SECTION SS-12

CURED-IN-PLACE PIPE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Plans, video recordings, and logs and general provisions of the Contract, including Section 100, General Provisions of the City of Columbus Construction and Material Specifications (CMS) apply to this work.

1.2 DESCRIPTION OF WORK

A. Scope of Work. Furnish and install the cured-in-place resin impregnated flexible tube pipe liner in accordance with the plans and as specified herein. When installed, cured, and complete, the liner shall extend from one manhole to the next in a continuous tight-fitting, watertight, pipe-within-a-pipe manner with a uniformly smooth interior providing hydraulic flow equal to or greater than the existing sewer in original condition.

1.3 QUALITY ASSURANCE

A. Standards. All work and materials used shall be in compliance with the following standards that are made part of this specification:

1. American Society for Testing and Materials (ASTM) (latest edition):
    a. ASTM D-543, Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
    b. ASTM D-638, Test Method for Tensile Properties of Plastics.
    c. ASTM D-790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
    d. ASTM D-5813, "Standard Specification for Cured-in-Place Thermosetting Resin Pipe"
    e. ASTM F-1216, Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin Impregnated Tube.
    f. 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) (if given approval on a case-by-case basis).
2. National Association of Sewer Service Companies (NASSCO).

B. Contractor's Qualifications. Installation of the sewer pipe lining system shall be performed by an experienced Contractor fully licensed and approved by the

lining process manufacturer. The Contractor shall have a minimum of three (3) years of experience in such work and shall have satisfactorily completed ten (10) similar regional projects for at least three (3) different utilities or agencies. If the Contractor anticipates utilizing steam curing, three (3) of these ten (10) regional projects must be a steam cured application.

1.4 SUBMITTALS

The following submittal (A) shall be made with the Bid:

A. Contractor's Qualifications. Submit copy of manufacturer's licensee certificate. Submit list of ten (10) similar regional jobs within the past three (3) years as well. Provide project information such as length of project, pipe diameter, date complete, project cost, owner contact (name and phone number), and installation/curing method. In addition, three (3) of the ten (10) regional jobs must indicate the successful use of steam curing if this method is to be utilized by the Contractor.

The following submittals (B-I) shall be made at the pre-construction meeting:

B. Product Data. Furnish manufacturer's general product data.

C. Material Certifications. Written certification is required from the manufacturer that all liner and resin used in the work were manufactured and tested in accordance with the ASTM Standards specified herein, and is being used or installed in conformance with the manufacturer's recommendations. Materials used on this project shall be the same as approved by the City of Columbus, Division of Sewerage and Drainage Trenchless Technology Committee.

D. Resident Notifications. The Contractor shall submit a copy of the resident notifications as described in Section 3.2.A.

E. Storage and Delivery Procedures. The Contractor shall provide the resin and liner manufacturer's recommended storage and delivery procedures. This shall include storage and delivery temperatures, maximum time from wet-out to installation, and other pertinent information.

F. Material Safety Data Sheets. The Contractor shall submit Material Safety Data Sheets (MSDS) for each component of the CIPP system.

G. Test Results. Prior to the use of any materials, the Contractor shall furnish, at its expense, the results of testing of the proposed materials by an independent laboratory in conformance with these specifications. All submitted test data shall have been performed on field installed samples within the last twelve (12) months. Any material not meeting the requirements of these specifications shall

be completely removed from the project. Materials acceptable to the Engineer shall be substituted for rejected items at the Contractor's expense.

The Contractor shall submit the following:

1. Testing by an independent laboratory to verify that the products to be used meet all minimum strength standards as set forth in ASTM F-1216, Table 1.
2. Testing by an independent laboratory to verify that the products used meet the Creep Factor specified within. The submittal shall include the long-term Flexural and Tensile Modulus of Elasticity measured in accordance with ASTM D2990.
3. Testing by an independent laboratory to verify that any product to be used on the project meets the minimum chemical resistance requirements as established in ASTM F-1216, Table 2, where the testing is in accordance with Appendix X2 of ASTM F-1216.

