ADDENDUM NO. II

DATE: January 19, 2018

TO: All Potential Bidders

FROM: Penny Owens, Assistant Purchasing Agent, City of Knoxville

SUBJECT: Addendum No. II to the Invitation to Bid for 2017 Large Diameter Cured-in-Place-Pipe Project

RFPS TO BE OPENED: January 31, 2018 at 11:00:00 a.m. (Eastern Time)

This addendum is being published to address the following items regarding the above referenced ITB. This addendum becomes a part of the contract documents and modifies the original specifications as noted.

ITEM 1: The City hereby revises the specifications by insertion, deletion, or revision in accordance with the attached Technical Specifications Revisions. Bidder must acknowledge receipt of this addendum on the bid form.

ITEM 2: This item answers questions submitted concerning the ITB referenced above.

Question #1: I am unclear from the Addendum. Is it stating that Permacast can be used in place of CIPP for this project? If so, it is a completely different product, it not a fully-deteriorated or fully-structural product, and not the same thing. This is evident in the flexural strength requirement for Permacast, per the addendum, is 1,080psi, as compared to CIPP, which has a flexural strength of 250,000psi!
If instead, Permacast is just a mortar patching product to be used only prior to CIPP installation, please state this.

Answer: No, Permacast is not an acceptable alternative to the CIPP.

Question #2: These documents state that we have to be a licensed contractor under HRA – Highway, Railroad & Airport Construction classification – is this correct? This is a cured in place pipe project and would it not be covered under the MU-A(2) classification which we have?

Answer: Yes, it is acceptable for the bidder to have a MU – Municipal and Utility Construction license OR the HRA – Highway, Railroad and Airport Construction classification. The Invitation to Bid is hereby revised to read, "All bidders must be licensed contractors and must have an HRA – Highway, Railroad and Airport Construction classification or a MU – Municipal and Utility Construction classification."

Question #3: Do you have any video of the pipes to be repaired available?

Answer: Yes. The City has Walker Springs Road footage from September 2016 and Longview footage from February of 2017. Please note the City of Knoxville makes no warranty of the current condition of the pipes and conditions may have changed since completion of the camera work. You may visit the following links to view camera footage:

Walker Springs: https://ws.onehub.com/folders/vils4xhi

Longview: https://ws.onehub.com/folders/u1zhcg6s

Question #4: I noticed you have a CIPP Project out for bid and wanted to see if you were specifying Insignia End Seals on your projects?

Answer: Yes. Please refer to Part 2.05 of the Specifications which states, “Acceptable End Seals are Insignia™ End Seals by LMK Enterprises, 1779 Chessie Lane, Ottawa, IL 61350 (815) 423-1275, or pre-approved equal.

END OF ADDENDUM II

ADDENDUM NO. 2

2017 LARGE-DIAMETER CURED-IN-PLACE PIPE PROJECT
SW-2017-0001

CITY OF KNOXVILLE ENGINEERING DEPARTMENT
KNOXVILLE, TENNESSEE

**** * * SPECIAL NOTICE * * ****

THE TIME AND LOCATION OF THE BID OPENING HAVE NOT CHANGED.

SPECIFICATIONS

After 0800-3-2 Prevailing Wage Commission Rules, insert Technical Specifications Table of Contents

Delete Section 01611 Storage and Protection in its entirety and replace with Section 01611 included with this addendum

Delete Section 01740 Warranties and Bonds in its entirety and replace with Section 01740 included with this addendum

After Section 02125 Erosion and Sedimentation Control, insert Section 02225 Trench Excavation and Backfill

Delete Section 13315 Preconditioning and Cleaning of Underground Storm Sewer Pipelines in its entirety and replace with Section 13315 included with this addendum

Delete Section 13330 Cured-in-Place Pipe (CIPP) in its entirety and replace with 13330 Water Cured-in-Place Pipe (CIPP)-Stormwater

After Section 13330 Water Cured-in-Place Pipe (CIPP)-Stormwater, insert Section 13331 Ultraviolet Light Cured-in-Place Pipe (UV-CIPP)

Delete Section 13345 Storm Sewer Point Repairs by Protected Cured-in-Place Sleeve in its entirety.

Bidder Must Acknowledge Receipt of this Addendum on Bid Form

January 12, 2018

S&ME, Inc.
6515 Nightingale Lane
Knoxville, Tennessee 37909
865.934.6023

TECHNICAL SPECIFICATION

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		Revision Date
02985	Seeding and Mulching	Feb-2017
03240	Concrete Reinforcement	Feb-2017
03310	Cast In Place Concrete	Feb-2017
13315	Preconditioning and Cleaning of Underground Storm Sewer Pipelines	Feb-2017
13320	Closed Circuit TV Inspection of Underground Storm Sewer Pipelines	Feb-2017
13330	Water-Cured-In-Place Pipe (CIPP)	Feb-2017
13331	UV-Cured-In-Place Pipe (CIPP)	Feb-2017

PART 1 - GENERAL

1.01 SCOPE

Equipment and materials used in the project shall be received inspected, unloaded, handled, stored, maintained, and protected by the Contractor in a suitable location on or off site, if necessary, until such time as installation is required.

1.02 STORAGE

A. The Contractor shall be responsible for providing satisfactory storage facilities which are acceptable to the ENGINEER. In the event that satisfactory facilities cannot be provided on site, bonded warehouse, acceptable to the ENGINEER, will be provided by the Contractor for such time until the equipment, materials, and products can be accommodated at the site.

B. Materials and Equipment that are properly and securely stored: 1) on the project site, or (2) in a bonded warehouse in Knox County, TN will be eligible to be included on an application for payment. Original unaltered invoices from manufacturers and suppliers must be presented with the pay request, with no erasures, white-outs, or other alterations. Payment will be authorized for no more than the amounts of the invoices (material, freights and taxes). The subcontractor shall submit his requests for payment to the General Contractor. The General Contractor will review and, if acceptable, will include the request on the monthly Application for Payment from the General Contractor to the Owner submitted through the Engineer for review and approval.

Each request for payment which includes amounts for materials or equipment stored off-site in a bonded warehouse must have an original Certificate of Insurance attached to the request for payment stating on the face of the original Certificate of Insurance a description of the insured stored material, the name and address of the bonded warehouse and naming the General contractor, the Owner, and the Owner's Agents each as Certificate Holders, each as Additional Insured and each as Loss Payee for the said material at the said location.

