

## SECTION 336084

### CURE IN PLACE PIPE LINING

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. Furnish all labor, materials, equipment, and incidentals required to install and test the cured in place pipe (CIPP) lining and appurtenances complete as shown on the Drawings and/or as specified herein, including, but not limited to services necessary for traffic control, bypass pumping and/or diversion of sewage flows, cleaning and television inspection of sewers to be lined, liner installation, reinstatement of service connections, quality control, providing samples for performance of required material tests, final television inspection, testing of lined pipe system and warranty work, all as specified herein.
- B. Sewer cleaning, pre-rehabilitation and post-rehabilitation closed circuit television (CCTV) inspection of all pipes to be rehabilitated by CIPP lining methods are required per applicable Specifications as listed herein. Note that the City will be performing the closed-circuit television (CCTV) inspection of all pipes to be rehabilitated. The Contractor will perform all post-rehabilitation CCTV inspections.
- C. Contractor shall remove obstructions and protruding service connections as required to complete the CIPP rehabilitation. Removal of all pipeline obstructions and protruding service connections required for sewer rehabilitation using cured in place pipe lining shall be completed prior to the pre-rehabilitation CCTV inspection.

Neither the CIPP system, nor its installation, shall cause adverse effects to any of the City's processes or facilities. The use of the product shall not result in the formation or production of any detrimental compounds or by-products in the system or at the wastewater treatment plant. Notify the City and identify any by-products produced as a result of the installation operations, test and monitor the levels, and comply with any and all local waste discharge requirements. Cleanup and restore existing surface conditions and structures, and repair any of the CIPP system determined to be defective. Conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses, and property owners or tenants.

- D. The Contractor, or Contractor performing the Work, shall not change any material, design values or procedural matters stated or approved herein, without informing the City/Engineer and receiving written approval of the change. Such changes constitute a breach of contract and shall result in rejection and removal of work performed with the unapproved materials or processes at no cost to the City.
- E. Maintenance and Protection of Traffic, confined space entry, and work site protection shall be the responsibility of the Contractor and costs of these items are included in the cost of the project. Notify Police, Fire, NPU, Ambulance agencies, and residents/businesses in advance of any and all road closures. Comply with applicable OSHA trench safety rules and confined space and sewer system entry.

## 1.2 RELATED WORK

- A. Maintenance of flow in existing sewers and drains.
- B. Sewer system smoke testing is included in Section 336065.
- D. Sewer line cleaning is included in Section 336070.

## 1.3 SUBMITTALS

- A. Submit to the City/Engineer, in accordance with Section 013000, shop drawings, product data, materials of construction, design calculations, and details of installation. The Contractor shall provide this information without delay or claim to any confidentiality. Contractor shall note that there are two different sets of submittals required with different time frames as shown below in Sections 1.3.B. and 1.3.C.
- B. Submittals required with the bid shall include the following:
  - 1. Letter to certify that the CIPP will conform to the project requirements as outlined in the Scope of Work and as delineated in these specifications and that the Contractor's personnel has had at least 5 (five) years active experience in the commercial installation of CIPP. In addition, the Contractor must have successfully installed at least 750,000 feet of a CIPP product in wastewater collection systems of a similar size, length and configuration as contained in this contract as documented by verifiable references. Submit name and experience of each lead individual performing work on this Contract. Personnel replaced by Contractor shall have similar verifiable experience as personnel originally submitted for project. Contractor's project managers must have

a minimum of two (2) years of CIPP installation experience and must be on-site during the installation of the CIPP products.

2. Submit information in following subparagraphs for review and approval before any CIPP lining work is performed.
  - a. Number of years of Contractor's experience in installing CIPP lining.
  - b. Documentation and a sufficient number of references to meet qualifications requirements as listed in Paragraph 1.5 Qualifications, of this Section.
  - c. Names and product information of the CIPP felt tubes and resin materials to be utilized for this project and their suppliers.
  - d. A certified statement from manufacturer that Contractor is an approved installer as certified and/or licensed by the CIPP liner manufacturer.
3. A list of a minimum of five (5) municipal clients that CIPP Contractor has performed this type of work for without defects or performance problems for a period of five (5) years after installation. The list shall contain the following:
  - a. Names, addresses, and telephone numbers, and e-mails of persons to be called to verify previous satisfactory performance.
  - b. A full description of the actual work performed.
  - c. Name of CIPP lining manufacturer and supplier for each referenced project.
4. Five (5) reports from projects within past two (2) years from independent testing laboratory analysis of liner materials showing: Modulus of elasticity as determined by appropriate ASTM standard and flexural stress as determined by ASTM D790 standard. Lining shall be of same resin system and felt tube materials as proposed for this project.

C. Submittals required within 10 days after notice to proceed shall include the following:

1. Detailed information on the CIPP installation procedures (wet-out, heating, curing, and cool down, if applicable) and all tools and equipment required for a complete installation. Identify which tools and equipment will be redundant on job site in the event of equipment breakdown. Equipment to be furnished for the project, including proposed back-up equipment, shall be clearly described. Contractor shall outline the mitigation procedure to be implemented in the event of key equipment

failure during the installation process.

2. CIPP lining schedules including field-verified lengths and diameters of all CIPP lining and appurtenances required. Plans should include map(s) that show insertion points for all CIPP installations.
3. Shop drawings and product data to demonstrate compliance with these specifications and identify materials of construction (including resins, catalysts, felt, etc.), felt manufacturer, location of the felt manufacturing facility, location of the wet-out facility, etc., flexible membrane (coating) material (including recommended repair/patching procedure, if applicable).
4. Manufacturers' shipping, storage and handling recommendations for all components of the CIPP System.
5. MSDS sheets for all proposed products and materials to be furnished for the project.
6. Detailed sample collection, laboratory testing and quality control procedures, including schedule and shipping and storage requirements.
7. Written description and/or plan for odor control that will ensure that project specific odors such as styrene will be minimized at the project site and surrounding area.
8. The end seal material(s) and description of their installation.
9. Detailed written plan of the method of flow maintenance (Bypass Pumping plan) and noise prevention measures.
10. A detailed description of the Contractor's proposed procedures for removal of any existing blockages in the pipeline that may be encountered during the cleaning process.
11. A detailed written traffic-control plan that details every street that will be impacted and how impacts will be mitigated.
12. Data on the maximum allowable stresses and elongation of the tube during installation and the means in which the Contractor will monitor stress and elongation (i.e., ideal inversion head and maximum cold head, minimum inversion head, maximum hot head).
13. A detailed public notification plan shall be prepared and submitted including detailed staged notification to residences affected by the CIPP installation.