H. Installation Procedures. The Contractor shall submit the CIPP liner manufacturer's detailed installation procedures for the installation method(s) to be utilized on this project.

I. Curing Cycle and Cooling Rate. The Contractor shall submit the resin manufacturer's recommended curing cycle as well as the recommended cooling rate. The Contractor shall submit inversion pressure (desired and maximum), curing pressure (desired and maximum) and times (part of the curing cycle) for air inversion/steam curing.

The following submittals (J-M) shall be made a minimum of ten (10) working days prior to lining:

J. Pre-rehabilitation video recordings and logs. The Contractor shall submit 2 copies of the pre-rehabilitation video recordings and logs to the Engineer that document existing conditions after the Contractor has cleaned the sewer line.

K. CIPP Liner Thickness Calculations. The Contractor shall perform CIPP liner thickness calculations for each manhole-to-manhole section and furnish them to the Engineer with supporting assumptions, including the actual pipe condition observed based upon the work performed in SS-5. All calculations shall be prepared under and stamped by a Professional Engineer registered in the State of Ohio. Submit P.E. Certification Form for all CIPP liner design data. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Design parameters given in Section 2.2.C shall be used in calculations.

L. Lateral Status Determination Report. The Contractor shall submit a lateral status determination report for each manhole to manhole section for approval by the Engineer. See Supplemental Specification Section SS-11 for details of this

report. No CIPP liner installation shall be performed until written approval of this report is issued by the Engineer.

M. Bypass Pumping Plan. The Contractor shall submit a bypass pumping plan for each manhole to manhole section to be lined for approval by the Engineer. See Supplemental Specification Section SS-3 additional details on this submittal.

The following submittals (N-O) shall be within one week after lining:

N. Cure Logs. The Contractor shall submit a copy of the cure logs for each manhole to manhole installation. The cure logs shall contain records of the curing cycle and the cooling cycle. Each cure log shall clearly indicate the project name, Capital Improvement Project (CIP) number, and the manhole section that was lined.

O. Post-rehabilitation video recordings and logs. The Contractor shall submit two (2) copies of the final television inspection that show the rehabilitated sewer along with reinstated service connections.

1.5 JOB CONDITIONS

A. Environmental Requirements

1. Contractor may be required to monitor styrene odors as necessary in businesses and residences to ensure that concentration levels are under recommended limits.
2. Contractor shall use caution when working in project sewers. During rain events, project sewers may reach capacity quickly and/or head up.

B. Safety. All work to be completed in conformance with all applicable safety standards, in particular OSHA Standard 29CFR 1910.146, Permit Required Confined Space Entry. See Supplemental Specification Section SS-1, "General Requirements".

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. CIPP material shall be delivered to the job site in a covered refrigerated truck to minimize exposure to sunlight and to maintain the temperature of the product within manufacturer's recommendations to avoid premature curing.
2. Delivery of material shall be coordinated with other trades to avoid delays.
3. Pipe preparations and field inspections shall be completed prior to delivery of liner to site.

B. Storage of Materials

1. Material shall be stored in the delivery truck in order to minimize exposure to sunlight and to maintain the temperature of the product to within manufacturer's recommendation to avoid premature curing.
2. No material shall be stored in the open or in contact with the ground.
3. **Temperature logs of liner from time of wet-out to installation shall be given to the City representative on site at the time of installation.** These logs shall contain the calculated volume of resin required and the actual volume of resin provided. The City representative shall verify that the volume of resin provided is 5 to 10 percent greater than the calculated volume of resin required per ASTM F-1216, 7.2.

C. Handling

1. Handle all products with care. Only sound, undamaged products shall be accepted.

1.7 GUARANTEE

A. The Contractor shall guarantee all work as stated in the CMS Section 109.12.

PART 2 – PRODUCTS

2.1 GENERAL

Not Used

2.2 MATERIALS

A. Only materials approved by the City of Columbus, Division of Sewerage and Drainage, Trenchless Technology Committee may be used for this project.

