



DENVER

THE MILE HIGH CITY

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS | ENGINEERING DIVISION

Storm Drainage and Sanitary Sewer Construction Detail and Technical Specifications

10.7 Cured In Place Pipe

10.7.1 General

This section outlines the guidelines & requirements for the reconstruction of pipelines and conduits by the Cured in Place Pipe Method (CIPP). CIPP is the installation of a resin-impregnated flexible tube which is inserted into an existing conduit and cured by the use of pressurized steam or circulated water under a hydrostatic head. When complete, the CIPP is continuous and fits tightly to the existing pipe.

10.7.2 Referenced Standards

This section references American Society for Testing and Materials (ASTM) standards, which are made a part of this specification by such reference. All standards shall be the latest edition and revision. The materials, manufacturing, operations, testing, inspection and production of cured in place pipe shall conform to the following standards.

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| ASTM D638 | Standard Test Method for Tensile Properties of Plastics |
| ASTM D790 | Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| ASTM D2122 | Determining Dimensions of Thermoplastic Pipe & Fittings |
| ASTM D2990 | Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastic |
| ASTM D5813 | Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems |

ASTM F1216-09 Standard Practice and Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

ASTM F1743 Practice of Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place

10.7.3 Submittals

Unless otherwise specified, the Contractor is responsible to have all submittals transmitted to the Project Construction Engineer in sufficient time to allow two weeks for review and acceptance prior to starting the construction or any work by the Contractor.

10.7.3.1 Installation

Prior to installation by Inversion or the Pulled-in-Place method, the Contractor shall provide the Project Construction Engineer with the following as applicable to the specific installation method:

- a. The minimum pressure required to hold the tube tight against the existing conduit and the maximum allowable pressure so as not to damage the tube. A complete log of the pressure (or head level) shall be maintained on the site and be furnished to the Project Construction Engineer after each installation.
- b. The maximum allowable force that can be used in pulling the tube into the existing pipeline for each size of line. A complete log of the pulling force used for each line shall be maintained on site by the Contractor and be furnished to the Project Construction Engineer after each installation.
- c. Minimum temperature and time required for cure on each size of line, based on installation method.
- d. For CIPP segments which are wet out on site, the Contractor must also submit (in spreadsheet form) information on allowable head pressure, roller spacing and gallons of resin to felt length with respect to diameter so the procedure can be verified on site.

10.7.3.2 Health and Safety Plan

Prior to site work, the Contractor shall provide the Project Construction Engineer, for review and acceptance, a Health and Safety Plan which includes (at a minimum) the following:

I) Introduction

- a. Provide project description and location and summary of key work activities.

II) Scope and Applicability

- a. Describe the scope of work for the General Contractor and 1st tier subcontractors performing the work
- b. Detail the planned site activities

- c. Describe who must adhere and abide by the Health and Safety plan
- d. Detail how site visitors will be addressed

III) Key Personnel, Responsibilities and Authority

- a. In relation to Health and Safety, describe the role of project managers, health and safety managers, technical supervisors (10.7.3.4), and other contractor and subcontractor staff.
- b. Provide resumes of Key Personnel, including background and training history.
- c. Identify the name, title, and contact information (phone, email, address) for key personnel.
- d. Identify the name, location, and contact numbers for ambulance, fire, police, hospital, Health and Safety managers (contractor and/or subcontractors), and other key personal or support contacts.

IV) Task/Operation Health and Safety Risk Analysis

- a. Identify, on a task specific basis the individual hazard elements that are present including chemical, physical, and biological.

V) Qualifications and Training Requirements for all Personnel

- a. Detail specific qualifications and training that are required.
- b. Discuss the frequency of safety and training refreshers.
- c. Detail the requirement for site personnel to read and acknowledge, in writing, their understanding of the Health and Safety plan.

VI) Engineering and Administrative Controls

- a. Describe in detail how engineering and administrative controls will be used to protect worker and public safety by preventing chemical exposure, injury, or illness.
- b. List controls in conjunction with each activity identified in the Task/Operation Health and Safety Risk Analysis section above.