14. A complete description of the proposed wet-out procedure for the proposed technology.
  15. A Safety Plan identifying all competent persons, a description of a daily safety program for the job site and all emergency procedures to be implemented in the event of a safety incident. All work shall be conducted in accordance with the Contractor's submitted Safety Plan.
  16. A detailed quality control plan (QCP) that fully represents and conforms to the requirements of these specifications. At a minimum the QCP shall include the following:
    - a. A detailed discussion of the proposed quality controls to be performed by the Contractor.
    - b. Defined responsibilities of the Contractor's personnel for assuring that all quality requirements for this contract are met. These shall be assigned by the Contractor, to specific personnel.
    - c. Proposed procedures for quality control including those pertaining to fit and finish, and product sampling and testing shall be defined and submitted as part of the plan.
    - d. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.
    - e. A schedule for performance and product test result reviews between the Contractor and City/Engineer at a regularly scheduled job meeting.
    - f. Inspection forms and guidelines for quality control inspections shall be prepared in accordance with the standards specified in this contract and submitted with the QCP.
  17. Design data and specification data sheets listing all parameters used in the CIPP liner design and thickness calculations based on ASTM F 1216 for fully deteriorated gravity pipe conditions. Thickness of liners for oval and egg-shaped pipe shall be calculated in accordance with the "Sewerage Rehabilitation Manual" published by the Water Research Center (WRC). All calculations shall be prepared under the supervision of and stamped by a Professional Engineer registered in the State of Florida.
- D. Submittals before, during and after CIPP installation work shall include the following:

1. Prior to each shipment of CIPP lining, submit certified test reports that the CIPP lining for this Contract was manufactured and tested in accordance with all ASTM Standards specified and referenced herein.
2. CIPP lining schedules including field-verified lengths and diameters of all CIPP lining and appurtenances required to show that the contractor has physically measured every pipe to be rehabilitated. Plans should include map(s) that show insertion points for all CIPP installations.
3. Detailed installation procedures and manufacturer's recommended cure method for each diameter and thickness of CIPP liner to be installed, including CIPP lining production schedule, acceptable inversion heads and pressures, inversion or winching procedures, curing and cool-down procedures detailing the curing rate of temperature increases and cool down and the method of application, and times for each stage of the process.
4. Wet-out forms/reports for each CIPP segment with detailed information including but not limited to: date and time of wet-out, wet-out facility address, volumes and/or weights of resin, length and diameter of CIPP liner (both wet-tube and dry-tube), roller gap settings, start times, finish times, resin used (product name and batch/shipment number) and quantity, gel times, resin injection locations, thickness of CIPP liner (dry and wet), catalyst(s) name and quantity used, and any other pertinent data documenting the wet-out for each section of CIPP liner manufactured. The wet-out forms shall be submitted prior to CIPP liner installation and shall be provided without delay or claim to any confidentiality. Wet out forms shall be submitted to the City/Engineer field representative on the day of delivery.
5. CIPP liner field curing reports documenting the liner installation for all sewer segments. The CIPP liner reports shall document all details of liner installation, including manhole numbers, street names/sewer location, project number, date, time, ambient temperature, heads used during the inversion process, pressures and/or heads (minimum inversion pressure, ideal head, maximum hot head and maximum cold head) used during curing (including cool down if applicable), curing temperature, curing time, rate of cool down, CIPP liner thickness, etc. A sample report shall be submitted to the City/Engineer for approval prior to the installation of any CIPP lining. The reports shall be submitted prior to requesting payment and shall be provided without delay or claim to any confidentiality.

NOTE: The following item (#6) is for UV cured CIPP. Delete if not used.

6. For UV cured liners, record the curing and light train speed (feet per minute), light source (number of lamps, intensity and wattage), inner air

pressure (psi), exothermic (curing) temperatures per unit time over the length of the liner, and temperature of the internal liner surface. Include liner manufacturer recommended citations in the submittal.

7. Complete certified copies of the report(s) output(s) of the continuous temperature monitoring systems used in the control of the curing, printed and in electronic format. The reports shall be submitted prior to requesting payment and shall be provided without delay or claim to any confidentiality. Also provide the City/Engineer with access to the website where the secure reports can be obtained.
8. Samples of installed liner(s) for testing to be performed by an ASTM-certified independent testing laboratory, as described further herein.
9. Information on any grouts, epoxy, or cements the Contractor is proposing to use for sealing at manholes or for other uses.
10. Submittals shall be provided in three-ring binders and/or electronic format.
11. Submit daily production reports to the City/Engineer's Superintendent and/or field representative at the end of each workday.
12. A list of all service laterals (with distances and clock position) that were abandoned or reconnected as part of the work as further defined herein.
13. Some installations may result in the need to repair or replace a defective CIPP. Submit in writing, for review by the City/Engineer, specific repair or replacement procedures for potential defects that may occur in the installed CIPP. Repair/replacement procedures shall be as recommended by the CIPP system manufacturer and shall be submitted to also include the following:
  - a. Defects in the installed CIPP that will not affect the operation and long-term life of the product shall be identified and defined.
  - b. Repairable defects that may occur in the installed CIPP shall be specifically defined by the Contractor based on manufacturer's recommendations, including a detailed step-by-step repair procedure, resulting in a finished product meeting the requirements of these contract specifications. Repairable defects may include but are not limited to blisters, wrinkles, fins, pinholes, over- or under-cut lateral connections, and any voids found between liner and the host pipe.
  - c. Un-repairable defects that may occur to the CIPP shall be clearly defined by the Contractor based on the manufacturer's

recommendations, including a recommended procedure for the removal and replacement of the CIPP. Un-repairable defects may include but are not limited to thickness below required minimum thickness, structural strength below required limits, lifts, shrinkage, folds, bulges, and delamination.

14. A list of all repair or replacement of CIPP defects that were executed by the contractor including identification of segment, location of the repair, and type of repair.

NOTE: The following item requires Contractor to provide NASSCO CIPP Inspector Training to City staff. Training of the City's inspectors by the CIPP system manufacturer is an alternative. If required, it should be scheduled during the first actual installation, so the inspector learns during actual field operations. The NASSCO Inspector training program (ITCP) is another alternative that provides training for the inspector specifically on Quality Assurance, inspection procedures and testing requirements based on industry standard principals. Leave or delete this item as appropriate.

- a. Two days of inspector training, by the CIPP system manufacturer, for the City's inspectors shall be provided. This training shall be prior to liner installation, include both technical and field training and include all key aspects of visual inspection and sampling procedures for testing requirements. On smaller projects having an estimated duration of less than two weeks of lining work, system manufacturer shall furnish a check list containing key elements of the CIPP installation criteria that is are important for the City's inspector to ensure that quality control and testing requirements are performed in accordance with Contract Documents.

#### 1.4 REFERENCED STANDARDS (LATEST REVISIONS)

##### A. ASTM International (ASTM):

1. ASTM D 543 - Standard and Practice for Evaluating the Resistance of Plastics to Chemical Reagents.
2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
3. ASTM D 790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
4. ASTM D 792 - Standard Test Methods for Density and Specific Gravity of Plastics by displacement.
5. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines



and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

6. ASTM F1336-15 - Standard Specification for Polyvinyl Chloride (PVC) Gasketed Sewer Fittings
7. ASTM F 1743 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).
8. ASTM F 2019 – 11 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)
9. ASTM D 2122-98(2004) - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
10. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
11. ASTM F 2561-11 - Standard Practice for Rehabilitation of a Sewer Service Lateral and Its Connection to the Main Using a One Piece Main and Lateral Cured-in-Place Liner.
12. F2599-11 - Standard Practice for Sectional Repair of Damaged Pipe by Means of an Inverted Cured-In-Place Liner.
13. ASTM D 2990 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.
14. ASTM D 5813 - Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems.

*NOTE: The following items (15-17) are not necessary for standard CIPP. They apply only to fiberglass reinforced CIPP. Leave or delete this item as appropriate.*

15. ASTM D 3567-97(2002) - Standard Practice for Determining Dimensions of Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings.
16. ASTM D 3681 - Standard Test Method for Chemical Resistance of “Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Pipe in a Deflected Condition.
17. ASTM F 2019-03 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass

Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).

- B. National Association of Sewer Service Companies (NASSCO):
  - 1. NASSCO Pipeline Assessment and Certification Program (PACP) Reference Manual, current edition, including addenda.
- C. Water Research Centre, UK:
  - 1. Sewerage Rehabilitation Manual, Type II Design, 4th edition (April 2001), WRC Publications.
- D. Where reference is made to one of the above standards, the latest revision/update in effect at the time of bid opening shall apply.