B. Products. Subject to compliance with requirements, provide one of the following:

1. Insituform®
2. InLiner USA®
3. CIPP Corp®
4. National Liner®
5. Spiniello Liner®
6. United Liner®

C. Design Parameters and Mechanical Properties. The following values are to be used to verify that the liner thickness equals or exceeds that shown in the plans and, where indicated by an ASTM standard, shall serve as the minimum acceptable strength requirements for the final cured liner.

Flexural Strength (ASTM D-790)	4,500 psi
Short-term Flexural Modulus of Elasticity (ASTM D-790)	250,000 psi
Creep Factor	50%
Factor of Safety	2
Ovality	5%
Soil Modulus	700

Each tube shall be designed to withstand internal and/or external pressures as dictated by site and pipe conditions as well as the installation process used by the Contractor.

The CIPP liner thickness has been calculated to withstand the soil loading at the deepest point (the maximum difference between the surface elevation and the pipe elevation) between manholes. Unless noted otherwise on the Contract Drawings or job-specific data is available, assume the water table to be four (4) feet below the **average** surface elevation. For **partially deteriorated** liner design, the water depth shall be taken from the pipe invert**.** For **fully deteriorated** liner design, the water depth shall be taken from the top of the pipe.

D. Fabric Tube. The flexible fabric tube shall consist of one or more layers of flexible needled felt or an equivalent woven and/or non-woven material capable of carrying resin, withstanding installation pressures and curing temperatures, and compatible with the resin system used. The tube shall be sized to accommodate the forces of installation, host pipe configuration, and any other pertinent factors to assure a tight fitting final product with a smooth finish.

E. Resin System. The resin system shall be a polyester, epoxy, or vinyl ester resin and catalyst system compatible with the insertion process. The resin system shall not contain fillers or additives, except those required for viscosity control, fire retardant, modulus enhancement, chemical resistance, or life extension. The following additives may not interfere with the visual inspection of the cured-in-place liner pipe or its required properties: thixotropic agents added for viscosity control, the opaqueness of the plastic coating, and resins that may contain pigments, dyes, or colors. Resin selected shall be reflected in the CIPP liner thickness calculations.

The tube shall be vacuum impregnated with resin (wet-out) under controlled conditions. The volume of resin used shall be sufficient to fill all voids in the tube material at nominal thickness and diameter and an allowance for migration of resin into the cracks and joints in the host pipe. A roller system shall be used to uniformly distribute the resin throughout the tube.

PET or recycled resins will not be permitted.

F. Inverting/Curing Medium. The inverting/curing medium shall be heated potable water or steam. In no instance will sewage be used to invert or cure liners or calibration tubes. If a private water source is proposed for use, a written agreement shall be obtained from the owner of the private water source and a copy of said agreement given to the Engineer.

2.3 EQUIPMENT.

A. All equipment required for the installation and curing of the resin impregnated flexible fabric tube, including cables, sleeves, rollers, compressors, generators, pumps, valves, gauges, water heaters, and accessories required for complete installation shall be in accordance with manufacturer's recommendations.

PART 3 – EXECUTION

3.1 EXAMINATION

A. General. Examine areas and conditions within the sewer system in which materials and products are to be installed.

B. Material. All sewer pipe liner materials shall be carefully inspected for defects prior to installation. The liner shall be homogeneous throughout, uniform in color, free of tears, holes, foreign materials, blisters, or other deleterious faults. Any material found during the progress of the work to have flaws or defects shall be rejected. All defective materials furnished by the Contractor shall be promptly removed by the Contractor from the project site.

C. Responsibility. The Contractor shall be responsible for all materials furnished and shall replace at its own expense all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all material and labor required for the replacement of installed material discovered defective prior to the final acceptance of the work.