VII) Personal Protective Equipment (PPE) Requirements

- a. PPE requirements should be listed in conjunction with each activity identified in the Task/Operation Health and Safety Risk Analysis.
- b. Detail applicable standards (e.g., ANSI, NIOSH, ACGIH, etc)

VIII) Health and Safety Monitoring

- a. Detail instruments, samples, and monitoring that will occur both on the jobsite and in response to complaint(s) or inquiries.
- b. Detail who is responsible for performing monitoring

- c. Detail frequency of monitoring
- d. Define the appropriate action levels and thresholds
- e. Describe standard operating procedures for Health and Safety monitoring

IX) Site control

- a. Describe work zones, buddy systems, and site security
- b. Address policies including drug and alcohol policies, personal hygiene requirements, heat and cold stress prevention
- c. Describe task specific site control (e.g., confined space entry, trenching, etc.)

X) Decontamination plan

- a. Eye and hand wash (if applicable)
- b. Site cleanup

XI) Emergency Contingency Plan

- a. Medical services
- b. Emergency phone numbers
- c. Personnel Injury
- d. Fire/Explosion
- e. Evacuation
- f. Emergency signals and communication
- g. First aid
- h. Emergency equipment list
- i. Map(s), addresses, and phone numbers of nearest medical facilities

XII) Appendices

- a. Safety forms (as needed)
- b. Supporting documentation and information
- c. Material safety data sheets (MSDS)

10.7.3.3 Weekly Installation Schedule

The Contractor shall submit a weekly construction schedule, 7 calendar days in advance of the work, to the Project Construction Engineer and the Denver Fire Department to include the following information:

1. The specific line number and related manhole numbers as designated in the project plans. The line length and service connection count information must also be included from the preliminary video investigation.

2. The specific date and timeframe each installation will occur. Night and weekend work must be approved by the Project Construction Engineer a minimum of 48 hours prior to the proposed commencement of the work.
3. The Technical Supervisor's name for the crew(s) that will be doing each specific installation.
4. The method of installation planned for each line in accordance with ASTM F1216 or F1743.
5. The location and schedule of the "wet-outs" in order to permit inspection of the materials and procedures. This information may be submitted separately.

10.7.3.4 Technical Supervision

Due to the technical aspects and complexity of the products used during the installation of CIPP, the Contractor is required to maintain a full time employee with a minimum of five years experience in the CIPP process of rehabilitation. This employee should be at the superintendent level or higher. This employee must be the direct, first line contact for all aspects of the project construction management. Resume and references, and copies of applicable required OSHA training certificates of this employee shall be submitted to the Project Construction Engineer for review and acceptance prior to the start of the project.

10.7.3.5 Test Results and Performance Studies

CIPP sample test results as well as long term performance studies, from an industry recognized independent laboratory, must be submitted for the materials from the specific supplier(s) to be used on the project in accordance with applicable ASTM standards. The CIPP liner material must meet the requirements of ASTM F1216 or F1743 and ASTM D5813 Sections 6 and 8 (Appendix X.1). The resin shall produce CIPP, which will comply with the structural and chemical resistance requirements of ASTM F1216 or F1743. It is required that CIPP samples with and without plastic coating meet these chemical testing requirements. The long term performance studies must show the proposed material consistently meets the required thickness and strength requirements per the Contract Documents.

The Long Term Performance Studies must be submitted and accepted prior to bidding to pre-qualify the prospective bidder. The CIPP liner material used for the project must be the exact same composition of the material used in the Long Term Performance Studies as outlined in this Section. Any deviation in the composition will require that a new Long term Performance Study is completed, submitted and accepted prior to installation.

10.7.3.6 Public Notice

A complete Public Information and Notification Program shall be submitted in writing to the Project Construction Engineer for review and acceptance. The Contractor shall provide up to date information for the Public Information and Notification program prior to any construction and submit review copies of the Public Notice to be delivered to each home or business describing work to be done as outlined in these specifications.

10.7.3.7 Street Occupancy Permits

The Contractor shall submit, to the Project Construction Engineer, copies of the street occupancy permits, including the approved traffic control plans prior to beginning work.