## 1.5 QUALIFICATIONS

- A. Contractor performing CIPP lining work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be certified and/or licensed as an installer by CIPP lining manufacturer. For a Contractor to be considered as considered qualified by the City, the Contractor must satisfy all insurance, financial, and bonding requirements of the City, and must have had at least 5 (five) years active experience in the commercial installation of CIPP. In addition, the Contractor must have successfully installed at least 750,000 feet of a CIPP product in wastewater collection systems of a similar size, length and configuration as contained in this contract as documented by verifiable references. Submit name and experience of each lead individual performing work on this Contract. Personnel replaced by Contractor shall have similar verifiable experience as personnel originally submitted for project. Contractor's project managers must have a minimum of two (2) years of CIPP installation experience and must be on-site during the installation of the CIPP products.
- B. Full-time, on-site superintendent/foreman that will supervise CIPP lining installation has have a minimum five (5) years as a foreman/superintendent, documented by verifiable references, for a cured-in-place lining crew (installing actual product included with this project), and a minimum of 300,000 lineal feet of cured-in-place lining installed under his/her supervision. Such experience shall include the actual product, by trade name, CONTRACTOR proposes to install. Acceptable documentation of these minimum installations must be submitted to the City.

- C. Lead personnel including superintendent, foreman and lead crew personnel each shall have a minimum of five (5) years of total experience with CIPP technology proposed and shall have demonstrated competency and experience to perform the scope of work as documented by verifiable references.
- D. City and/or Engineer reserves the right to approve or disapprove Contractor, Superintendent, and/or manufacturer based on submitted qualifications and a follow-up interview.
- E. Contractor shall self-perform a minimum of eighty (80%) percent of the CIPP in a given work authorization and the overall project.
- F. CIPP felt and resin manufacturer(s) shall have successfully supplied a minimum of 500,000 feet of proposed liner and one million pounds of resin as documented by verifiable references.
- G. The lateral cutter is required to have at least six (6) months of experience reinstating the connection between the sewer main and lateral lining as documented by verifiable references.

#### 1.6 GUARANTEE

- A. CIPP lining placed shall be guaranteed by Contractor and manufacturer for a period of five (5) years from date of Substantial Completion. During this period, serious defects discovered in CIPP lining, as determined by City and which may materially affect the integrity, strength, function and/or operation of pipe, shall be removed and replaced as recommended by the manufacturer in a satisfactory manner by Contractor at no cost to the City. The City may conduct an independent CCTV inspection, at its own expense, of CIPP lining work prior to completion of warranty period. Defects replaced at that time shall be fully warranted by Contractor and manufacturer for a period of two (2) years from date the defect was repaired. Wrinkles in flow stream, blisters that may affect the longevity of CIPP liner, dry spots where liner tube has no resin saturation, or other defects that may affect the integrity or strength of the CIPP or the flow capacity of the pipe, are unacceptable. Contractor shall be responsible to remove and repair, at Contractor's expense, all such defects in a manner that is satisfactory to City/Engineer. Defects also include but not limited to the following:

1. Leakage through the liner or between liner and pipe.
2. Reduction of liner thickness of more than ten percent (10%) of the thickness designed and/or required. Final liner thickness shall be delivered by Contractor based on installed product physical properties and as specified in Contract requirements.

3. Separation of liner from host pipe where an annular space is clearly noticed, shrinkages (longitudinal and/or circumferential), dry spots, delamination of liner, cured lifts, dry spots, bulges due to external loading, reverse curvatures, splits, cracks, lifts, breaks, folds, major wrinkles (as defined further herein), flats, pinholes, crazing and any other defects that in the CIPP lining will compromise the longevity of the installed product.
4. Circumferential defects (wrinkle, fin, bulge, etc.) in the invert of pipe between 4:00 and 8:00 o'clock shall not exceed three (3%) percent of the host pipe diameter or one half (1/2")-inches by visual measurement, whichever is smaller, at the discretion of the City.
5. Longitudinal wrinkles or fins shall not exceed maximum allowable height of five (5%) percent of equivalent host pipe diameter or one (1")-inch, whichever is smaller.
6. Structural strength below the required limits.

#### 1.7 QUALITY ASSURANCE

- A. CIPP linings shall follow the quality control plan submitted by Contractor.
- B. CIPP linings shall be from a single manufacturer. Suppliers shall be responsible for provisions of all test requirements specified herein as applicable. In addition, CIPP lining to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the City. Contractor shall require manufacturer's cooperation with these inspections. Cost of plant inspection of all CIPP lining approved for this Contract will be the responsibility of the City.
- C. Inspections of CIPP lining may also be made by Engineer or other representatives of City after delivery. CIPP lining shall be subject to rejection at any time on account of failure to meet any of the requirements specified, even though sample CIPP lining may have been accepted as satisfactory at the place of manufacture. CIPP lining rejected after delivery shall be marked for identification and shall be removed from the job site.
- D. In the event that an installation is rejected based on review of the Contractor's post-rehabilitation CCTV inspection, the Contractor shall repair the sewer segment to the satisfaction of the City/Engineer at no additional cost to the City.
- E. Along with the physical properties testing, the Contractor shall deliver a

certified copy of the curing report output from the temperature monitoring system used in the control of the curing process for pipes; or provide the City/Engineer with access to the website where the secure report can be obtained.

## 1.8 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in shipping, handling and laying to avoid damaging the CIPP liner. CIPP liner damaged beyond repair in shipment shall be replaced as directed by the City/Engineer.
- B. Any CIPP liner showing a visible split, tear, or defect, at no additional cost to the City, shall be repaired per manufacturer's recommendations and to the satisfaction of the Engineer or, if not possible, shall be removed at once from the project site.
- C. While stored, CIPP shall be adequately supported and protected in a manner as recommended by manufacturer.
- D. CIPP liner shall be maintained at a proper temperature in refrigerated facilities to prevent premature curing at all times prior to installation. CIPP liner shall be protected from UV light. CIPP liner showing evidence of premature curing will be rejected for use and shall be immediately removed from the site.

## PART 2 - PRODUCTS

### 2.1 CIPP FELT LINER AND RESIN

NOTE: For item B, normal recommended ratio of resin and felt by volume is 85% and 15% with some minor tolerances. The CIPP is based on the resin volume provided not the amount of felt carrier material. If the carrier material includes fiberglass or is all fiberglass, then the resin to fabric will be adjusted as recommended by the manufacturer. If there are missing pipe segments, this usually will require some additional reinforcement or a pre-liner to avoid overstretching of the liner.

- A. CIPP liner shall be Granite Inliner by Granite Construction, Inc., Insituform by Insituform Technologies, Inc., National Liner by National EnviroTech Group LLC, SAK Liner by SAK Construction LLC, CIPP Corp., Sancon CIPP by Sancon Engineering Inc., Improved Technologies Group, or pre-approved equal.
- B. CIPP liner shall be composed of tubing material consisting of one or more layers of a flexible non-woven polyester felt with or without additives such as woven fiberglass or other fibers and meet the requirements of ASTM F 1216, ASTM F 1743, and ASTM D 5813. Felt

content of CIPP liner shall be determined by Contractor, but shall not exceed 15 percent of the total impregnated liner volume. Fabric tube shall be capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and stretch to fit irregular pipe sections. Contractor shall submit certified information from felt manufacturer on normal void volume in the felt fabric that will be filled with resin.