3.2 PREPARATION

A. Resident Notification. The Contractor shall be responsible for resident notification which shall include three (3) separate notices. The initial notification shall contain general information about the project and the cured-in-place pipe process using graphics as necessary to illustrate the procedure. This letter shall also request that individuals with respiratory ailments contact the contractor directly so that a personalized notification plan can be developed for that resident. Other information to be included shall be project CIP number, project name, description of the work to be performed, time frames for the work, and precautions to take during the course of the project (keeping water in the trap,

keeping toilet lids down, etc.) The Contractor shall list the superintendent on the job along with its mobile telephone number as the primary contact. Secondary contact information shall be the company name, address, and telephone number. This initial resident notification shall be submitted **at the pre-construction meeting** for approval by the Engineer. Upon approval, the Contractor shall immediately distribute this information to all residents affected by the work.

The second resident notification shall alert residents to any utility disruptions and to advise minimal water usage. This notification shall provide the beginning date and time of the disruption, the length of the disruption, and the ending date and time of the disruption. Contact information shall be repeated on this notification. The second resident notification shall be distributed by the Contractor two (2) working days prior to commencement of the work.

The third resident notification shall inform residents that work on their portion of the sewer is complete and they may resume normal water usage. The Contractor shall distribute this notice immediately upon completion of the work.

B. **Cleaning.** All sewers to be lined shall be cleaned as required prior to lining with CIPP. The term "cleaned" shall mean the removal of all sand, dirt, roots, grease, and all other solids or semisolid materials from the interior face of the sewer lines. Refer to specific recommendations Supplemental Specification Sections SS-4, Sewer Cleaning.

C. **Sewer Video Recording and Inspection.** The Contractor shall televise the sewer to provide a detailed record of existing conditions and lateral connections as described in Supplemental Specification Section SS-5. Two (2) copies of the pre-rehabilitation inspection shall be submitted to the City. The Contractor shall be responsible for having a copy of the pre-rehabilitation inspections in the field as well. Immediately prior to CIPP liner insertion, the camera shall traverse the sewer to inspect for debris which may have entered the sewer line after the existing condition video recording. **A City representative must sign off on this reconnaissance television inspection for the CIPP lining work to proceed.**

D. **Laterals.** Lateral sewer pipes protruding into the main sewer shall be trimmed flush with the inside of the main sewer wall prior to lining. Trimming must be done in a neat, workmanlike manner, causing no damage to the lateral pipe beyond the inside face of the main sewer. Point repairs shall be made as needed around laterals to ensure a smooth, watertight opening following lining of the main and reestablishment of the lateral. This item shall be included in the unit price bid for CIPP unless a pay item is provided.

E. **Bypassing Sewage.** The Contractor shall bypass the sewage around the sections of the sewer that are to be lined as required. The bypass shall be made in accordance with Supplemental Specification Sections SS-3, "Bypass Pumping".

F. Line Obstruction. It shall be the responsibility of the Contractor to clear the sewer of obstructions, solids, protruding services, or collapsed pipe that will prevent the proper installation of the liner.

If the pre-rehabilitation video recording and inspection reveals an obstruction that cannot be removed by trenchless means from within the sewer, the Contractor shall notify the Engineer. Upon approval of the Engineer, the Contractor shall make a point repair excavation per Supplemental Specification Section SS-8, "Open Cut Point Repairs" to remove the obstruction and repair the sewer.

If the pre-rehabilitation video recording and inspection reveals a sag in the sewer that has a vertical displacement greater than one-half the pipe diameter, the Contractor shall notify the Engineer. Upon approval of the Engineer, the Contractor shall make a point repair excavation per Supplemental Specification Section SS-8, "Open Cut Point Repairs" to eliminate the sag.

In addition, any equipment that is lost, broken, wedged, or stuck in a line section shall be removed by the Contractor at the Contractor's expense.

G. Protective Measures. To prevent burnt grass, the Contractor shall provide protective measures (e.g. felt, blocks of wood) to create a barrier between the boiler hoses and the grass for each installation.

For steam curing, the Contractor shall take appropriate measures to ensure that non-water residuals/byproducts of steam curing do not enter nearby streams, storm sewers, etc.

