eight (8) foot centers along each springline. As grouting advances each of the completed grout holes shall be plugged to a watertight condition.

25.5.5. Threading Carrier Pipe

Carrier pipe interior and the access pits at each end shall be kept free of water at all times during the insertion and backfilling of the carrier pipe. Where the maximum elevation of the ground water table is at or above the casing pipe invert elevation, the carrier pipe shall have two (2) pair each of chocks and skids, steel banded on the pipe barrel section, at approximately six (6) foot centers or centering and restraining casing spacers and insulators installed every 10 feet on the carrier pipe prior to insertion with an additional spacer placed within 6" of each end of casing pipe. Chocks atop the carrier pipe or centering restraining casing spacers and insulators will not be required when the maximum ground water table elevation is below the casing pipe invert. Sand filler, however, is required if chocks or

centering restraining casing spacers and insulators are not installed on the carrier pipe regardless of groundwater level. Sand filler shall not be required when chocks and skids are placed on the carrier pipe or when prefabricated, centering, restraining casing spacers and insulators are used.

Plastic or redwood skids and chocks shall be no less than three (3) inches in width by three and one-half (3 1/2) feet in length and varied in height such that during insertion in the casing the:

- A. Bells of the pipe will clear the casing pipe invert a minimum of one (1) inch and;
- B. The chocks when mounted seven (7) to ten (10) degrees each side of vertical centerline, atop the pipe barrel and in conjunction with the skids, will clear the casing pipe wall by no more than one-half (1/2) inch.

Once the skids and chocks or casing spacers and insulators are properly attached to the carrier pipe barrel, the section is ready for insertion. Subsequent sections shall be properly lubricated, gasketed and joined to each other as they are set. The assembled line shall then be progressively threaded through the casing by means of applying force at the exposed end of the carrier pipe. Care shall be exercised to provide watertight joints and to protect the ends of the pipe as they are pulled or pushed, by uniformly transferring said force through the carrier pipe axially along its horizontal plane.

On gravity lines it may be necessary to vary the location and thickness of the skids and chocks or casing spacers and insulators to obtain a uniform invert grade throughout the carrier pipe. This is especially critical when the alignment and grade for the casing pipe approaches the minimum allowable limits specified.

#### 25.5.6. Backfill of Carrier Pipe

Immediately after threading and aligning the pipe through the casing, the void between the carrier and casing pipe shall be blown full with clean dry sand, or squeegee unless skids and chocks have been used or centering and restraining casing spacers and insulators are used on the carrier pipe. Dry pea-gravel may be used to fill the void when the diameter of the carrier pipe is equal or greater than thirty (30) inches in diameter. Filler material shall be blown in, under pressure, from each end of the casing pipe through one (1) inch to three (3) inch diameter pipe or hose with nozzle, making sure the center portion of the casing is filled first. Once the center portion is filled, the nozzle shall be caused to gradually recede, while continuing to blow filler material and filling the entire void throughout the entire length of the casing. Once the annular void has been filled the ends of the casing pipe shall be sealed shut with pull on rubber end seals, unless otherwise called for on the plans.

Unless otherwise specified the annular space will be considered full when the level of filler material is within two (2) inches of the crown of the casing pipe. When concrete pipe is installed as the carrier pipe the annular space will be considered full when the level of filler material is no less than two (2) inches above the carrier pipe springline.

#### 25.6. **TESTING OF SEWER LINES**

Tests for watertightness shall be conducted by the Contractor, in the presence and under the direction of a City representative, on all new sewer lines prior to final acceptance.

Should the rate of leakage be found to exceed the prescribed amount, the Contractor shall stop all construction, locate the leak, make appropriate repairs and then continue to test the conduit until the leakage is within the allowable limits.

25.6.1. Low Pressure Air Test

Low pressure air tests in accordance with UNI B-6-98 shall be used for testing of sewer lines.

- A. Flush and clean the sewer line prior to testing, thus serving to wet the pipe surface as well as clean out any debris. Plug all pipe outlets to resist the test pressure. For safety reasons it is extremely important that the various plugs be installed and braced such a way as to prevent blowouts. As a safety precaution, pressurizing equipment may include a regulator or relief valve set at ten (10) psi maximum to avoid over pressurizing and damaging an otherwise acceptable line.
- B. Determine the test duration for the section under test by computation from the applicable formulas shown in UNI-B-6-98 or from Table 25-III. The pressure-holding time is based on an average holding pressure of three (3) psi gauge or a drop from three and one half (3.5) psi to two and one half (2.5) psi gauge. Add air until the internal air pressure of the sewer line is raised to approximately four (4.0) psi gauge. After an internal pressure of approximately four (4.0) psi is obtained, allow time for the air pressure to stabilize. The pressure will normally show some drop until the temperature of the air in the test sections stabilizes.
- C. When the pressure has stabilized and is at or above the starting pressure of three and one half (3.5) psig, commence the test. Before starting the test, the pressure may be allowed to drop to three and one half (3.5) psig. Record the drop in pressure for the test period. If the pressure has dropped more than two (2.0) psig during the test period, the line is presumed to have failed. The test may be discontinued when the pressure test time has been completed even though the one (1.0) psig drop has not occurred.
- D. A timed pressure drop of 0.5 psig may be used in lieu of the 1.0 psig timed pressure drop. If a 0.5 psig timed pressure drop is used, the appropriate required test times shall be exactly half as long as the required test times for a 1.0 psig timed pressure drop.