"Materials" and "Equipment" are defined as items which have been manufactured or fabricated to the point they are ready for delivery to the Project Site and ready for installation, but the Contractor has chosen for his own purposes to delay their delivery and installation. For example: Such Materials and Equipment would include assembled cabinets and casework, but would not include unassembled panels and other components to be used in fabricating cabinets and casework; such Materials and Equipment would also include the structural and miscellaneous steel which has been punched, drilled, fitted and otherwise uniquely fabricated for this project, but would not include steel shapes which have not been through the fabricator's shop; such Materials and Equipment would not include lumber and plywood for the purpose of constructing formwork, but would include lumber and plywood to be incorporated as part of the building construction as framing and decking.

C. The Contractor shall be responsible for the maintenance and protection of all equipment, materials, and products placed in storage and shall bear all costs of storage, preparation for transportation, transportation, re-handling, and preparation for installation.

D. Equipment and products stored outdoors shall be supported above the ground on suitable wooden blocks or braces arranged to prevent excessive deflection or bending between supports. Items such as pipe, structural steel, and sheet construction products shall be stored with one end elevated to facilitate drainage.

E. Unless otherwise permitted in writing by the ENGINEER, building products and materials such as cement, grout, plaster, gypsum board, particleboard, resilient flooring, acoustical tile, paneling, finish lumber, insulation, wiring, etc. shall be stored indoors in a dry location. Building products such as rough lumber, plywood, concrete block, and structural tile may be stored outdoors under a properly secured waterproof covering.

F. Tarps and other covering shall be supported above the stored equipment or materials on wooden strips to provide ventilation under the cover and minimize condensation. Tarps and covers shall be arranged to prevent ponding of water.

1.03 EXTENDED STORAGE

In the event that certain items of major equipment such as air compressors, pumps, and mechanical aerators have to be stored for an extended period of time, the Contractor shall provide satisfactory long-term storage facilities which are acceptable to the ENGINEER. The Contractor shall provide all special packaging, protection coverings, protective coatings, power, nitrogen purge, desiccants, and lubricants, and exercising necessary or recommended by the manufacturer to properly maintain and protect the equipment during the period of extended storage.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

Part 1 General

1.01 Project Maintenance and Warranty

A. Maintain and keep in good repair the Work covered by these Drawings and Specifications until acceptance by the Owner.

B. The Contractor shall warrant for a period of one (1) year from the date of Owner's written final acceptance of the Project, as defined in the Contract Documents, that the completed Work is free from all defects due to faulty products or workmanship and the Contractor shall promptly make such corrections as may be necessary by reason of such defects. Prior to the end of the warranty period, the Owner will perform Closed Circuit Television (CCTV) inspection on a percentage of the total footage rehabilitated within the scope of the project, at the expense of the Owner. Should the results indicate that greater than twenty percent (20%) of the inspections are found to be defective in any part, the Contractor shall be required to perform CCTV inspections on the remaining segments where rehabilitation was performed to verify conditions, at no expense to the Owner, and shall be completed prior to the end of the warranty period.

The Owner will give notice of observed defects with reasonable promptness. In the event that the Contractor should fail to make such repairs, adjustments or other work that may be made necessary by such defects, the Owner may do so and charge the Contractor the cost thereby incurred. The Performance Bond shall remain in full force and effect throughout the warranty period.

C. The Contractor shall not be obligated to make replacements which become necessary because of ordinary wear and tear, or as a result of improper operation or maintenance, or as a result of improper work or damage by another Contractor or the Owner, or to perform any work which is normally performed by a maintenance crew during operation.

D. In the event of multiple failures of major consequences prior to the expiration of the one (1) year warranty described above, the affected unit shall be disassembled, inspected and modified, or replaced as necessary to prevent further occurrences. All related components which may have been damaged or rendered non-serviceable as a consequence of the failure shall be replaced. A new twelve (12) month warranty against defective or deficient design, workmanship, and materials shall commence on the day that the item is reassembled and placed back into operation.

As used herein, multiple failure shall be interpreted to mean two (2) or more successive failures of the same kind in the same item or failures of the same kind in two (2) or more items. Major failures may include, but are not limited to, cracked or broken housings, piping, or vessels, excessive deflections, bent or broken shafts, broken or chipped gear teeth, premature bearing failure, excessive wear, or excessive leakage around seals. Failures which are directly and clearly traceable to operator abuse, such as operations in conflict with published operating procedures or improper maintenance, such as substitution of unauthorized replacement parts, use of incorrect lubricants or chemicals, flagrant over-or under-lubrication, and using maintenance procedures not conforming with published maintenance instructions, shall be

exempted from the scope of the one year warranty. Should multiple failures occur in a given item, all products of the same size and type shall be disassembled, inspected, modified, or replaced as necessary and rewarranted for one year.

E. The Contractor shall, at Contractor's own expense, furnish all labor, materials, tools, and equipment required, and shall make such repairs and removals, and shall perform such work or reconstruction as may be made necessary by any structural or functional defect or failure resulting from neglect, faulty workmanship, or faulty materials, in any part of the Work performed by the Contractor. Such repair shall also include refilling of trenches, excavations, or embankments which show settlement or erosion after backfilling or placement.

F. Except as noted on the Drawings or as specified, all structures, such as embankments and fences, shall be returned to their original condition prior to the completion of the Contract. Any and all damage to any facility not designated for removal, resulting from the Contractor's operations, shall be promptly repaired by the Contractor at no cost to the Owner.

G. The Contractor shall be responsible for all road and entrance reconstruction, and repairs and maintenance of same, for a period of one (1) year from the date of final acceptance. In the event the repairs and maintenance are not made immediately, and it becomes necessary for the owner of the road to make such repairs, the Contractor shall reimburse the owner of the road for the cost of such repairs.

H. In the event the Contractor fails to proceed to remedy the defects upon notification within fifteen (15) days of the date of such notice, the Owner reserves the right to cause the required materials to be procured and the work to be done, as described in the Drawings and Specifications, and to hold the Contractor and the sureties on Contractor's bond liable for the cost and expense thereof.

I. Notice to Contractor for repairs and reconstruction will be made in the form of a registered letter addressed to the Contractor at Contractor's home office.

J. Neither the foregoing paragraphs, nor any provision in the Contract Documents, nor any special guarantee time limit, implies any limitation of the Contractor's liability within the law of the place of construction.