3.3 INSTALLATION PROCEDURE

A. General. Installation shall be by inversion (ASTM F-1216). Pulled-in-place installation (ASTM F-1743) may be allowed on a case-by-case basis, if approved by the Engineer. The Contractor shall deliver the liner to the site and provide all equipment required to insert the liner into the sewer and cure it in place. The Contractor shall designate the location where the tube will be vacuum impregnated prior to installation. The Contractor shall allow the Owner to inspect the materials and the "wet-out" procedure upon request. All procedures to prepare the liner for installation will be in strict compliance with the manufacturer's recommendation. Any material not properly prepared shall be rejected and replaced with acceptable materials at the Contractor's expense. Contractor shall not proceed with work until satisfactory conditions are present in the sewer.

B. Installation. A scaffold, elevated platform, or other means of providing required pressure shall be provided at the access point. The resin-impregnated tube shall be pulled and/or inverted into the host pipe by methods approved by the

manufacturer and proven through previous successful installations. The insertion method used shall not cause abrasion or scuffing of the tube. Hydrostatic or air pressure shall be used to inflate the tube, molding it against the walls of the host pipe. Tube installation pressures shall be limited so as not to stretch the tube longitudinally by more than five (5) percent of the original length.

C. Curing.

1. Using Circulated Heated Water:
   After the installation is complete, the Contractor shall supply a suitable heat source, water recirculation equipment, and a curing medium as approved by the Engineer. The equipment shall be capable of uniformly raising the water temperature to a level required to effectively cure the resin.

2. Using Steam:
   After the installation is complete, the Contractor shall supply suitable heat steam-generating equipment as approved by the Engineer. The equipment shall be capable of delivering steam throughout the section to uniformly raising the temperature within the pipe to a level required to effectively cure the resin.

3. General.
   The equipment shall be muffled to reduce excess noise during the curing process. All night work performed shall be in conformance with Section 105.07 of the CMS.

   The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge shall be placed between the tube and the host pipe in the downstream manhole at or near the bottom to determine the temperatures during cure. Water temperature in the pipe during the cure period shall be as recommended by the resin manufacturer.

   Initial cure shall be deemed complete when the exposed portions of the tube appear to be hard and sound and the temperature sensor indicates the recommended temperature of the manufacturer. The cure period shall be of a duration recommended by the resin manufacturer and may require continuous recirculation of the water to maintain the temperature.

D. Cool Down.

1. **After Heated Water Cure.** The Contractor shall cool the hardened pipe to a temperature below 100 degrees Fahrenheit before relieving the hydrostatic head. Cool-down shall be accomplished by introducing cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Rate of cooling shall not exceed resin manufacturer's recommendations.

2. **After Steam Cure.** The Contractor shall cool the hardened pipe to a temperature below 113 degrees Fahrenheit before relieving the internal pressure within the section. Cool-down may be accomplished by introducing cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Rate of cooling shall not exceed resin manufacturer's recommendations.

E. Finish. The new pipe shall be cut off in the manhole at a suitable location. Excavation will not be allowed at cleanouts unless approved by the Field Engineer. The finished product shall be continuous over the length of the pipe reconstructed and be free from dry spots, delamination, lifts, and debris under the liner. If any unsatisfactory condition is present in the lined pipe, the Engineer reserves the right to require a suitable repair.

F. Invert through Manholes. The invert shall be continuous and smooth through all manholes. If a liner is installed through a manhole, the bottom portion of the liner shall remain and the bench of the manhole shall be grouted with a resin mixture compatible with the CIPP and shaped as necessary to support the liner. If the liner terminates on either side of a manhole, the invert shall be built up to remove any flow restrictions and to form a continuous invert through the manhole. The cost of this work shall be included in the unit price bid for CIPP.

G. Sealing Pipe in Manholes. A tight seal shall be formed between the CIPP and the manhole wall at the pipe penetration. Prior to liner installation, a ½-inch thick activated Oakum band soaked in chemical sealant, or equivalent hydrophilic waterstop, shall be installed inside the host pipe near the manhole. Seal any annular space greater than ½-inch with manhole wall repair material. Finish off the seal and seal any annular spaces less than ½-inch with urethane, grout or fiber reinforced cementitious material placed around the pipe opening from inside the manhole in a band at least 4-inches wide.