10.7.3.8 Digital Video and Log Sheets

The Contractor shall submit all log sheets and digital video files for pre and post installation, together, the week immediately following completion of each work segment. All digital video and log sheets must be submitted electronically, *on a USB Plug and Play device (flash drive or hard drive)*. *Video shall be in MP4 format and logs shall be in .pdf format* All video and logs shall be submitted utilizing the following naming convention:

- a. Video Files and Log Sheets
 - i. Named using the following items sequentially, followed by a space
 1. City of Denver Contract Number
 2. Line Number From Plans
 3. GIS Facility ID From Plans (line segment, manhole, etc.)
 4. Type Of File ('Pre' or 'Post' for Video, 'Pre Log' or 'Post Log' for applicable log sheets)
 5. Extension of file (.mp4 or .pdf)
 - ii. Examples:
 1. CE80123 Line72 31814SAGM Post Log.pdf
 2. CE80123 Line72 31814SAGM Post.mp4
 3. CE80123 Line72 31814SAGM Pre Log.pdf
 4. CE80123 Line72 31814SAGM Pre.mp4
 5. CE80123 Line73 31825SAGM Post Log.pdf
 6. CE80123 Line73 31825SAGM Post.mp4

10.7.4 Materials

10.7.4.1 Textile Tube

1. The tube shall meet the requirements of ASTM F1216 or F1743 and ASTM D5813 Sections 6 and 8. The finished CIPP shall be fabricated from materials which when cured will be chemically resistant to withstand internal exposure to domestic sewage. The textile tube shall be continuous in length for the associated run. The wet-out textile tube shall meet ASTM F1216 or F1743, as applicable, have sufficient strength to bridge missing pipe segments and have a uniform thickness that when compressed at installation pressure will equal the specified nominal tube thickness, with a -5% manufacturing tolerance allowed. 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 installation. The minimum length shall be that deemed necessary by the Contractor to effectively span the distance between respective access points, unless otherwise specified. It is the

- Contractor's responsibility to verify the CIPP lengths and diameters in the field before fabricating the tube.
2. Prior to installation the outside layer of the tube shall be coated with a translucent plastic coated flexible material that clearly allows inspection of the resin impregnation, or wet-out procedure. The plastic coating shall not be subject to delamination after curing of the CIPP. The tube shall be homogenous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials shall be included in the tubes that are subject to delamination from the cured CIPP.
 3. The wall color of the interior pipe surface of the CIPP after installation shall be light green or light brown so that a clear and detailed examination with closed circuit television inspection equipment may be made.
 4. The wet-out textile tube shall meet ASTM F1216 or F1743, as applicable, shall have a uniform thickness and 5% to 10% excess resin distribution that when compressed at installation pressures will meet or exceed the design thickness after the cure.

10.7.4.2 Resin

1. The resin/liner system shall conform to ASTM D2990 and ASTM D5813 Section 8.2.2 – 10,000-hour test.
2. The resin shall be a general purpose, unsaturated, styrene-based, thermoset resin and catalyst system or epoxy resin and hardener that are compatible with the inversion or pulled in place process as per the requirements of ASTM F1216 or F1743. The resin shall be tinted so that adequate saturation can be readily observed. Only resin with a minimum long term (50 years) Modulus of Elasticity of 48% of the initial Modulus of Elasticity will be accepted.
3. The tube shall be impregnated with sufficient amount of resin to insure that the resin will be observed on the outer surface of the tube when squeezed. After the tube is cured, it shall show satisfactory evidence of a fully impregnated tube or the existence of excess resin on the outer surface.

10.7.4.3 Calibration Hose

If a calibration hose is required to be used during the process of the installation of the CIPP, the hose shall be wet and vacuum impregnated with sufficient amount of resin prior to inversion to prevent delamination after the curing of the CIPP. Delaminating or failure of the calibration hose will be cause for rejection or complete removal of the CIPP section at the discretion of the Project Construction Engineer.

10.7.4.4 Structural Requirements

1. The CIPP shall be designed as per ASTM F1216, Appendix X.1. The CIPP design shall assume no bonding to the original pipe wall, a fully deteriorated condition, 5% ovality and a conservative groundwater presence over the pipeline. The CIPP thickness must meet the

required minimum nominal thicknesses specified in the table below, or for pipe larger than 18-inches in diameter as specified within the Contract Documents.

Internal Pipe Diameter (inches)	CIPP Minimum Nominal Thickness (mm) Based on Modulus of Elasticity Values	
	Modulus of Elasticity (E) 250,000 psi	Modulus of Elasticity (E) 400,000 psi
8	6	5
10	7.5	6
12	9	7.5
15	10.5	9
18	12.5	10.5
For pipe larger than 18-inches in diameter, the CIPP minimum nominal thickness is specified within the Contract Documents		

- The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers; nor shall separation of the layers occur during the required testing.
- The cured pipe material (CIPP) shall conform to the minimum structural standards, as listed below:

Flexural Stress	ASTM D790	4,500 psi
Modulus of Elasticity	ASTM D790	250,000 or 400,000 psi
Tensile Strength	Pressure Pipe - ASTM D638	3,000 psi

Either of the listed Modulus of Elasticity values noted may be used as long as minimum nominal thicknesses are adhered to in accordance with the table or as noted within the Contract Documents.