- C. CIPP liner tube may be made of single or multiple layer construction, with any layer not less than 1.5 mm thick, unless the tube is made of fiberglass material. Wet-out fabric tube shall have a uniform thickness and void space for resin distribution that when compressed at installation pressures will produce a predictable finished thickness that meets or exceeds the design thickness after cure.
- D. No material shall be included in fabric tube that may cause de-lamination in cured CIPP. No dry or unsaturated layers shall be acceptable upon visual inspection as evident by color contrast between felt fabric and activated resin containing a colorant.
- E. Wall color of interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made. Hue of the color shall be dark enough to distinguish a contrast between fully resin saturated felt fabric and dry or resin lean areas.
- F. Seams in the fabric tube, if applicable, shall meet the requirements of ASTM D5813.
- G. The outside layer of the tube shall be coated with an impermeable material compatible with the resin and fabric.
- H. Resin: Shall be a corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system manufactured specifically for sewer rehabilitation, that, and when properly cured within the tube composite, meets the requirements of ASTM F 1216, ASTM F 1743 or ASTM F 2019, the physical properties herein, and those, which are to be utilized in the design of CIPP for this project. Resin shall produce CIPP that will comply with or exceed structural and chemical resistance requirements of this specification. Liner material and resin shall be completely compatible. Generally, resin shall not contain fillers, except those required for viscosity control or fire retardance or increase strength, and with applications for which inert fillers would facilitate better heat transfer and retention during installation. Liner contractor may add up to five (5%) percent by mass, a thixotropic agent for viscosity control, which will not interfere with visual inspection.

- I. Resins may contain pigments, dyes, or colorants, which shall not interfere with visual inspection of cured liner. Quantity of resin used for tube impregnation shall be sufficient to fill volume of air voids in tube with additional allowances for polymerization shrinkage and loss of resin through cracks and irregularities in original pipe wall. Use serial vacuum impregnation or pressure impregnation process (or equal) to provide maximum resin impregnation throughout the tube.
- J. Prior to inversion, if applicable, outside and/or inside layer of tube (before inversion/pull-in as applicable) shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate, if applicable, vacuum impregnation and monitoring of resin saturation during the resin impregnation (wet out) procedure.
- K. Exterior of manufactured tube shall have distance markings along its length at regular intervals not to exceed five (5') feet. Use these marks as a gauge to measure elongation during insertion. Should overall elongation of a reach exceed five (5%) percent, liner tube shall be rejected and replaced.
- L. Contractor shall identify the wet-out facility where all CIPP liner under this Contract will be manufactured. All CIPP liner shall be manufactured from this designated wet-out facility throughout entire Contract unless specifically approved otherwise by Engineer in writing. Multiple wet-out facilities shall not be allowed.
- M. City and/or an agent of City may inspect CIPP liner during manufacturing and wet-out. City/Engineer shall be given an opportunity to witness manufacturing of all CIPP liner for this project. The City is responsible for costs associated with witnessing the manufacturing of CIPP liner.
- N. If City/Engineer decides to inspect the manufacturing of CIPP liner, Contractor shall provide full access to witness wet-out process and shall provide any and all information related to the manufacturing as requested by City or City's agent without delay and without claims of confidentiality or product privacy.
- O. Application of resin to felt tubing (wet-out) shall be conducted under factory conditions using vacuum impregnation and materials shall be fully protected against UV light, excessive heat and contamination at all times. If on-site wet out is required, Contractor shall be required to maintain ambient conditions similar to those encountered during factory wet outs.
- P. Liners that are impregnated at the factory and transported to the project site in refrigerated trucks shall be installed as soon as possible and no more than two (2) weeks after the date of impregnation at the factory.

NOTE: If the sewer system contains traces of materials other than normal domestic sewage as defined in ASTM D 5813 then testing of the flow must be performed to verify that the proposed resin will be adequate. If not, then an alternative resin must be selected.

- Q. When cured, CIPP liner shall form a continuous, tight-fitting, hard, impermeable liner that is chemically resistant to any chemicals normally found in domestic sewage per Table 2.1 in ASTM F 1216. CIPP liner shall be chemically resistant to trace amounts of gasoline and other oil products commonly found in municipal sewerage and soils adjacent to sewer pipe to be lined.

NOTE: For brick sewers and other irregular sewers, the circumference needs to be measured at a minimum every 50 feet to capture any variations in dimensions.

- R. CIPP liner tube shall be manufactured or fabricated to a size that will tightly fit internal circumference of sewer being rehabilitated after being installed and cured. CIPP liner shall be capable of fitting into irregularly shaped pipe sections and through bends and dips within the pipeline. Allowance for longitudinal and circumferential expansion shall be taken into account when sizing and installing CIPP liner. Tube shall be properly sized to diameter of existing pipe and length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends. Contractor shall determine minimum tube length necessary to effectively span designated run between manholes. Contractor shall verify lengths in field prior to ordering and prior to impregnation of tube with resin, to ensure that tube will have sufficient length to extend entire length of the run, which is defined as the length of the existing host pipe measured from the interior walls of the manholes, and/or from the ends of the pipe when/if the pipe extends into the manholes. Contractor shall also measure inside diameter and circumference of existing pipelines at face of each manhole in field prior to ordering liner so that liner can be installed in a tight-fitted condition with little or no wrinkling.

- S. Length of CIPP liner shall be as deemed necessary by Contractor to effectively carry out insertion of CIPP liner and sealing of CIPP liner at outlet and inlet manholes. Required diameter and length of each pipe segment shall be measured in advance of wet-out and a list of these measurements shall be submitted to Engineer at least one week prior to installation of each CIPP liner.

- T. Contractor shall be responsible for ensuring that correct liner is installed in each sewer reach being rehabilitated.



U. All pipes of diameter 12-in and greater shall have a minimum finished thickness of six (6) millimeters or as designed, whichever is greater.

V. Contractor shall verify proposed CIPP liner thicknesses and submit associated calculations. Actual cured liner thickness shall be -5/+10 percent of approved design thickness and shall not include thickness of any non-structural membrane (inner/pre- liner). CIPP liner shall be designed in accordance with applicable provisions of ASTM F 1216 for “fully deteriorated gravity pipe conditions”, unless Engineer agrees, in writing, prior to installation that “partially deteriorated gravity pipe conditions” shall apply based upon review of CCTV video. CIPP liner shall meet following design conditions, unless Engineer agrees, in writing, of their change:

1. AASHTO H 20 Live Load.
2. Constrained soil modulus of native soil in the pipe zone of 1,000 psi.
3. Soil weight of 120 pounds per cubic foot and a coefficient of friction of  $Ku=0.130r$  shall be used for the installed depths.
4. Long-term flexural modulus used in design calculations shall be estimated by multiplying lowest short-term flexural modulus used in design calculations by a retention factor of 0.50 (i.e., long-term retention of mechanical properties equal to 50 percent.)
5. Design safety factor of 2.0.

*NOTE: Groundwater depth shall be per the geotechnical report. In very conservative cases, groundwater depth can be considered to be at the ground surface.*

6. Typical groundwater levels shall be estimated at one half (1/2) the distance between crown of pipe and ground surface. If actual groundwater depth information is available from USGS or other sources, it shall be utilized in calculations. Groundwater depth used in calculations shall be from estimated maximum groundwater level from surface to invert of interior pipe or at elevation specified for bidding purposes in Contract Documents.
7. Service temperature range shall be 40 to 100 degrees F.
8. Minimum ovality of host pipe of two (2) percent.
9. Long-term retention of mechanical properties equal to 50 percent.
10. Thickness to be used for CIPP liner shall be largest thickness as

determined by calculations for deflection, bending, buckling and minimum stiffness.

11. CIPP liner thickness for non-round pipes or circular pipes with greater than 10% ovality shall be designed on accordance with WRc Sewerage Rehabilitation Manual, Type II Design, Section 5.3.2.iii.
12. Minimum liner thickness after installation and curing for all pipes 12-inches in diameter and larger shall be six (6) mm or as designed, whichever is greater. Thicknesses following installation and curing shall be based on design calculations provided by Contractor.
13. CIPP liner shall provide a minimum service life of 50 years and, for design purposes, shall have the following minimum initial and long-term properties:

Property	Test Method	Initial (psi)	Long Term (psi)
Flexural Strength	ASTM D790	4,500	2,250
Flexural Modulus of Elasticity	ASTM D790	350,000	175,000

14. The CIPP shall be designed to withstand all imposed loads, including dead and live loads and, if applicable, hydrostatic pressure. The liner shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation.