END OF SECTION

Part 1 General

1.01 Scope

A. Submittals

1. Provide and maintain temporary and permanent erosion and sedimentation controls as shown on the Drawings. This Section also specifies the subsequent removal of temporary erosion and sedimentation controls.

2. Temporary and permanent erosion and sedimentation controls include grassing and mulching of disturbed areas, and structural barriers at those locations which will ensure that erosion during construction will be maintained within acceptable limits. Acceptable limits are as established by Section 402 of the Federal Clean Water Act, and applicable codes, ordinances, rules, regulations, and laws of local and municipal authorities having jurisdiction.

3. Submit product data in accordance with the requirements of Section 01300 of these Specifications.

4. At the Preconstruction Conference, submit a written plan for both temporary and permanent grassing. The plan shall include selection of species, dates, and rates of application for seeding, fertilizer, and mulching. No work shall be started until the erosion and sedimentation control schedule and methods of operation have been approved by the Engineer.

B. Basic Principles

1. The Contractor is responsible for inspecting and maintaining all existing erosion and sedimentation control measures.

2. Conduct the earthwork and excavation activities in such a manner to fit the topography, soil type and condition.

3. Minimize the disturbed area and the duration of exposure to erosion elements.

4. Stabilize disturbed areas immediately.

5. Safely convey run-off from the site to an outlet such that erosion will not be increased off site.

6. Retain sediment on site that was generated on site.

7. Minimize encroachment upon watercourses.

C. Implementation

1. The erosion and sedimentation control measures shown on the Drawings are minimal requirements. The Contractor's methods of operation may dictate additional erosion and sedimentation control measures not shown on the Drawings, which shall be the Contractor's responsibility to determine and install said measures. The Contractor's failure to stabilize disturbed areas immediately following intermediate or final grading may dictate additional erosion and sedimentation control measures not shown on the Drawings which shall be the Contractor's responsibility to determine and install said measures.

2. The Contractor shall notify the Engineer of any changes and/or additions to the erosion and sedimentation control plan necessary to accommodate the Contractor's methods of operation. No additional payment shall be made for erosion and sedimentation control measures made necessary by the Contractor's methods of operation.

3. The Contractor shall be solely responsible for control of erosion within the Project site and prevention of sedimentation of any adjacent waterways.

4. The Contractor shall install controls which will ensure that stormwater and drainage from the disturbed area of the Project site shall pass through some type of filter system before being discharged. The filter system must meet the requirements of the Tennessee Department of Environment & Conservation (TDEC).

D. Temporary Erosion and Sedimentation Control: In general, temporary erosion and sedimentation control procedures shall be directed toward:

1. Preventing soil erosion at the source.

2. Preventing silt and sediment from entering any waterway if soil erosion cannot be prevented.

3. Preventing silt and sediment from migrating downstream in the event it cannot be prevented from entering the waterway.

E. Permanent Erosion Control: Permanent erosion control measures shall be implemented to prevent sedimentation of the waterways and to prevent erosion of the Project site.

1.02 Quality Assurance

A. General: Perform all work under this Section in accordance with all pertinent rules and regulations including, but not necessarily limited to, those stated herein and these Specifications.

B. Conflicts: Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.

Part 2 Products

2.01 Temporary Erosion and Sedimentation Control Materials

A. Silt Fence

1. Silt fence shall be polymer type netting with a built-in cord running throughout the top edge of the fabric. Posts shall be either steel, pressure treated fir, southern pine, or hemlock and shall be spaced not more than six feet (6') on center. Silt fence shall be provided with netting to provide reinforcing when necessary. Silt fence shall have an Equivalent Opening Size (EOS) of forty (40) to one-hundred (100). Silt fence fabric shall have a maximum permeability of forty gallons per minute per square foot (40 gpm/ft^2).

2. Silt fence fabric shall be equal to Mirafi 100X, Amoco 1380, or Exxon GTF-100 Series.

B. Hay bales shall be clean, seedfree cereal hay type.

C. Netting shall be 1/2-inch, galvanized steel, chicken wire mesh.

D. Filter stone shall be crushed stone conforming to Tennessee Department of Transportation (TDOT) Specifications, mineral aggregate size 57.

E. Concrete block shall be hollow, non-load-bearing type.

F. Plywood shall be 3/4-inch thick exterior type.

G. Erosion Control Matting shall be North American Green S-75 or approved equal.

2.02 Riprap

A. Stone Riprap: Use sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Specific gravity shall be 2.0 or greater. Riprap shall have less than sixty-six percent (66%) wear when tested in accordance with AASHTO T-96. Unless shown or specified otherwise, stone riprap shall be Type 1 riprap.

1. Type A-1 Machined Riprap: The pieces shall vary in size from two inches (2") to 1.25 feet, with no more than twenty percent (20%) by weight being less than four inches (4"). The thickness of the stone layer shall be 1.5 feet, with a tolerance of three inches (3"). Riprap size shall conform to the Tennessee Department of Transportation (TDOT) Section 709.03-machined riprap, Type A-1.

2. Type A-2 Machined Riprap: Shall be identical to Class A-1, except that hand placed rubble stone rip-rap placed one foot (1') thick in accordance with Section 709 of the Tennessee Department of Transportation (TDOT) Specifications for Roadway Design may be substituted for 1.5 feet of machined rip-rap.

3. Type A-3 Machined Riprap: Shall vary in size from two inches (2") to six inches (6") with no more than twenty percent (20%) by weight being less than four inches (4").

4. Type B machined riprap shall vary in size from three inches (3") to twenty-seven inches (27") with no more than twenty percent (20%) by weight being less than six inches (6").

5. Type C machined riprap shall vary in size from five inches (5") to thirty-six inches (36") with no more than twenty percent (20%) by weight being less than nine inches (9").

2.03 Filter Fabric

A. The filter fabric for use under riprap shall be a monofilament, polypropylene woven fabric meeting the specifications as established by Task Force 25 for the Federal Highway Administration. The filter fabric shall have an equivalent opening size (EOS) of 70.

B. Filter fabric shall meet the requirements of Trivera Spunbound 011/280, Mirafi 180N or Amoco 4553.

Part 3 Execution

3.01 General

Standards: Provide all materials and promptly take all actions necessary to achieve effective erosion and sedimentation control in accordance with the Tennessee Department of Environment & Conservation (TDEC), local enforcing agency guidelines and these Specifications.