H. Air Test. The Contractor shall run an air test on each 18" and smaller liner after it has been installed and cured but prior to reinstating laterals or intermediate manholes. The Contractor shall furnish all equipment and materials to perform the test, the pressure gauge shall be graduated to a tenth of a psi.

Just prior to installing the liner, the sewer shall be inspected to determine whether there is any infiltration to the sewer indicating groundwater is present.

The section being tested shall be pressurized to 4 psi if groundwater is not present [5 psi if groundwater present]. This pressure shall be maintained for at least 2 minutes for air temperature to stabilize, only adding enough air during this time to maintain the pressure between 3.5 and 4 psi (4.5 and 5 psi if groundwater present). Once stabilized no more air is to be added.

Before the pressure reading falls to 3.5 psi [4.5 psi if groundwater present] start the stopwatch and record how long it takes pressure to drop 0.5 psi from when stopwatch started. Record the starting psi, ending psi, and time (minutes and seconds) to the 0.5 psi drop. Test can be stopped if 0.5 psi drop does not occur before the following minimum test time is reached (liner passes air test):

Sewer Size	Minimum Test Time (minutes)
8”	4
10”	5
12”	6
15”	7
18”	9

The sewer must meet the above minimum test times to pass air test. If the sewer fails, the Contractor shall make necessary repairs and retest at the Contractor’s expense.

I. Service Connections. The exact location and number of service connections shall be verified during the initial television inspection. It shall be the Contractor’s responsibility to accurately field locate all existing active service connections. The Contractor shall reconnect all active service connections to the liner pipe.

The Contractor shall be responsible for restoring/correcting, without any delay, all missed or faulty reconnections, as well as any damage caused to property owners for not reconnecting the services soon enough or for not giving notice to the owners.

All existing active service connections shall be reconnected by a remote controlled cutting device directed internally by a television camera or by internal manual cutting. They shall be made by experienced operators so that no blind attempts or holes are made in the liner pipe. Location shall be verified carefully to match earlier tapes for accurate locations especially where dimples are not well defined or clearly ascertained. The Engineer reserves the right to require reestablishment of a service connection by excavation at the Contractor’s cost at any location, if the quality or workmanship for the cut is not satisfactory.

The cut shall be smooth and circular in nature as seen by a television inspection camera. Lateral cuts shall be brushed as necessary to ensure smooth openings. It shall be properly aligned, invert to invert, to the existing connection with no obstructions to the flow. Resin slugs shall be removed as necessary from reinstated service connections. Any miscuts shall be repaired at no cost to the Owner and to the full satisfaction of the Engineer. All coupons cut from the liner for reopening of lateral connections shall be retrieved from the sewer, accounted for by the Contractor, and turned over to the City.

J. **Final Television Inspection.** The Contractor shall televise the rehabilitated sewer to provide a detailed record of finished conditions and lateral connections. Lateral connections shall be observed while the camera is stopped and viewing the connection squarely. Within 14 days after lining of sewer, the Contractor shall submit two (2) copies of the rehabilitated sewer inspection, along with the accompanying logs, which shall be printed clearly or typed as requested in Supplemental Specification Section SS-5.

3.4 RESTORATION

A. **Where portions of the site,** either inside or outside the contract limits, not designated for change or new work become damaged during the course of construction by the Contractor's operations, the Contractor shall repair or replace at no additional cost to the City such damage to original or better condition in conformance with the Contract Documents. This shall include, but not be limited to, reseeding, replacing shrubbery in kind, replacing damaged fence, etc.

B. **Manhole reconstruction to accommodate CIPP liner installation** shall be included in the lining costs. Casting replacement, however, shall be paid for separately under Supplementary Specification SS-10, if corbelling is removed for CIPP liner insertion.

3.5 FIELD QUALITY CONTROL

A. **General.** The rehabilitated pipe shall be continuous (without joints) over the entire length of an insertion run between two manholes. The liner shall be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The liner surface shall be free of leaks, cracks, and crazing with a smooth finish. Some minor waviness that, in the Owner's opinion, will not appreciably decrease the flow cross section or affect the flow characteristics shall be permissible.