## 2.2 END SEALS

- A. End seals shall be composed of hydrophilic rubber and molded as a one-piece, three-inch (3") wide cylinder which when installed will form a 360-degree seal between the host pipe and the newly installed liner. Use of caulking, rope or band type of an end seal shall not be allowed. Acceptable end seals are Insignia™ End Seals by LMK Enterprises or approved equal.

*NOTE: For projects in which manholes will also be rehabilitated, the following item (item B) should be deleted. For projects in which manholes are not being rehabilitated, the hydrophilic seals are sufficient enough to prevent any infiltration migrating to the manhole, and installing an additional seal at the manhole wall will add price and may also prevent an inspector to confirm that the hydrophilic seals have been installed by the contractor. If required to have the end of the pipe at the manhole wall covered, item B can be included.*

- B. Contractor shall install epoxy at the end of each lined pipe to cover any

piece of existing pipe that are exposed at the manhole wall. Acceptable epoxy resins are Sikadur 31 or approved equal.

## 2.3 SERVICE LATERAL SEALS

*NOTE: If the sewer is located in groundwater table conditions, then hydrophilic rubber connections are required. If there is no groundwater present, chemical grouting is acceptable.*

- A. Service lateral connections shall be sealed. If the sewer is not under the phreatic surface, for the purposes of this specification anything deeper than five (5') feet from land surface is considered below the phreatic surface, seal service lateral connection by injecting a chemical hydrophilic grout into the space between the connection and the main line. If the sewer is under the phreatic surface, for the purposes of this specification, below five (5') deep, seal the service lateral connection by installing a hydrophilic rubber connection seal.
- B. Chemical grouts shall conform to Section 336090.
- C. Rubber connection seals shall be composed of a hat made of hydrophilic polymeric neoprene rubber designed with a specified wall thickness to provide a compression seal at connection of a lateral and a mainline pipe. Use of caulking, rope or band type of an end seal shall not be allowed.
- D. Acceptable hydrophilic rubber seals are Insignia™ Hydrophilic Connection Hat by LMK Enterprises, or approved equal.

## 2.4 CIPP SPOT REPAIRS

- A. Install a sectional CIPP spot repair for areas where longitudinal shrinkage of the installed CIPP liner near the manholes is three (3") inches or more, at no cost to the City/Engineer.
- B. For any other longitudinal shrinkage observed within a pipe segment, install a sectional CIPP spot repair.

NOTE: Select either B or C as an approved spot repair. B refers to an air inverted Performance Liner sectional spot repair by LMK Technologies; C is an ambient cured fiberglass mat that cures at ambient temperature.

- C. CIPP spot repair shall be accomplished using a liner tube of a particular length and a thermo-set resin with physical and chemical properties appropriate for the application. The tube positioned within a translucent inversion bladder is vacuum impregnated with the resin, then placed inside a protective launching device and winched through the sewer

pipe. The tube shall consist of one or more layers of flexible non-woven needled felt or a reinforced non-woven. The tube shall be continuous in length exhibiting a uniform minimum wall thickness based upon design calculations found in ASTM F1216 appendix XI. No overlapping sections shall be allowed in the circumference or the length of the liner. The tube shall include compressible material at each end forming a smooth transition to the host pipe. The liner shall be capable of conforming to offset joints, bells, and disfigured pipe sections. The resin shall be polyester, vinyl-ester or epoxy with proper catalysts as designed for the specific application. The cured-in-place pipe shall provide a smooth bore interior. Each installation shall have a design report documenting the design criteria for a fully deteriorated pipe section, or a partially deteriorated pipe in cases where the pipe has previously been lined. The installation procedure shall conform to ASTM F2599-11 "Standard Practice for Sectional Repair of Damaged Pipe by Means of an Inverted Cured-In-Place Liner". The cured-in-place pipe shall meet or exceed the minimum test standards specified by the American Society for Testing Methods as described in the most current edition of ASTM F1216 standard, most current edition. Acceptable CIPP spot repairs are LMK Performance Liner or approved equal.

- D. CIPP spot repairs shall be ambient cure and shall have a fiberglass mat consisting of two or more layers of 0/90 degrees bias woven fiberglass with a Trevara felt coating on one side and capable of carrying a two component, 100% solid epoxy or silicate base resin. Acceptable fiberglass CIPP spot repairs are Prime Line sectional lining spot repair or approved equal.

## 2.5 STYRENE REDUCING AGENT (IF APPLICABLE)

- A. The styrene reducing agent shall be StyRedux by Integrated Chemical & Equipment Corporation, or approved equal.
- B. The styrene reducing agent shall be a gelatin, water soluble, biodegradable, non-toxic, FDA approved powder and/or capsule. The styrene reducing agent shall be added in a calculated amount according to manufacturer's recommendations into the down-tube for water curing or directly into the water holding tank for steam curing.

## PART 3 – EXECUTION

### 3.1 PRE-INTSTALLATION

- A. Examine the City's CCTV video of each pipe segment before starting work.

- B. Notify all property owners or businesses that discharge sewage directly to sewer being lined and whose service lateral will be affected by lining work, that their service will be temporarily interrupted during installation of CIPP liner. Deliver written notification to each such resident or business at least 72 hours in advance, giving the date, start time and estimated completion time for the work being conducted, and any restrictions on use of sewage system facilities including exact days and hours when sewer system cannot be used. Method of notification, and the text included in the notification, shall be approved by the City.
- C. Clean each length of pipe to be lined and shall dispose of all resulting material offsite as specified in Section 336070.
- D. The Contractor's project manager and/or superintendent shall review the City provided pre-rehabilitation inspection videos to confirm the quality of the videos, locations of lateral connections, and locations of point repairs to be performed. The City/Engineer will review pre-rehabilitation inspection videos to confirm locations of point repairs to be performed by Contractor. If an Inspector or Engineer is on site or immediately available, Contractor shall allow the Inspector or Engineer to view the pre-installation video to verify the pipe is ready for CIPP installation which includes proper cleaning, trimming protruding taps and mitigating and any significant infiltration.
- E. If the data is available, the City/Engineer will provide Contractor information on location of known active laterals and cleanouts; however, this list may not be interpreted as all-inclusive. Contractor shall be responsible for verifying active customer service connection prior to rehabilitation. Contractor shall compare service connections from CCTV video and compare with above ground measurements at approximate location of center of each house or building. Any discrepancies between CCTV data and above ground measurements of laterals shall be brought to attention of the City/Engineer for a determination of lateral reinstatements. If Contractor discovers an error or addition to the list provided, Contractor shall immediately notify Engineer for additional investigation. Upon completion of rehabilitation work, a list of all service laterals abandoned or reconnected as part of the work shall be submitted to the City. Compiled list can be in the form of post-inspection installation inspection logs and shall include the following information:
1. Location of each service lateral based on CCTV inspection logs. Location shall include both accurate distance measured from centerline of starting manhole as well as a notation (by clock-reference) of where on circumference of pipe, the service lateral connects.
  2. Status (Active or Inactive).
  3. Address of each customer and associated active lateral location.