3.02 Temporary Erosion and Sedimentation Control

A. Temporary erosion and sedimentation control procedures should be initially directed toward preventing silt and sediment from entering the creeks. The preferred method is to provide an undisturbed natural buffer, extending a minimal twenty-five feet (25') from the top of the bank to filter the run-off. Should this buffer prove infeasible due to construction activities being too close to the creek, or if the amount of sediment overwhelms the buffer, the Contractor shall place silt fences to filter the run-off and, if necessary, place permanent riprap to stabilize the creek banks. When excavation activities disturb the previously stated preventative measures, or if they are not maintained, or whenever the construction activities cross the creeks, the check dams shall be installed downstream and within two-hundred feet (200") of the affected area.

B. Silt dams, silt fences, traps, barriers, check dams, appurtenances, and other temporary measures and devices shall be installed as indicated on the approved plans and working drawings, and shall be maintained until no longer needed, and shall then be removed. Deteriorated hay bales and dislodged filter stone shall be replaced with new materials. Detention ponds, if constructed, shall be maintained in a condition ensuring that unfiltered water will not leave the pond.

C. Where permanent grassing is not appropriate, and where the Contractor's temporary erosion and sedimentation control practices are inadequate, the Engineer may direct the Contractor to provide temporary vegetative cover with fast growing seedings. Such temporary vegetative cover shall be provided by the Contractor in compliance with the Tennessee Department of Environment & Conservation (TDEC), specifically in the selection of species, planting dates, and application rates for seedings, fertilizer and mulching, with the exception that kudzu shall not be permitted.

D. All erosion and sedimentation control devices, including check dams, shall be inspected by the Contractor at least weekly and after each rainfall occurrence, and cleaned out and repaired by the Contractor as necessary.

E. Temporary erosion and sedimentation control devices shall be installed and maintained from the initial land disturbance activity until the satisfactory completion and establishment of permanent erosion control measures. At that time, temporary devices shall be removed.

3.03 Permanent Erosion Control

A. Permanent erosion control shall include:

1. Restoring the work site to its original contours, unless shown otherwise on the Drawings or directed by the Engineer.

2. Permanent vegetative cover shall be performed in accordance with Article 3.04 of this Section.

3. Permanent stabilization of steep slopes and creeks shall be performed in accordance with Article 3.05 of this Section.

B. Permanent erosion control measures shall be implemented as soon as practical after the completion of pipe installation or land disturbance for each segment of the Project. In no event shall implementation be postponed when no further construction activities will impact that portion or segment of the Project. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.

3.04 Grassing

A. General

1. All references to grassing, unless noted otherwise, shall relate to establishing permanent vegetative cover as specified herein or shown on the Drawings for seeding, fertilizing, mulching, etc.

2. When final grade has been established, all bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized, and mulched in an effort to restore to a protected condition. Critical areas shall be sodded as approved or directed by the Engineer.

3. Specified permanent grassing shall be performed at the first appropriate season following establishment of final grading in each section of the site.

4. Permanent grassing shall be of a perennial species.

B. Replant grass removed or damaged in residential areas using the same variety of grass and at the first appropriate season. Where sod is removed or damaged, replant such areas using sod of the same species of grass at the first appropriate season. Outside of residential or landscaped areas, grass the entire area disturbed by the work on completion of work in any area. In all areas, promptly establish successful stands of grass.

C. Grassing activities shall comply with the Tennessee Department of Environment & Conservation (TDEC) Specifications, specifically for the selection of species, planting dates, and application rates for seeding, fertilizer, and mulching. (Kudzu shall not be permitted.) Where permanent vegetative cover (grassing) cannot be immediately established (due to season or other circumstances), the Contractor shall provide

temporary vegetative cover. The Contractor must return to the site (at the appropriate season) to install permanent vegetation in areas that have received temporary vegetative cover.

3.05 Riprap

A. Unless shown otherwise on the Drawings, riprap shall be placed where ordered by the Engineer, at all points where banks of streams or drainage ditches are disturbed by excavation, or at all points where natural vegetation is removed from banks of the streams or drainage ditches. Carefully compact backfill and place riprap to prevent subsequent settlement and erosion. This requirement applies equally to construction along side a stream or drainage ditch, as well as crossing a stream or drainage ditch.

B. When trenching across a creek, place riprap a distance of ten feet (10') upstream and ten feet (10') downstream from the top of the trench excavation. Place riprap across creek bottom, across creek banks and extend riprap placement five feet (5') beyond the top of each creek bank.

C. Preparation of Foundations: The ground surface upon which the riprap is to be placed shall be brought into reasonably close conformity with the correct lines and grades before placement is commenced. Where filling of depressions is required, the new material shall be compacted with hand or mechanical tampers. Unless at creek banks or otherwise shown or specified, riprap shall begin in a toe ditch constructed in original ground around the toe of the fill or the cut slope. The toe ditch shall be two feet (2') deep in original ground, and the side next to the fill or cut shall have that same slope. After the riprap is placed, the toe ditch shall be backfilled and the excess dirt spread neatly within the construction easement.

D. Placement of Filter Fabric: The surface to receive fabric shall be prepared to a relatively smooth condition free from obstructions, depressions, and debris. The fabric shall be placed with the long dimension running up the slope and shall be placed to provide a minimum number of overlaps. The strips shall be placed to provide a minimum width of one foot (1') of overlap for each joint. The filter fabric shall be anchored in place with securing pins of the type recommended by the fabric manufacturer. Pins shall be placed on or within three inches (3") of the centerline of the overlap. The fabric shall be placed so that the upstream strip overlaps the downstream strip. The fabric shall be placed loosely so as to give and therefore avoid stretching and tearing during placement of the stones. The stones shall be dropped no more than three feet (3') during construction. The fabric shall be protected at all times during construction from clogging due to clay, silts, chemicals, or other contaminants. Any contaminated fabric or any fabric damaged during its installation or during placement of riprap shall be removed and replaced with uncontaminated and undamaged fabric at no expense to the Owner.

E. Placement of Riprap: The riprap shall be placed on a six inch (6") layer of soil, crushed stone, or sand overlaying the filter fabric. This six inch (6") layer shall be placed to maximize the contact between the soil beneath the filter fabric and the filter fabric. Riprap shall be placed with its top elevation conforming with the finished grade or the natural slope of the stream bank and stream bottom.