10.7.5 Quality Control

It shall be the contractor's responsibility to ensure that the CIPP installed on the project meets all requirements of the Contract Documents and that the final product provided to the City is of the highest quality possible.

10.7.5.1 Testing

In the event that the results of any tests do not meet the requirements of the Contract Documents and/or referenced ASTM standards, the Contractor may proceed with the work at his/her own risk and will be required to submit to the Project Construction Engineer the proposed changes in the process to meet the required properties of the CIPP.

If any lined pipe segment fails to meet the required properties, the Contractor's attention is directed to General Condition 304 – “Substituted Performance”. At the discretion of the Project Construction Engineer and at the Contractor’s own expense, the Contractor will be required to remove and replace any lined pipe segment, or install another liner on top of the one that failed in order to meet the specified requirements of the Contract Documents

The City may elect at any time to decrease or increase the frequency of these sample and testing requirements.

10.7.5.1.1 On-Site Thickness Testing

A minimum of 2 (two) samples will be collected or 2 locations tested using ultrasonic methods, for on-site thickness at each installation by the contractor. All samples collected for testing shall be restrained with equivalent diameter pipe to match the actual field installed liner. A minimum of eight measurements at evenly spaced intervals around the circumference (internal or external based on method) of the pipe will be made to ensure that minimum and maximum thicknesses have been achieved. For pipe diameters fifteen inches or greater, a minimum of sixteen evenly spaced measurements shall be recorded. Any plastic coatings or CIPP layers not included in the structural design of the CIPP must be deducted from the measured thickness value. The average thickness will be calculated using all measured values and shall meet or exceed the minimum required design thickness. Additionally, the minimum wall thickness measured at any one point around the circumference shall not be less than 87.5% of the specified design thickness as specified within the Contract Documents.

The wall thickness will be measured in accordance with the applicable sections of ASTM D2122 or ASTM E797 and shall incorporate the following, as applicable:

1. For onsite samples collected for testing: A cylindrical anvil tubing micrometer accurate to +0.02 mm (+0.001 inch) will be used. The minimum wall thickness tests will be performed by the Project Construction Engineer (or assigned field representative) from the two samples at each installation. All costs associated with providing the required samples shall be borne by the Contractor.
2. For onsite testing using Ultrasonic methods: Testing will be performed by the ultrasonic pulse echo method, in accordance to ASTM E797. Measurements will be taken and calculated at both ends of the pipe run, around the internal circumference of the installed CIPP and at a distance of 12 to 18 inches from the end of pipe, as noted in item 1 above. The ultrasonic method will utilize a flaw detector with A-scan display and a direct thickness readout as defined in 6.1.2 of ASTM E797. A calibration block shall be manufactured from the identical materials used in the installed CIPP to calibrate sound velocity through the liner. Calibration of the transducer shall be performed daily in accordance with the equipment manufacture’s recommendations.

If the deviation in thickness of any one sample is less than 5% (five percent), no payment adjustment will be required. If the deviation in thickness is measured to be between 5%-10% (five percent and ten percent) an adjustment of 10% (ten percent) reduction of the liner unit bid cost will be applied. If the deviation in thickness is greater than 10% (ten percent), the entire run will be rejected and removed and replaced solely at the Contractor’s expense.

10.7.5.1.2 Allowable Pulling Force

Prior to installation, the Contractor shall submit to the Project Construction Engineer the maximum allowable force, per the material manufacturer, that can be used in pulling the tube into the pipe without rupturing or diminishing the diameter and/or the thickness of the tube. Such pulling force shall be monitored at all times during the installation operation with a gauge that is available for viewing by the City and the tube shall be rejected and removed if the allowable pulling force is exceeded.