- F. Prior to installation of CIPP lining, all service lateral connections protruding into main line by one half (1/2")-inch or more shall be internally cut or ground down flush with pipe wall with a robotic cutter specifically designed for this purpose. Internal cutter shall be capable of cutting unreinforced concrete pipe (CP), cast iron pipe, PVC, vitrified clay pipe (VCP), ductile iron pipe, and Orangeburg pipe. All materials / cuttings shall be removed from sewer and properly disposed of.
- G. Infiltration runners or gushers as defined by NASSCO PACP that are observed during the pre-rehabilitation CCTV shall be stopped by injecting a chemical hydrophilic grout as required in Section 336090 using a remote packer, unless otherwise approved by the City/Engineer. If the pipe is larger than 36", man-entry with hand-applied fast-setting epoxy can be performed to stop the infiltration.
- H. Maximum amount of time any home or business shall be without sanitary sewer service is 10 hours and not between 6:00 PM and 8:00 AM. Any service out longer than 10 hours shall be bypassed to a sanitary sewer at no cost to the City.
- I. Provide bypass pumping of sewage flows in accordance with Section 336081. Service connection effluent may be plugged only after proper notification to affected residence and may not remain plugged overnight. Installation of liner shall not begin until Contractor has installed required plugs or a sewage by-pass system and all pumping facilities have been installed and tested under full operating conditions including bypass of mainline and side sewer flows. Once lining process has begun, existing sewage flows shall be maintained, until resin/felt tube composite is fully cured, cooled down, fully televised and CIPP ends finished.
- J. Wastewater flows from existing sewers shall not be allowed to enter the new or rehabilitated facilities until the new or rehabilitated facilities have been cleaned and tested as required in the Contract Documents.
- K. Provide CIPP liner in full length of sewer as shown on work orders. Installation of CIPP liner shall be in complete accordance with applicable provisions of ASTM F 1216 or ASTM F 1743 and manufacturer's recommendations.
- L. Install a hydrophilic end seals at face of each manhole at all manhole penetrations per Paragraph 2.2 prior to inverting or pulling in uncured CIPP liner.
- M. If in the opinion of CIPP liner manufacturer and/or the City/Engineer, rate of infiltration in sewer segment is high enough to risk washout of resin, perform measures, as required, to minimize infiltration prior to installation,

including pre-liners, grouting, etc. If during pre-lining CCTV inspection, any infiltration runners or gushers (per NASSCO PACP®) are observed, Contractor shall submit, in writing for approval by the City/Engineer, methods and materials for mitigating any adverse impacts from the infiltration.

- N. Pressure gauges for the ends shall be digital pressure/vacuum gauges with a pressure range of 0 to 50 psi and  $\pm 0.25\%$  test gauge accuracy.
- O. For pipes 18-in diameter and larger, install and use continuous temperature sensor strips. Provide the City's representative with access to the longitudinal temperature monitoring system data during the installation via digital data, web-based or other approved methodology and printed reports.

### 3.2 INTALLATION

- A. CIPP liner shall be installed via inversion using hydrostatic head or air pressure in accordance with ASTM F 1216 or ASTM F 1743 and manufacturer's recommendations or inserted through a manhole by means and methods required by the manufacturer. Hydrostatic head and/or steam pressure used during installation process shall be sufficient to hold liner tight to pipe wall; producing dimples at all service connections, and flared ends at two access manholes. Contractor shall closely follow the requirements in the submitted liner field curing reports, including the minimum inversion pressure, ideal head, maximum hot head and maximum cold head for each installation.
- B. If CIPP does not fit tightly against original pipe at its termination points, at no additional cost to the City, the full circumference of CIPP exiting host pipe shall be filled with a resin mixture compatible with CIPP, approved by CIPP manufacturer and the City/Engineer. There shall be no significant leakage of groundwater between existing pipe and CIPP at manhole connection or service lateral connections. Any leakage shall be removed and/or eliminated by Contractor at no additional cost to the City. Any infiltration found at manhole and/or service connections shall be eliminated by Contractor at no additional cost to the City. Any infiltration runners or gushers as defined by NASSCO PACP shall be stopped with chemical hydrophilic grouting as required in Section 336090.
- C. Fit heat source with monitors to accurately gauge temperature of incoming and outgoing water or steam supply. Place another such gauge between CIPP liner and pipe invert at downstream end to determine temperature during curing process. Temperature in CIPP during curing process shall be as recommended by resin manufacturer. Length of time for allowing curing process to be completed shall be of

duration recommended by manufacturer, during which time Contractor shall maintain required temperature throughout CIPP. Provide a written temperature data chart/curing log to the City's Representative for review to ensure that curing temperatures for resin meet manufacturer's recommendations.

- D. The full length from manhole to manhole of the installed resin-impregnated flexible felt tube CIPP liner shall be cured using circulating heated water or steam in accordance with ASTM F 1216 and manufacturer's recommendations or with UV light sources to affect desired cure throughout length of the tube, extending full length from manhole to manhole(s). Resin shall be cured into a hard impermeable pipe with minimum specified thickness, providing a structurally sound, uniformly smooth interior and tight-fitting liner within existing pipe. Cool-down procedures shall be in accordance with ASTM F 1216 and manufacturer's recommendations. The cool-down shall follow manufacturer's guidelines, be measured digitally to allow inspector to inspect or record, be linear, and be gradual; no super cooled air shall be allowed to be injected. UV cured CIPP shall not be permitted without written approval from the City/Engineer and after documentation has been reviewed that liner is compatible with all specifications and other related work including any lateral lining systems.
- E. For pull-in-place liners cured by UV light (ASTM F2019)
1. Fiberglass liner shall be cured with UV light sources at a constant inner pressure sufficient to maintain the liner tight against the existing wall of the pipe.
  2. The time, the rate of travel of the ultraviolet light assembly, light sources and the internal pressures shall all be recorded and as specified by the liner manufacturer. This segment curing data shall be submitted to the City/Engineer, along with the manufacturer's curing standards
- F. Contractor may install CIPP lining in multiple sewer segments at one time where possible. When installing CIPP lining in multiple sewer segments at one time, the top one-half of CIPP liner in intermediate manhole shall be neatly removed, leaving the invert in place, and void between CIPP liner and existing channel shall be filled with non-shrink grout. Manhole bench shall be reconstructed as required to provide a smooth transition to new CIPP liner.
- G. All cutting and sealing of CIPP liner at manhole connections shall provide watertight pipe and manhole seals. All cut edges of cured liner shall be thoroughly sealed with same resin as was used in liner. Catalyst or hardener used shall be compatible with resin/catalyst used



in liner previously, but shall not require an external heat source to begin exothermic reaction (curing). There shall be no leakage of groundwater into manhole between CIPP liner and existing sewer pipe and between existing sewer pipe and manhole wall.

- H. Continuous temperature monitoring systems are required for all 18-inches or larger sewer or any sized sewer in locations with significant known groundwater infiltration or if pipe is within 50 feet of stream, river or lake for liners being cured by heated water or steam. This system shall be installed at the invert of pipe and be installed per manufacturers recommended procedures. Temperature sensors shall be placed at upstream and downstream ends of reach being lined to monitor pressurized fluid's (air or water) temperature during curing process. To monitor temperatures inside tube, wall and to verify proper curing, temperature sensors shall be placed between host pipe and liner in bottom of host pipe (invert) throughout the reach to record the heating and cooling that takes place on the outside of liner during processing. As a minimum, sensors shall be spaced apart at intervals no greater than 20-feet for pipe sizes up to 15-inches in diameter; and no greater than 10-feet for pipe sizes 18-inches and larger. Additionally, sensors shall be strategically placed at points where a significant heat sink is likely to be anticipated. Monitoring of these sensors shall be by a computer that can record temperatures at this interface throughout processing of CIPP utilizing a tamper-proof database. Temperature monitoring systems shall be Zia Systems or Vericure by Pipeline Renewal Technologies.
- I. Prior to installing liner in host pipe, temperature monitoring system's proper functioning shall be confirmed by hooking it up to computer and seeing that sensors are reporting their ambient temperatures. No more than two sensors in sequence can be found faulty during this test. If three or more sensors in sequence are discovered faulty, a new sensor array shall be provided and installed at no extra cost to the City; and the new array shall be again tested for its proper functioning.
- J. Curing of resin system shall be as per recommendations of CIPP system manufacturer of CIPP product. Temperatures achieved and duration of holding the liner at those temperatures shall be per System Manufacturer's established procedures. If any sensor or sensors along reach indicates that there is a localized issue with respect to achieving proper curing per written installation procedure, Contractor shall address the issue prior to acceptance of the liner. Sensor array's database required in above paragraph shall have an output report that identifies each sensor by its station in reach and shows maximum temperature achieved during processing of CIPP and time sustained at or above Manufacturer's required curing temperature at each sensor.