1. Stone Riprap: Stone riprap shall be dumped into place to form a uniform surface and to the thickness specified on the Drawings. The thickness tolerance for the course shall be between six inches (6") and plus-twelve inches (+12"). If the Drawings or the Bid do not specify a thickness, the course shall be placed to a thickness of not less than eighteen inches (18")

END OF SECTION

Part 1 General

1.01 Scope

The work covered by this Section includes furnishing all labor, material, equipment, and services required for cleaning all stormwater sewer pipelines, prior to inspection of the storm sewers, by closed circuit television (CCTV), authorized by the Engineer, as shown on the Drawings and/or specified herein. Preconditioning and cleaning involves removal of silt, which is defined as any and all solid or semi-solid materials, including fine and granular material, such as sand, grit, gravel, and rock, as well as debris, grease, oil, sludge, slime, or any other loose material or encrustation lodged in the catch basin or storm sewer. Preconditioning and cleaning also involves removal of invading roots, corroded concrete, intruding laterals, and any other extraneous debris.

1.02 Definitions

A. The term "cleaning" as used in this Section, shall mean removing all sand, dirt, roots, grease and all other solid or semi-solid materials from the storm sewer pipelines, so that a closed circuit television camera can be used in the internal pipeline inspection for the purpose of discerning structural defects, misalignment and infiltration/inflow sources.

B. "Heavy Cleaning" shall be defined as performing cleaning, as defined above when greater than twenty-five percent of a pipe's cross-sectional area is full of debris, silt, roots, sand, grit, gravel, rock, grease, oil, sludge, slime, or any other loose material or encrustation or when the use of mechanical apparatuses (i.e., buckets, pigs, rodding machines, grinders, etc.), are required to remove debris and/or obstructions from a pipe.

Part 2 Products (Not Used)

Part 3 Execution

3.01 General

A. The Contractor shall certify that sufficient cleaning units can be provided, including standby units in the event of breakdown, in order to complete the work within the contract period. Further, the Contractor shall certify that standby or back-up equipment can be delivered to the site within twenty-four (24) hours in the event of equipment breakdown.

B. The Contractor shall be responsible for coordinating payment and usage with the local owning utility for water withdrawn from hydrants.

C. All details of the point of water connection, backflow protection, conveyance methods, draw-off rates, times, and all local conditions regarding the use of water shall be approved by the Engineer prior to commencement of work. All equipment, labor, and material required for obtaining water for the work shall be provided by the Contractor.

D. The Contractor must ensure that a six inch (6") minimum air gap is maintained at the water supply point on desilting/cleaning/jetting equipment or any other receiving apparatus.

3.02 Cleaning

A. Cleaning shall be accomplished by utilizing a high pressure, hydraulic sewer pipeline cleaner. Pressure jetting equipment used shall be sufficient for the purposes of attaining the degree of cleanliness in sewers as specified.

B. The cleaning unit(s) shall be capable of operating routinely, up to a minimum of five-hundred feet (500') from the point of access to the sewer. Minimal hose diameter shall be one inch (1") diameter.

C. The Contractor's rates specified in the bid shall be for jetting in sewers both upstream and downstream.

D. Cleaning shall be performed immediately prior to the internal inspection to preclude the build-up of debris. Should television inspection reveal that a pipeline is not clean, the cleaning operations shall be repeated until the pipeline is clean. This additional cleaning shall be done at the expense of the Contractor, at no additional cost to the Owner unless "Heavy Cleaning" as described in Section 1.02, Item B of this Specification is authorized by Engineer.

E. During preconditioning and cleaning work and all other associated Contract operations, wastewater service shall be maintained at all times. This requirement may be relaxed only with the written approval of the Engineer.

F. Cleaning shall include the trapping and removal of all sediments and residual wastes from successive catch basins as the cleaning progresses. When hydraulic cleaning equipment is used, a suitable weir or dam shall be constructed in the downstream catch basin, in such a manner, that the solids and water are trapped. Under no circumstances shall solids removed from the pipeline or catch basin, be dumped onto streets, into catch basins, or into storm drains. Material which could cause pipeline stoppages, accumulations of sand in wet wells, or damage to pumps, shall not be permitted to pass from catch basin section to catch basin section. Residual wastes shall be removed and transported to a pre-approved disposal facility in a manner approved by the Engineer and the Owner.

G. The Contractor shall provide for the pumping down of any surcharged pipe or catch basin and provide all bypass pumping, if required, during the cleaning operation.

H. The Contractor shall submit a comprehensive equipment list to the Engineer before commencement of the work. The complete list, which shall include all backup and standby equipment, shall be broken down into the following categories (at a minimum):

1. Catch basin preconditioning and cleaning equipment
2. Storm sewer preconditioning and cleaning equipment
3. Flow diversion and flow control equipment
4. Traffic control equipment
5. All other equipment necessary for the completion of the work

I. Blockages in the system shall be reported to the Engineer immediately.

J. A responsible representative of the Contractor shall be present on the site of the work, or other location approved by the Engineer, to provide supervision of the work. At all times, and especially when a change of work location is underway, the Contractor's representative shall keep the Engineer continuously aware of the location, progress, planned execution of the work, and problems encountered.

K. Flows may be attenuated using suitable flow control devices, such as plugs designed and manufactured specifically for use in storm sewers. Sand bags or other types of devices shall not be used within storm sewer pipelines or catch basins.

3.03 Heavy Cleaning

If, during the course of cleaning and/or inspection operations, the Contractor believes a pipeline will require "heavy cleaning", the Contractor shall inform the Engineer prior to conducting "heavy cleaning" operations. Visual evidence in the form of a CCTV image or digital image of the pipeline shall be provided by the Contractor to the Engineer to justify heavy cleaning operations. After reviewing the evidence, the Engineer shall make a determination if the evidence provided meets the definition of "heavy cleaning". If it is determined that "heavy cleaning" is required, the Engineer shall provide written authorization to the Contractor to proceed with "heavy cleaning" operations at the rate set forth in the Bid for the pipe or pipes determined to require "Heavy Cleaning".

3.04 Precautions

A. The Contractor shall take all necessary precautions to ensure that water used does not flood property or buildings served by the pipeline being cleaned.