10.7.5.1.3 Allowable Elongation of Flexible Tube

Prior to installation, the flexible tube shall be measured and marked equal to the installation run (distance between manholes less one manhole diameter). After the completion of installation, the length of the flexible tube outside of the installation run (face of the manhole to the mark) shall be measured. This length or elongation shall not exceed 3% (three percent) of the original length of measured flexible tube. In the event that this length is exceeded, the entire run length may be rejected and permanently discarded, the Project Construction Engineer may order an additional tube to be inserted at no cost to the City, or may accept the elongated tube, but reduce the price paid for the work by 5% (five percent) for every percent elongation above the 3% (three percent) allowable tolerance, as provided by General Condition 304, Substituted Performance. Acceptance will be at the sole discretion of the Project Construction Engineer.

10.7.5.1.4 Laboratory Testing

At the start of construction, at least two CIPP field samples will be taken and submitted for laboratory testing. CIPP samples shall be prepared and tested in accordance with ASTM F1216.

A CIPP sample is required to be prepared for each installation segment, using one of the following two methods (depending on the size of the host pipe):

1. For pipe sizes of 18 inches or less: the sample will be cut from a section of cured CIPP at an intermediate manhole or at the termination point. If the sample is taken at a termination point the CIPP must have been inverted through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags.
2. For pipe sizes greater than 18 inches and areas with limited access: the sample must be fabricated from material taken from the tube and the resin/catalyst system used. This fabricated sample must be cured in a clamped mold which is placed in the down tube (when curing using circulating hot water) or in the silencer (when curing using steam). If approved by the Project Construction Engineer, this method can be used for preparing a test sample on any size of CIPP in situations where preparing samples in accordance with section F1216-09, sec. 8.1.1 is not possible due to physical constraints.

Samples must identify the City contract number, project name, line number, date sample was taken and the specified thickness requirement. Testing for cured liner thickness, modulus of elasticity, flexural stress and tensile strength shall be performed by a Certified Independent laboratory approved by the Project Construction Engineer. Test results are to be submitted to

the Project Construction Engineer and all costs of tests shall be included in the related bid price unless specified elsewhere in the Contract Documents. The Contractor shall take samples from the first week's installation and have the short term tests completed and results to the Project Construction Engineer prior to application for the first pay estimate. Additional testing will commence at intervals required by the Project Construction Engineer.

Additional laboratory testing, at the City's expense, may be requested as frequently as every CIPP installation, at the discretion of the Project Construction Engineer. The Contractor will be reimbursed for additional testing at the Contract unit bid price. At the option of the Project Construction Engineer any sample taken by the Contractor may be sent to an independent laboratory for similar testing.

10.7.5.1.5 Infiltration Test

If the ground water level is above the top of the pipe throughout the length being reconstructed, the Project Construction Engineer, at his/her discretion, may order that an infiltration test be performed. The maximum allowable infiltration shall be 50 gal per day/inch dia/mile (.95 gpd/inch/100 ft.). If the infiltration is found to exceed the prescribed amount, the Contractor shall make the appropriate repairs as approved by the Project Construction Engineer. Additional infiltration tests will be performed until acceptable results are obtained.

Unless otherwise specified, infiltration will be measured by a subcontractor specializing in CIPP testing who is mutually agreed upon by the City and Contractor. Payment for this testing is at the City's expense and will be handled by change order.

10.7.5.1.6 Exfiltration Test

In the absence of ground water, the Project Construction Engineer, at his/her discretion, may order an exfiltration test be performed in accordance with these specifications. The allowable rate of exfiltration shall be equal to the limits of infiltration stated above. Each section of CIPP will be tested between successive manholes by closing the lower end of a sewer and the upper manhole(s) to the proper level with water. The water level in the upper manhole shall be a minimum of 4 feet above the level of the ground water.

For the purposes of exfiltration leakage, manholes shall be considered to be equivalent length of pipe equal to the diameter of the manhole (i.e. 48, 60 or 72 inch diameter). Air pocket entrapment shall be avoided when filling the line with water. Once filled with water, the system shall be allowed to stabilize for a period of two hours before starting the test.

Exfiltration leakage rate is determined by measuring the amount of water required to maintain a constant level in the upper manhole. Test duration is to be no less than two hours.

If the leakage, as shown by the test, exceeds the allowable value, the Contractor shall make the necessary correction at his expense to reduce the exfiltration to within the permissible limits. The Contractor shall furnish all water, material and labor required to perform the test. All tests shall be made in the presence of the Project Construction Engineer.