The temperature of the liner shall be recorded until the liner has completed the cool-down process.

- K. If cool-down is to be accomplished by introduction of cool water into an inversion standpipe to replace water being drained from a small hole made in downstream end, the hardened liner shall be cooled down to a temperature below 100 degrees F (38 degrees C), or ambient temperature, whichever is lower, before relieving static head in inversion standpipe. Contractor shall take measures to ensure that, in release of static head, a vacuum will not be produced that could damage the newly installed CIPP liner.
- L. Incorporate mitigation measures to control styrene odors during installation and curing of the liner. If any styrene odor complaints occur on the jobsite, the Contractor shall have means and methods to immediately mitigate the issue.
- M. Vent and/or exhaust noxious fumes or odors generated during and remaining after curing process is completed. This process shall remain in place at all manholes, laterals, etc., until noxious odors have dissipated to an acceptable level in accordance with OSHA requirements for materials used and there is no more air pollution or potential health hazard left to general public or construction workers.
- N. Coordinate with the City on where curing water can be discharged.
- O. Provide piping, pumps, valves, and other equipment to discharge curing water.
- P. After the installation of the first 1,000 linear feet of CIPP lining, no additional CIPP lining shall be installed until acceptance testing demonstrates that the product meets all thickness and strength properties specified herein. Once the City/Engineer has reviewed and approved the test results, the remainder of the lining installation may resume.

### 3.3 REINSTATEMENT OF SERVICES

- A. After new CIPP has been cured and completely cooled down, if applicable, Contractor shall reconnect existing service laterals as designated by pre-installation television inspection report generated by Contractor. This shall be done without excavation but from interior of pipeline by means of a television camera and a remote cutting device that reestablishes service connection to not less than 90 percent or better of original diameter and to a maximum of 100 percent of original diameter; overcut connections are not acceptable. All openings shall be clean and neatly cut and the cut shall be buffed with a wire brush to

remove rough edges and provide a smooth finish. Bottom of openings shall be flush with bottom of lateral pipe and shall have smooth edges with no protruding material capable of hindering flow or catching debris. All service lateral connections shall be sealed per section 2.3 of this specification.

- B. Coupons shall be removed from laterals by any means possible including entering homes to flush the material via access from cleanout.
- C. Excess resin that builds up and hardens in and around the lateral connections(s) must be removed and/or ground down prior to acceptance of the re-instatement. Contractor will be required to supply an extended lateral cutter bit to reach resin buildup beyond standard length bits.
- D. Inactive service laterals identified in Drawings and elsewhere in the Specifications will be abandoned by not reopening the service connection after installation of the cured-in-place pipe liner. If necessary, because of uncertainty of matching each tap in the sewer with each property, the Contractor shall dye test to verify if a service connection is active at the direction of the City/Engineer.
- E. Service laterals that were determined to be inactive during CCTV inspection will be abandoned by not reopening service connection after installation of cured-in-place pipe liner. All lateral connections shall be identified as repaired or abandoned in post rehabilitation CCTV (to be performed by the Contractor). Contractor to provide image file for all lateral locations along a given pipe segment. Contractor to provide image file at location of lateral even if lateral connection has been abandoned.
- F. Contractor shall not open abandoned/capped service connections except at the City's/Engineer's direction. If an abandoned service connection is opened without the City's/Engineer's approval, Contractor shall perform an internal spot repair to close connection, at no additional cost to the City.
- G. Contractor shall provide a fully operational backup device for reinstating service laterals. If there is any doubt about live vs. dead service based upon above property comparison with pipe connections, then Contractor shall verify with dye testing. If for any reason remote cutting device fails during reinstatement of a service lateral, Contractor shall immediately deploy standby device to complete reinstatement. Backup equipment shall be onsite throughout reinstatement process.
- H. For service lateral reconnections and/or renewals to be made by

excavation methods, InsertaTeEs may be used for solid wall pipes having a 0.36-inch or greater wall thickness. InsertaTeEs shall be "Fatboy" type with hub manufactured of SDR 26 PVC material incorporating a 360-degree integral stop on the hub surface and exceeding ASTM F1336 Section 10.3 Pipe Stop Load Support Test, or approved equal. Romac type saddles shall be used for pipes having a wall thickness thinner than 0.36-inches. Saddle connections shall be seated and sealed to new CIPP using grout or resin compatible with the CIPP. Other services shall be renewed by trenchless lateral lining.

- I. All existing break-in and/or hammer-tap (break-in) laterals shall be cut and sealed per Paragraph 2.03 of this Section to provide a watertight connection between the lateral and the lined pipe. Contractor shall submit a method for cutting and sealing of each lateral.

#### 3.4 FIELD TESTING AND ACCEPTANCE

- A. Field acceptance of CIPP lining shall be based on the City's and Engineer's evaluation of installation, including a review of the CIPP liner curing data, review of post-rehabilitation CCTV inspection data (post-rehabilitation CCTV to be performed by the Contractor), and review of certified test data for installed CIPP liner, including air testing. All CIPP sample testing, and repairs to installed CIPP as applicable, shall be completed before final acceptance, meeting requirements of these specifications and documented in written form.
- B. For every 1,000 linear feet of CIPP liner installed for the first 5,000 linear feet, the Contractor shall perform sampling and testing to determine the installed CIPP liner flexural properties and CIPP liner thickness. After the first five (5) test results have been collected and all have passed the minimum standards per the specification, the City may require collecting random samples up to one sample per 5,000 linear feet for testing. Frequency of testing may be reduced as approved by the City/Engineer after sufficient tests are performed to verify CIPP liner design, production and installation procedures. Likewise, frequency of testing may be increased by the City/Engineer and performed by Contractor at no additional cost to the City when required tests show that installed CIPP liner does not meet specifications. If a test is not passed, Contractor shall re-evaluate liner thickness design to determine if installed physical properties meet minimum design requirements; if it does not, liner shall be replaced or relined with approval from the City/Engineer at no additional cost to the City.
- C. Testing shall be performed by an independent testing laboratory certified by the American Association for Laboratory Accreditation (A2LA). Contractor shall submit to the City/Engineer the name and location of independent testing laboratory, a certified statement from

laboratory indicating that they are independent from and not associated with Contractor in any way, and A2IA certification for independent testing laboratory.

NOTE: This testing to be paid by the Contractor.

- D. All expenses for sampling and testing of installed liner shall be paid for by the Contractor. Chain of custody for test samples shall be through City's representative. Cost of all manufacturer's testing to qualify products furnished to project site shall be the responsibility of Contractor.

NOTE: Note that restrained samples may not be practical for pipes larger than 18-inches in diameter; in this case, plate samples are allowed.