B. No fire hydrant shall be obstructed.

C. The Contractor shall take all necessary precautions to protect the storm sewer pipelines from damage that might be caused by use of cleaning equipment and shall

repair, at no cost to the Owner, any damage caused by the cleaning operation.

D. The Contractor shall furnish to the Owner certification of the accuracy of the automatic counter before any work begins on this Project. If, at any time, the Engineer has reason to believe that the counter is inaccurate, the calibration of the counter will be checked before any more work progresses.

E. The Contractor shall provide, operate, maintain, and subsequently remove upon completion, adequate ventilation apparatus in the form of blowers and/or fans. The ventilation apparatus shall introduce a fresh air supply to support a safe environment for Work in storm sewers, catch basins, and all other confined spaces, which shall be kept free from dangerous, toxic and/or explosive gases, whether generated from sewage, soil strata, or other source.

F. The Contractor shall employ the "best practicable means" to minimize and mitigate noise as well as vibration resulting from operations. Mitigation measures shall include the utilization of sound suppression devices on all equipment and machinery particularly in residential areas and in the near vicinity of hospitals and schools, especially at night.

G. The Contractor shall inform the Engineer before the commencement of any portion of the work of any significant change in the methods of noise attenuation from those previously utilized.

H. All pumps, generators, combination cleaners, or other noise emitting equipment be shall be suitably screened to minimize nuisance and noise pollution. This requirement shall not be taken as preventing or prohibiting the execution of work necessary for the saving of life, protection of property, or safety of the personnel and/or facilities. The Contractor shall notify the Engineer of such use of plant or equipment in an emergency situation as soon as practicable.

I. Contractor shall take all necessary precautions for safe installation and removal of flow attenuation devices, such as plugs.

3.05 Data Collection

A. The Contractor shall complete a cleaning report for each storm sewer segment cleaned. A hard copy of this report shall be furnished on a weekly basis to the Engineer. The information required on the cleaning report shall be as follows:

1. Upstream and downstream catch basin identifications corresponding to the section of storm sewer cleaned.

2. Degree and nature of deposits prior to cleaning.

3. Length of storm sewer cleaned.

4. Method and man-hours required for cleaning.

B. The Contractor shall submit a legibly hand written, tabular inspection sheet that includes the above required items. Contractor shall submit samples of the inspection sheet they intend to use for approval of the Engineer prior to beginning inspection activities.

END OF SECTION

Part 1 General

1.01 Scope

A. Furnish all labor, material, and equipment to provide for the reconstruction of existing stormwater pipes using an approved Cured-In-Place Pipe (CIPP) method by forming a new pipe within an existing pipe.

B. The sewer reconstruction shall be accomplished by the installation of a thermosetting resin-impregnated flexible felt-fiber tube coated on one side with an impermeable plastic which is installed into the existing stormwater sewer utilizing a hydrostatic head, or air pressure. Curing is accomplished by circulating hot water or the introduction of controlled steam throughout the length of the inverted tube to cure the resin into a hard, impermeable pipe with the plastic coating on the interior surface of the newly formed pipe.

The CIPP shall extend the full length of the original pipe segment and shall provide a structurally sound, joint-less, close-fitting, and corrosion resistant cured-in-place pipe. Hydrostatic inversion and water curing CIPP methods shall be the primary means of completing all work shown in these specifications. Air inversion and steam curing will only be allowed in extreme circumstances where the Contractor can clearly demonstrate that hydrostatic inversion and water curing cannot be physically performed, pose a safety threat to personnel or property, or result in an inferior installation. Air inversion and steam curing methods must be pre-approved in writing by the Engineer after the Contractor has submitted documentation and a request to utilize these methods.

C. It is the intent of this Specification to provide for the reconstruction of existing storm sewers by the CIPP method in pipes which have generally maintained their original shape. The CIPP shall provide flow capacity not less than one-hundred percent (100%) of the original pipe's flow capacity when new.

D. The Contractor shall utilize the services of specialty subcontractors on those parts of the Work which, under normal contracting practices, are best performed by specialty subcontractors, as required by the Engineer in the Engineer's sole discretion, at no additional cost to the Owner.

If the Contractor desires to perform specialty work, the Contractor shall submit a request to the Owner, accompanied by evidence that the Contractor's own organization has successfully performed the type of work in question, is presently competent to perform the type of work, and the performance of the work by specialty subcontractors will result in materially increased costs or inordinate delays.

E. The work performed under this Section of the Specifications is deemed to be Specialty Contractor Work and is subject to the provisions of Section 00700 General Conditions, Article 10, subparagraph (b).

1.02 Reference Standards

Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), or other recognized standards. The latest revisions of all standards in effect on date of advertisement are applicable. Where discrepancies exist between this Specification and referenced product/process standards, this Specification shall govern.

1.03 Quality Assurance

A. In order to establish minimum product quality and Installer capability, the following minimum requirements shall be met. The purpose for these submittals is to allow the Owner/Engineer the opportunity to conduct a complete, thorough, and objective evaluation of proposed CIPP products, and the Installing Contractor and to determine if the submitted products and Installer meet all experience, quality, and utility standards required by the specification.

B. CIPP System Manufacturer: The cured-in-place system must have a minimum proven performance record of three-hundred-and-fifty-thousand linear feet (350,000 LF) installed of the exact name-brand product bid in the United States. Documentation shall be submitted to the Engineer during the submittal review process. Any exceptions to this footage requirement must be approved in writing by Engineer.

C. Contractor/Installer Experience: The Installing Contractor for the cured-in-place reconstruction of sewers must have a minimum of three (3) years' experience using the exact named product proposed and, have installed at least two-hundred-thousand linear feet (200,000 LF) of the exact named proposed product, including at least ten-thousand linear feet (10,000 LF) of twenty-four inch (24") diameter (or larger) cured-in-place product. Documentation along with contact names and telephone numbers from the last ten (10) projects shall be submitted as part of the bid package. Any exceptions to this footage requirement must be approved in writing by Engineer.

D. On-Site Field Superintendent: The Qualifying Superintendent must have a minimum of five (5) years' experience with cured-in-place pipe products. In addition, the Qualifying Superintendent must have supervised jobs in which at least twenty-thousand linear feet (20,000' LF) of pipe has been reconstructed using the exact named product proposed including a minimum of five-thousand linear feet (5,000 LF) of twenty-four inch (24) diameter (or larger) cured-in-place product. The Contractor shall submit information to document his experience as part of the bid package. The superintendent for the job shall be on-site during all phases of the work involving any pre- and post-installation video inspection, sewer cleaning, or insertion and processing of the CIPP.