10.7.6 Public Information and Notification

All written notices shall be issued on current City letterhead templates, prepared in a professional manner and must be approved by the Project Construction Engineer prior to

distribution. All contact with the Public shall be executed in a business professional manner, including adhering to professional standards regarding courtesy, grooming and maintaining visible/legible identification.

The Public Information and Notification program shall at a minimum, require the Contractor to be responsible for contacting each home or business affected by the sewer construction and informing them of the work to be done in all of the following ways:

1. Personally contacting each home and business owner on the day of pre-installation inspection of the sewer and coordinating with that owner the verification of their existing service connection. If the owner is unavailable, other arrangements shall be made for existing service connection verification.
2. Written notice shall be delivered a minimum of 48 hours in advance of the installation, to each home or business describing the work, schedule, how the construction affects them, and a local telephone number of the Contractor they can call to discuss the project or any problems that may arise.
3. Personally contacting each home or business owner and providing written notice the day prior to beginning work on the section of sewer to which they are connected.
4. Personally contacting any home or business owner which cannot be reconnected within the time stated in the Written Notice. Anticipated service tap reconnection time shall be noted within another notice.
5. Provide written notice with the time of reactivation posted on the front door of a residence or business if and only if personal contact is not possible.
6. Upon request by residents and businesses affected by the work, portable toilets shall be furnished and serviced by the Contractor. Reimbursement for the costs of these items will be covered through change order with the Project Construction Engineer.

10.7.7 Installation

10.7.7.1 Access Points

The City has shown all existing manhole access points on the Contract Documents, to the best of its knowledge. It is the Contractor's responsibility to fully examine the project site to verify the location of existing manholes and to determine if all manholes are accessible, as necessary for completion of the work. It will be the Contractor's responsibility to notify the Project Construction Engineer far enough in advance of the CIPP lining process to allow time for the City to make necessary repairs and provide access to the manholes that are not accessible. The Contractor will reschedule the work as needed so that repair work, either by the City or by the Contractor, can be completed.

10.7.7.2 Pre-Installation Inspection

Inspections of pipelines shall be performed by experienced personnel trained in locating and identifying defects, breaks, obstacles, and service connections by closed circuit television.

Certification by NASSCO, PACP program is preferred for inspection personnel. The pre-inspection of pipelines shall also determine active service connections, the addresses served (both visible on the digital recording and audible), as well as which service connections are opened, capped or misaligned. Only active service connection and laterals shall be re-established unless directed otherwise by the Project Construction Engineer.

The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the CIPP. It is the Contractor's responsibility to notify the Project Construction Engineer of any conditions which may prevent proper installation of the CIPP. These types of conditions shall be recorded and submitted digitally, as described elsewhere in these specifications, to the Project Construction Engineer within 5-calendar days of observance, to allow for remedial action and rescheduling of installation for that section of CIPP.

10.7.7.3 Bypassing Sewage

The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for reconstruction. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow with backup pumps onsite. Bypass pumps must be monitored at all times. Leaking equipment will not be permitted. Bypass pumping must be provided for all mainline and service line flows affected by construction. Wastewater shall not be allowed to spill into storm drains, street gutters, or open excavations. Any spills that occur must be addressed immediately and in full conformance with local regulations and requirements. The Project Construction Engineer shall be notified immediately and the Contractor shall bear all costs associated with any spills.

10.7.7.4 Cleaning of the Sewer Line

The Contractor shall be required to remove all existing internal debris from the sewer line with the use of water jet, and/or grinding equipment that is accepted by the Project Construction Engineer. The cleaning operation shall remove any and all existing debris so that each pipe joint can be thoroughly inspected and successfully reconstructed or rehabilitated. Excessively hard deposits that can not be removed by regular cleaning equipment or grinding which require special tools to remove, will be paid for negotiated separately by the City

All sludge, dirt, sand, rocks, grease, and all 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 section to another shall not be permitted.

All such debris resulting from cleaning operations shall be removed from the site and disposed of in a 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. The City will negotiate for costs associated with material disposal if Hazardous Wastes are encountered during testing.

At the end of each work day, all debris shall be removed from the downstream manhole and from the construction site. No debris shall be left at the construction site unattended by the

Contractor. Under no circumstances will the Contractor be allowed to accumulate debris beyond the stated time limit. In the event the Contractor leaves debris unattended at the construction site beyond the stated time, the Contractor will not be allowed to proceed with the work until the debris is properly removed.