- E. Sampling and testing of the installed CIPP liner shall conform to ASTM F 1216 and the following requirements:

1. Remove one restrained sample of installed CIPP liner at least 18-inches in length. Sample shall be captured by installing CIPP liner through a section of PVC pipe (same diameter as existing sewer diameter) within the most downstream manhole of installation and at all intermediate manholes if multiple sewer segments are lined at same time. Contractor may elect to cut the sample longitudinally and provide 1/2 the sample to City's representative or inspector for direct shipping to laboratory and keep other half of sample for additional testing if necessary.
2. CIPP liner thickness shall be measured in accordance with ASTM D 5813. Flexural properties shall be determined in accordance with ASTM D 790. Contractor shall label and date all samples and provide to inspector or City's representative same day of installation for shipping to independent testing laboratory. The City/Engineer shall be copied on all transmittals to independent testing laboratory. Testing results shall be submitted to Engineer or City within 30 days after installation of CIPP liner or payment will be withheld.

NOTE: For structural and thickness tests, if tests are within 90 percent of specification payment shall be 90 percent of bid price per item. If tests are between 75 percent and 89 percent, then 75 percent of price shall be paid. If below 75 percent, Contractor shall reline segment with a new liner that meets structural requirements.

3. After recalculations performed in accordance with Paragraph 3.4, B above, any CIPP lining that does not meet new calculated thickness requirements shall be corrected by Contractor in a manner approved by

the City/Engineer at no additional cost to the City. The City's decision on how to correct deficient CIPP liner installations shall be final. Options for correcting deficient CIPP liner installations that will be considered by the City include the following: removal of existing CIPP liner and re-lining the sewer, open-cut replacement of sewer from manhole to manhole, re-lining sewer with existing CIPP liner in place.

- F. The Contractor shall perform a post-rehabilitation CCTV inspection of all sewers rehabilitated using CIPP lining methods. Post-rehabilitation CCTV inspection shall be performed following installation of CIPP liner and reinstatement of all active service laterals. The Contractor's project manager and/or superintendent shall review the post-rehabilitation inspection videos to confirm the quality of the videos and of the installed CIPP. If it is determined that any repairs are needed at any segment, a new CCTV inspection shall be performed of the entire segment(s) after the repairs have been completed.
- G. Liner Installation Inspection - A visual inspection of the liner will be considered acceptable if liner shows no significant, wrinkles, lifts, ridges, splits, cracks, delaminations, flats, dry spots, pinholes, shrinkage, foreign inclusions, crazing, reverse curvatures, or other type of defects in the CIPP lining. Significant defects shall be defined as those listed in paragraph 1.6 of this section; and/or any defect that may create a maintenance issue in future such as inhibiting CCTV cameras or allowing solids to get caught on defect, and/or any defect that appears to reduce long-term structural strength or stability of pipeline. Longitudinal wrinkles/fins in height up to a maximum of five percent of inside diameter of host pipe or one (1")-inch, whichever is smaller, may be acceptable and shall be evaluated by Engineer for acceptance on a case by case basis. Defective lining shall be repaired or replaced at no additional cost to the City. If during removal process, the pipe is damaged, Contractor shall perform a point repair at Contractor's own expense.
- H. The Contractor shall provide post CCTV Video Inspection and Submittals:
  - 1. Removal of wrinkles or fins deemed significant at the discretion of the City, shall be removed using a milling head, relined or replaced by the Contractor as directed by the City at no additional cost. There shall be no evidence of other major defects in the CIPP lining.
  - 2. Longitudinal shrinkage of the CIPP liner's length, of more than three (3") inches from the face of the manhole shall be repaired with a fiberglass reinforced CIPP spot repair per Paragraph 2.4 of this Section at no cost to the City.

3. Circular shrinkage shall be measured by the Contractor via man entry to try to insert a 1/16" thick ruler or similar into any gap more than eight (8") inches past the MH wall. The Contractor shall document these measurements with digital photos that shall be submitted to the City/Engineer for approval. Circular shrinkage shall be repaired per manufacturer recommendations at no cost to the City.

I. The CIPP liner shall be watertight. Groundwater infiltration through the wall of the liner shall be zero.

NOTE: Epoxy sealing by hand may be allowed for pipes 30-inches in diameter or larger within the pipe and hand applied for any size sewer if within 2 feet of the manhole wall.

J. All service connections shall be opened to a minimum of 95 percent and a maximum of 100 percent of opening so that a new lateral or lateral lining can be installed properly. Any overcuts more than 105 percent shall be repaired with hydrophilic seal hat connection, CIPP liner or other approved method by the City/Engineer.

K. All coupons and excess resin shall be removed from reinstated service laterals prior to acceptance of CIPP lining.

L. All pipe-to-manhole connections shall be watertight and free of infiltration.

NOTE: Either an air test or hydrostatic test is required. Air tests are typically performed on steam cured liners and hydrostatic exfiltration test are typically performed on water installations. In the case of high groundwater installations, an infiltration test is acceptable. In the case of pipes larger than 36-inch diameter in no groundwater, it is very hard to perform an exfiltration or infiltration test. ASTM F 1216 (item 8.2) allows 50 gal/day/in diam./mile and 1 psi drop in time and also has an allowance for leakage. However, for larger CIPP installations that after the liner has cured it is recommended to use the downtube of the upstream CIPP inversion to monitor the water level before the downstream end is opened up to confirm that no water is being lost.

M. When CIPP is installed using pressurized air, Contractor shall perform an air-test per Section 336065 in presence of the City's representative immediately following cool down and prior to lateral reinstatement. Otherwise, hydrostatic testing (exfiltration test) of completed liner shall be performed after liner curing and cool down in accordance with ASTM F 1216. Hydrostatic testing shall be performed prior to reinstatement of active services.

NOTE: For large diameter pipes (36 inches or greater), an exfiltration test may be allowed.

- N. Installed CIPP shall be tested for water tightness using an exfiltration test. Maximum allowable leakage shall be 50 gallons per day per diameter inch of pipe per mile in accordance with ASTM F 1216.

NOTE: For projects in which manholes will also be rehabilitated, the following item (item O) should be deleted. For projects in which manholes are not being rehabilitated, the hydrophilic seals are sufficient enough to prevent any infiltration migrating to the manhole, and installing an additional seal at the manhole wall will add price and may also prevent an inspector to confirm that the hydrophilic seals have been installed by the contractor. The end of the pipe at the manhole wall may be required to be covered, in which case item O can be included.

- O. After all installations are complete, inspected, post-construction CCTV has been reviewed and approved by the City/Engineer, and all work is satisfactory to the City/Engineer, contractor shall cut and trim the new liner at each manhole wall. Seal liner to manhole wall with a sealant material per Paragraph 2.2 of this Section.

### 3.5 MEASUREMENT AND PAYMENT

#### A. PAYMENT

1. Payment for CIPP pipe liner shall be made at Contract unit price per linear foot for each size as stated in the Bid, complete in place, in accordance with Contract Documents. Payment will be based on actual number of feet installed, as measured by Engineer. Pipe will be measured horizontally, on surface, from center-to-center of manholes to nearest 0.1-foot, unless another method is approved by the City/Engineer. Payment for service lateral reinstatement and service lateral sealing will be made at Contract unit price per lateral reinstated and/or sealed.
2. Price paid per linear foot for pipe liner shall include full compensation for furnishing labor, materials, tools, equipment and incidentals necessary to provide CIPP liner, manhole seals, traffic control, sewage bypassing, control of water, manhole connections, preconstruction inspection, cleaning, disposal of sewer cleaning materials, final inspection, perform leakage testing of the CIPP pipe liner, post-construction inspection, protection of existing utilities and adjacent property, and all required surface restoration work and traffic control, complete in place, as shown in Drawings and specified herein.



END OF SECTION