E. Resin Class

1. The Contractor shall designate a wet-out facility and shall provide wet-out liner

tubes from this designated facility only. Multiple facilities to supply wet-out liner tubes for the duration of this Contract may not be used without prior approval of the Engineer.

2. The Contractor shall place a sampling valve in-line at a point in the resin/catalyst mixing stage so that a sample of non-catalyzed resin may be taken. A second sampling valve shall be placed in-line at a point after the resin/catalyst mixing stage, but prior to catalyzed resin injection into the liner so that a resin sample may be taken. Both sampling valves shall be left in place for the duration of the Contract.

3. The Engineer shall have the right to inspect the designated wet-out facility and draw samples form one (1) or both sampling valves without prior notice to the Contractor for the duration of the Contract.

4. Infrared Analysis

   a. The Engineer reserves the right to subject resin samples to an infrared analysis (IR Scan). This standard analytical test involves shining a beam of light in the infrared frequency region through a thin sample of subject resin. The frequency of light is then varied across the infrared spectrum. Chemical functional groups present in the resin being analyzed will absorb infrared light as specific frequencies and with characteristic absorption intensities.

   b. A spectrum created from the measurement of light transmitted through the sample across the range of infrared frequencies shall be used to determine the resin's chemical fingerprint. An overlaid IR spectrum of Reichhold Polylite® 33420 shall be used as a baseline comparison for the purpose of a polyester test. The baseline comparison for vinyl ester shall be Reichhold Dion® 9800.

   c. The Engineer may perform random Infrared Scans (IR Scans) and/or Composite Burn-offs to ensure resin quality and consistency throughout the duration of the Contract.

1.04 Submittals

A. Submit shop drawings in accordance with the requirements of Section 01300 of these Specifications. Specific submittal information shall include the following:

1. The Contractor shall furnish design calculations for each pipe establishing the structural capabilities, chemical composition, thickness, and other mechanical properties of the liner system proposed.

2. The Contractor shall furnish a Summary Table of CIPP material properties, including short-term flexural modulus of elasticity, fifty (50) year flexural modulus of elasticity, short-term flexural strength, fifty (50) year flexural strength, and chemical resistance. Certified test reports shall be submitted verifying each value.

3. The Contractor shall furnish independent third-party certified laboratory test reports demonstrating that the exact resin/liner combination to be used for the project meets the requirements for initial structural properties per ISO 178 with wall thickness measured per DIN EN 13566-4, and for chemical resistance with testing performed in accordance with ASTM F1216-Appendix X2.

4. The Contractor shall furnish independent third-party certified laboratory test reports demonstrating the exact resin/liner combination to be used for the project has been tested for long-term flexural modulus of elasticity and long term flexural strength in accordance with ASTM 2990

5. The Contractor shall furnish copies of the manufacturer's brochures giving a complete description of the product proposed, its physical and chemical composition, the same for the thermosetting resin or epoxy hardener.

6. Pre- and post-installation videos and logs per Article 3.04 shall be submitted during the course of work.

7. Catalyst system and resin/catalyst ratio.

8. The proposed curing schedules/process shall be approved by the resin manufacturer in writing. Cure schedules shall include specific information on "step curing" procedures, "cooking times", duration and "cool down" procedures – all to be approved by the resin manufacturer and the Engineer in writing.

9. The Contractor shall submit a Certificate of Authenticity from the resin manufacturer for each shipment to the wet-out facility to include the date of manufacture and Heat Distortion Temperature. This information shall be submitted before the manufacture or installation of any CIPP.

10 The Contractor shall submit a written Contingency Plan, including methods and equipment to be used to repair unacceptable liner defects and for removing failed liners. The Contingency Plan should account for availability and accessibility of backup equipment.

B. The manufacturer shall submit a CURRENT written certification that the lining system complies with all applicable requirements of these Specifications.

Part 2 Products

2.01 Resins

A. Polyester Resins

1. The resin for CIPP installed under this Contract shall be a Standard Polyester Resin or Enhanced Polyester Resin unless otherwise directed by the Engineer due to site-specific field conditions and/or design requirements.

B Standard Polyester Resins

1. The resin used shall be a corrosion resistant isophthalic polyester specifically designed for the CIPP being installed. Only premium, virgin, non-recycled resin shall be used. The resin shall be manufactured under ISO 9002 certified procedures.

2. The resin shall have been tested according to ASTM D2990, D5813, and F1216 by accredited, third-party testing facilities. Results of these tests shall be made available to Engineer upon request.

3. The resin vendor must be able to reference the corrosion scale with the resin itself having a heat deflection temperature greater than two-hundred-twelve degrees Fahrenheit (212° F).

C. Enhanced Polyester Resins

1. The resin used shall be a corrosion resistant enhanced thixotropic, medium reactivity, high viscosity, and rigid, chemical resistant isophthalic resin. These resins contain a mineral filler to enhance mechanical properties and are specifically formulated for use in the cured-in-place pipe (CIPP) industry.

2. The resin shall have physical and chemical properties equal to those of Reichhold Polylite® 33420-E and shall have been tested according to ASTM D 2990, D 5813 and F 1216 by accredited third party testing facilities. Results of these tests shall be made available to the Engineer upon request.

3. The resin must be manufactured under ISO 9002 certified procedures. The resin vendor must be able to reference the corrosion scale with the resin itself having a heat deflection temperature greater than two-hundred-twenty-four degrees Fahrenheit (224° F). Only premium, non-recycled resins will be accepted. The resin vendor must be able to reference the corrosion scale, with the resin itself having a heat deflection temperature greater than one hundred degrees Celsius or two-hundred-twelve degrees Fahrenheit (100° C or 212° F).

D. Resins shall be shipped directly from the resin manufacturer's facility to the CIPP wet-out facility. Resins shall not be sent to any intermediate mixing facility. Copies of the shipping documents from the resin manufacturer shall be submitted to the Engineer indicating dates of shipment, originating and receiving locations.