25.6.2. Vacuum Testing Manholes

The City reserves the right to require a vacuum test on all new manholes installed, particularly in areas where the groundwater level is high or where there are questions regarding the integrity of the new barrel sections. All manholes shall be vacuum tested in accordance with ASTM C1244. All lift holes and any pipes entering the manhole shall be plugged prior to a vacuum being drawn and the drop over a specified time determined. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations. A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 inches of mercury. 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 below.

Depth (feet)	<u>Diameter, inches</u>								
	30	33	36	42	48	54	60	68	72
	<u>Time, seconds</u>								
<=8	11	12	14	17	20	23	28	29	33
10	14	15	18	21	25	29	33	38	41

12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	39	34	40	46	52	58	57
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	63	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	38	42	51	59	64	78	87	97
26	36	38	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

25.6.3. Television Inspection

All newly installed, repaired or rehabilitated sewer mains or trunk lines will be inspected by the City's Wastewater Division Television Inspection Crew prior to commencement of the two year warranty period. Any defects found during television inspection shall be repaired prior to connecting any services to the main. Newly installed sewer mains in areas to be paved will be television inspected only after the first lift of paving has been installed. All new sewer mains must be jet cleaned after the final lift of paving has been installed and prior to the television inspection.

**25.7. HOUSEKEEPING, RESTORATION AND CLEANUP**

See Section 5 of these Specifications.

**25.8. WARRANTY AND ACCEPTANCE**

During the last two (2) months of the two (2) year warranty period, the City will reinspect the project and advise the Developer or Contractor of any deficiencies and irregularities, if any, which the Developer or Contractor shall correct. A letter of final acceptance will be issued upon the Developer or Contractor's completion of the remedial measures.

TABLE 25-III

AIR TEST - BASED ON FORMULAS FROM UNI-B-6-98

SPECIFICATION TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP FROM 3 1/2 TO 2 1/2 PSIG  
WHEN TESTING ONE PIPE DIAMETER ONLY

Length Ft.	PIPE DIAMETER, INCHES														
	<u>4</u>	<u>6</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>15</u>	<u>18</u>	<u>21</u>	<u>24</u>	<u>27</u>	<u>30</u>	<u>33</u>	<u>36</u>	<u>39</u>	<u>42</u>
25	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:40	25:30	28:20	31:10	34:00	36:50	39:40
50	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:40	25:30	28:20	31:10	34:00	36:50	39:40
75	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:40	25:30	28:20	32:19	38:28	45:09	52:21
100	3:47	5:40	7:33	9:27	11:20	14:10	17:00	19:50	22:48	28:51	35:37	43:06	51:17	60:11	69:48
125	3:47	5:40	7:33	9:27	11:20	14:10	17:00	21:49	28:30	36:04	44:31	53:52	64:06	75:14	87:15
150	3:47	5:40	7:33	9:27	11:20	14:10	19:14	26:11	34:11	43:16	53:25	64:38	76:56	90:17	104:42
175	3:47	5:40	7:33	9:27	11:20	15:35	22:26	30:32	39:53	50:29	62:20	75:25	89:45	105:20	122:10
200	3:47	5:40	7:33	9:27	11:24	17:48	25:39	34:54	45:35	57:42	71:14	86:11	102:34	120:23	139:37
225	3:47	5:40	7:33	9:27	12:49	20:02	28:51	39:16	51:17	64:55	80:08	96:58	115:24	135:26	157:04
250	3:47	5:40	7:33	9:54	14:15	22:16	32:03	43:38	56:59	72:07	89:02	107:44	128:13	150:28	174:31
275	3:47	5:40	7:33	10:53	15:40	24:29	35:16	47:59	62:41	79:20	97:56	118:31	141:02	165:31	191:58
300	3:47	5:40	7:36	11:52	17:60	26:43	38:28	52:21	68:23	86:33	106:51	129:17	153:51	180:34	209:25
350	3:47	5:40	8:52	13:51	19:57	31:10	44:52	61:05	79:47	100:58	124:39	150:50	179:30	210:40	244:19
400	3:47	5:42	10:08	15:50	22:48	35:37	51:17	69:48	91:10	115:24	142:28	172:23	205:09	240:45	279:13
450	3:47	6:25	11:24	17:48	25:39	40:04	57:42	78:32	102:34	129:42	160:16	193:55	230:47	270:51	314:07

Table based on allowable air loss of .0015 ft.<sup>3</sup>/min. per square foot of internal pipe surface and a maximum air loss per test section of 1.0 ft.<sup>3</sup>/min.