Any defects in the product shall be repaired at the Contractor's expense in a manner mutually agreed upon by the Owner and Contractor. The Contractor shall reinspect these repairs before the one (1) year guarantee period expires. During the one (1) year guarantee period, any defects that are discovered that will affect the integrity or strength of the product shall be repaired at the Contractor's expense in a manner mutually agreed upon by the Owner and the Contractor. These repairs shall be granted a three (3) year extended guarantee period by the Contractor from the date of repair. The Contractor shall reinspect these repairs prior to the expiration of the three (3) year extended guarantee period.

B. **Testing.** The following tests shall be performed for each length of CIPP length installed per ASTM F-1216 and/or F-1743 (when approved):

1. Short-term Flexural (Bending) Properties – The initial tangent flexural modulus of elasticity and flexural yield strength shall be measures in accordance with ASTM D790.

The Contractor is to provide test samples to the City in accordance with ASTM F-1216, Item 8.1.1. The sample should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been inverted through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags.

The City will retain a laboratory to perform these tests. All laboratories utilized for testing of CIPP samples shall be located within 100 miles of the City of Columbus to facilitate ease of inspection for all parties involved. All samples shall be labeled before shipment for testing. The Owner also retains the right to test coupons retrieved from the sewer and turned over to the City. If the Contractor performs independent tests for their purposes, additional samples shall be provided by the Contractor for that use.

C. Final Installed Liner Thickness. The final installed liner thickness shall not be less than the thickness specified in the Contract Documents or approved shop drawings. The final installed liner thickness shall not be more than 10% greater than the specified or approved thickness. The final installed liner thickness measurement shall be determined from pipe samples, coupons retrieved from the sewer, or as deemed necessary by the Engineer. It shall be the Contractor's responsibility to consider site conditions and their installation process to determine the liner thickness to install.

D. Non-Compliance. In the event the samples do not meet the required thickness or Flexural Strength of 4,500 psi and Flexural Modulus of Elasticity of 250,000 psi as outlined in Section 2.2 C; actual installed samples must be taken and tested. The installed samples shall be taken as directed by the City and in accordance with all applicable ASTM requirements, and the area repaired to the satisfaction of the City. All work associated with obtaining sample and repair shall be at the Contractor's expense.

In the event that any liner installation does not meet specified strengths and/or thicknesses, the conformity of the work with the plans and specifications shall be in accordance with Section 105.03 of the CMS.

3.6 MEASUREMENT AND PAYMENT

A. Liner. This item of work shall include all necessary television observation, protruding lateral removal and repair, sewer cleaning, pipe preparations, liner resins, water, equipment, labor, testing, clean up, manhole reconstruction required by construction means and methods of CIPP installation, and all other expenses whether specifically mentioned or not to install the cured-in-place pipe.

The CIPP thickness shown for SS-12 is the final cured thickness, not the thickness of the bag prior to installation

Payment will be made at the unit price bid per lineal foot as measured from center of manhole to center of manhole along the horizontal centerline of the rehabilitated sewer, complete, tested, and ready for service.

B. **Lateral Sewers Reestablished for CIPP.** This item of work shall include all necessary equipment, materials, and labor to reestablish lateral sewers in cured in place pipe.

Payment will be made at the unit price bid per each lateral sewer reestablished, complete, and ready for service.

C. **Increase/Decrease Pay Item.** Contractor shall include a price for increase or decrease of pipe wall thickness. The basis for payment shall be in 1.5 mm increments. The minimum acceptable thickness shall be 6 mm.

D. **Air Test**. This item of work shall include all necessary equipment, materials, and labor to air test the cured liner.

ITEM	UNIT	DESCRIPTION
SS-12	EA	Lateral Sewer Reestablished
SS-12	LF	8” Cured-In-Place Pipe (CIPP), 6 mm Design Thickness)
SS-12	LF	1.5 mm Incremental Wall Thickness Increase or Decrease
SS-12	EA	Air Test

END OF SECTION