During all sewer cleaning operations, precautions shall be taken to protect the sewer lines from damage that might be inflicted 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 and/or private property being served by the sewer line section involved. The Contractor shall bear all costs associated with flooding, damage to basements or structures, and the City's sewer.

10.7.7.5 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 installation of the CIPP. If the pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, collapse or obstruction that will prevent the rehabilitation process and cannot be removed by conventional sewer cleaning equipment, grinding or extended tap cutting, then the Contractor shall notify the Project Construction Engineer immediately. These conditions shall be recorded and a digital video file and log sheet must be submitted to the Project Construction Engineer so that the existing conditions are documented and may be reviewed to determine the extent of repair required prior to CIPP installation. The Project Construction Engineer will notify the Contractor upon completion of required repair(s), at which time the Contractor shall perform sewer line cleaning and a pre-installation inspection prior to CIPP installation.

10.7.7.6 Methods

All bidders proposing to use the CIPP process for a project must use a method that has been approved by the City prior to bid opening. All approved CIPP methods must meet these Detail and Technical Specifications. Any proposed deviation from these Detail and Technical Specifications must be submitted in writing for acceptance at least eight calendar days prior to the bid opening. CIPP installation shall be in accordance with ASTM F1216, Section 7 for the Inversion Method, or Section 6 of ASTM F1743 for the Pulled-In-Place Installation Method, with the following requirements:

1. The Contractor shall designate a location where the tube will be impregnated prior to installation. The Contractor shall notify the Project Construction Engineer of proposed "wet-outs" in order to inspect the materials and procedure. A resin and catalyst system compatible with the requirements of this method shall be used.
2. Once inversion has started, the pressure shall be maintained between the minimum and maximum pressures, as set by the liner's manufacturer, until cure completion. A continuous, constant pressure must be maintained for all air inversion steam cure (AISC) installations. If pressure is lost at any time during installation/cure (for inversion or pulled in place methods), the City may request that the CIPP product be removed and the line segment re-inspected, at the contractor's expense, prior to allowing re-installation and curing.

3. The Contractor shall pull or invert the flexible tube through the existing sewer line in a method which has been reviewed and approved by the Project Construction Engineer. The Contractor will not be allowed to use water to float the inserted flexible tube into the existing sewer line. Immediately after installation of the tube, a heat source will be applied to start the curing process. Constant pressure shall be maintained until the tube has completely cured out.
4. 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 manhole to determine the temperature at that location during cure. The Contractor must maintain an on-site written log during the CIPP curing process for each installation, tracking temperature, pressure (for steam cure) and curing time. This log must be available for review at any time by the Project Construction Engineer. If air pressure and steam are used, a Safety Gas Detector shall be used to ensure that it does not reach the explosive limit.
5. As noted within the submittals portion of this specification, before the installation process begins, the Contractor shall submit to the Project Construction Engineer, the minimum pressure required to hold the tube tight against the existing conduit (including considerations for external ground water pressure, if present) and the maximum allowable pressure to avoid damaging the tube. This data shall be obtained by the Contractor from the tube manufacturer.

If the CIPP is installed via inversion, the pressure shall be maintained between the minimum and maximum pressures until the entire operation has been completed (inversion and cure). If the CIPP is installed using the pulled-in-place method, the pressures shall be maintained, after initial inflation, between the minimum and maximum pressures until the entire operation has been completed (inflation and cure).

If the pressure drops below the recommended minimum at any time during installation or curing of the CIPP, the liner should be removed and the host pipe re-inspected for dislodged pipe fragments or fallen debris which may cause bulging or protrusions within the cured CIPP. In addition, under the above circumstances, the CIPP product should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable ASTM F1216 and F1743 requirements. Should the pressure deviate from within the range of minimum and maximum pressures, the installed tube may be rejected and the Contractor will be responsible for the removal of the CIPP and replacement with new CIPP at no additional cost to the City.

Once the cure has started and dimpling for laterals is completed, the required pressures shall be sustained until the cure has been completed. A complete log of the pressures shall be maintained on the site and furnished to the Project Construction Engineer after each installation.

6. The plastic coating of the tube shall be translucent to allow visual proof that the resin has wet out the entire tube and that there are no dry areas.

7. The Contractor shall maintain a log on site for each installation section documenting elongation, thickness and pulling force.
8. The finished CIPP shall be continuous over the entire length of an installation run between two manholes and be free, as commercially practicable, from visual defects such as foreign inclusions, dry spots, pinholes, folds and delamination.
9. If the CIPP fails to make a tight seal at each manhole, the Contractor shall apply a joint sealant at that point with a material compatible with the CIPP. The Contractor shall provide a submittal to the Project Construction Engineer for approval on the proposed sealant material.
10. Individual installation runs can be made over one or more manhole sections as determined in the field by the Contractor. The maximum allowed installation run is 1,200 feet. Intermediate manholes will be reopened as directed by the Project Construction Engineer.

10.7.7.7 Sewer Service Connection and Reactivation

The Contractor shall determine if a service connection is active prior to rehabilitation of the sewer. Only active service connections and laterals shall be re-established. All costs incurred to verify active service connections are included within the “Cured-In-Place-Pipe” bid item within the contract. No additional payment for verification shall be considered.

After the curing of the CIPP has been completed, the Contractor shall reopen and restore the existing active service connections and branch connections. It is the intent of these Detail and Technical Specifications that the active service connections and branch connections be reopened without excavation. When the pipe size is too small to facilitate direct manned reactivation, a remotely controlled cutting device, monitored by a close circuit television camera shall be used. The cutting device is required to re-establish service connections to not greater than 100% (one hundred percent) capacity, and not less than 95% (ninety five percent) capacity, while conforming to the shape of the existing opening. The Contractor shall be responsible for completing point repairs of any active service connections that are damaged or misaligned during reactivation procedures. These point repairs shall be completed as directed and approved by the Project Construction Engineer and all costs shall be born by the Contractor.

The Contractor shall certify he/she has a minimum of 2 (two) complete working cutting devices, plus spare key components on the site before each installation.

Service connections shall not remain out of service for more than 12 hours at a time, without the Contractor providing some means of temporary facilities or hotel accommodations for the affected residents or property owners.

10.7.8 Post Installation Inspection

Post installation video inspection of all CIPP line segments shall be completed by the contractor and recorded using closed circuit television in accordance with ASTM F1216 or F1743. The post inspection of pipelines shall be performed in a manner which allows the invert to be clearly viewed and inspected. The recorded video must show that all active service connections have been reactivated, the addresses served (both visible on the digital

recording and audible), as well as any inclusions or visual defects present. All service connections and laterals which are not plugged or capped shall be re-established unless directed otherwise by the Project Construction Engineer. The contractor shall review all post inspection videos and notify the City immediately of any visual defects, inclusions, or issues with the installation. Digital video records shall be submitted, as described elsewhere in these specifications.

10.7.9 Clean-Up

The Contractor shall reinstate all project areas affected by their operations to an equal or better condition than existing upon completion of the CIPP installation. All restoration must be completed prior to submitting that section of CIPP for consideration for payment.

10.7.10 Record Documentation

1. Digital Video and Log Sheets

The Contractor is required to provide pre and post video files, as well as associated log sheets, for all pipe segments rehabilitated under the contract. All video and log sheets must be submitted to the City and County of Denver. All digital video files shall be submitted in .mp4 format and log sheets shall be submitted in .pdf format. All files will be labeled in accordance with the instructions provided by the Project Construction Engineer.

Pre and post inspection log sheets and digital video should be submitted together the week immediately following completion of each work segment, unless the contractor is submitting pre-inspection results separately to convey potential problem areas to the Project Construction Engineer. Log sheets and digital video files not submitted at least 5 business days prior to a pay estimate cut-off date will not be considered for payment until the following month. It is the Contractor's responsibility to submit digital video media and log sheets in a timely fashion and as outlined in these specifications.

2. As-Built Drawings

A final set of red-lined drawings shall be submitted by the Contractor on a clean, full size set of project plans for As-Built purposes prior to processing final payment and releasing remaining retainage. A clean set of project plans may be obtained from the Project Construction Engineer upon request.

The red-lined drawings shall include the following: location and size of all pipe segments rehabilitated, the location of all restored service connections (showing distances from the downstream manhole), and the field recorded length of each rehabilitated segment (face of manhole to face of manhole). Providing inaccurate or incomplete record information is reason for withholding of progress payment as outlined in the General Contract Conditions.

10.7.11 Patents

The Contractor and the Contractor's suppliers shall warrant and save harmless the City against any and all claims, potential litigation involving patent infringement, copyright violations and any loss thereof.