2.02 Catalyst Systems

A. The catalyst system shall be made up of a primary catalyst and a secondary catalyst. The primary catalyst shall be Akzo Perkadox 16 or approved equal and shall be added at a maximum of one percent (1%) of the resin volume by weight unless otherwise approved by the Engineer. The secondary catalyst shall be Akzo Trigonox or approved equal and shall be added at a maximum of 0.5% of the resin volume by weight unless otherwise approved by the Engineer.

B. "Quick-Cure" or accelerated resin systems including those formulated by substantially increasing the amount of catalysts from that specified above will not be allowed. Resins, catalysts and resin/catalyst mix ratios shall not be changed or altered during this Contract unless specifically approved by the Engineer in writing.

2.03 Liner Tube

A. The tube shall consist of two (2) or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F1216. In the event of a discrepancy between the referenced ASTM requirement and this Specification, this Specification will govern.

B. The acceptable liner tube shall be constructed under ISO 9002 certified procedures. Proper certification shall be provided prior to the manufacture or installation of any CIPP.

C. The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe, and stretch to fit irregular shaped pipe sections.

D. The wet-out tube shall have a uniform thickness that when compressed at installation pressures shall meet or exceed design thickness.

E. The tube shall be manufactured to a size that when installed shall tightly fit the internal circumference and length of the original pipe. No more than one (1) splice per two-thousand linear feet (2,000 LF) shall be allowed. In the event that under-sized pipe is present, the liner tube shall be manufactured so that overlap folds or wrinkles do not occur. Allowances shall be made for circumferential stretching during inversion.

F. The outside layer of the tube, before installation, shall have an impermeable polyurethane or polyethylene plastic coating. This coating shall be an impermeable, flexible membrane that shall contain the resin and facilitate monitoring of resin saturation during resin impregnation. This coating shall form the inner layer of the finished pipe and is required for enhancement of corrosion resistance, flow and abrasion properties.

G. The tube shall be homogeneous across the entire wall thickness, containing no intermediate or encapsulated layers. No material may be included in the tube that may cause de-lamination in the cured liner, and no dry or unsaturated areas or layer shall be evident. Liners with delineation and/or blistering will be cause for rejection.

H. The wall color of the interior liner surface after installation shall be a light-reflective color so that a clear, detailed inspection with Closed-Circuit Television (CCTV) equipment may be conducted.

I. The outside of the tube shall be marked for distance at regular intervals not to exceed ten feet (10'). Such markings shall include the manufacturer's name or identifying symbol.

J. The minimum length necessary to effectively span the distance between catch basin sections of the segment to be lined shall be deemed by the Contractor unless otherwise specified. The line lengths shall be verified in the field before impregnation of the tube with resin. The minimum length should include and make allowance for samples of eighteen-inches (18") on each segment as required and requested by Owner and Engineer.

1. The Internal Diameter (I.D.) of the host pipe shall be measured from twelve (12) to six (6) o'clock and from nine (9) to three (3) o'clock. The average of these two (2) numbers shall be considered the I.D. of the host pipe. The host pipe shall be measured during pre-TV by placing a "Fat-Boy" or equivalent tape measure at the mouth of the host pipe so that the camera records a true measurement of the host pipe from the twelve (12) to six (6) o'clock position in the pipe.

2.04 CIPP Design

A. Liner Thickness

1. The CIPP shall be designed in accordance with the applicable provisions of ASTM F1216 and D2412 for "fully deteriorated gravity pipe conditions" and shall meet the following design conditions:

a. AASHTO HS20-44 Live Load, whether under streets or not. The live load will vary based on depth of pipe.

b. A dead load based on the depth of pipe shown in the Master Spreadsheet. A soil modulus of elasticity of one-thousand pounds per square inch (1,000 psi), soil weight of one-hundred-twenty pounds per cubic foot (120 lbs/ft^3), and a coefficient of friction of Ku'=0.130r.

c. Short-term flexural modulus and long-term modulus when tested in accordance with ASTM D790.

i. Standard Polyester: 250,000 psi and 125,000 psi
ii. Enhanced Polyester: Short-term flexural modulus of 250,000 psi and long-term modulus of 125,000 psi. Flexural strength of 4,500 psi.

d. Minimum Flexural Stress of 4,500 psi, when tested in accordance with ASTM D790.

e. Safety factor of 2.0 shall be used.

f. Groundwater elevation at the ground surface.

g. Pipe ovality of 5%.

h. Poisson ratio of 0.3.

i. Enhancement factor (K) of 7.

j. Service temperature range shall be 40 to 140 degrees F.

k. Maximum long-term deflection shall be 5%.

2. Minimum Acceptable Pipe Thickness

The CIPP shall conform to the minimum requirements demonstrated in the following table:

Physical Property		Minimum Value
Flexural Stress	ASTM D 790	4,500 psi
Flexural Modulus of Elasticity	ASTM D 790	250,000 psi

a. The minimum cured liner thickness shall be as follows, regardless of what the calculations indicate as the required minimum thickness:

Pipe Diameter (Inches)	Depth to Invert (Feet)	Minimum Thickness (Installed) (mm)
8 and 10	0-17	6.0
8 and 10	> 17	7.5
12	0-8	7.5
12	8-16	7.5
15	0-16	10.5
18	0-18	13.5
24	0-18	16.5
30	0-18	18.0
36	0-18	18.0
48	0-18	30.0

b. The above table is in regards to **MINIMUM** installed liner thicknesses only. It is the Contractor's responsibility to determine the site specific external loads on the liner and increase its thickness as required. The Contractor shall submit his proposed plan for ensuring that the finished and installed CIPP meets the above minimum thickness requirements. The plan shall include detailed inversion procedures to reduce stretching and resin loss.

c. **Any liner that does not meet the specified strength and/or thickness requirements, regardless of the amount below the specified requirements, shall be corrected by the Contractor in a manner approved by the Engineer at no additional cost to the Owner. The Engineer's decision on how to correct deficient CIPP installations shall be final.**

d. All references to cured liner thickness shall be defined as total thickness after installation and after curing is complete.

4. The finished CIPP shall provide a uniform smooth, interior wall surface and will have at least one-hundred percent (100%) the flow capacity of the original pipe before rehabilitation. In lieu of measurements, calculated capacities may be derived using a Manning "n" coefficient of 0.013 for the original pipe material and a Manning "n" coefficient of 0.010 for a joint-less smooth-wall cured-in-place pipe.

2.05 Hydrophilic End Seals

A. Contractor is to install Hydrophilic End seal at all catch basin penetrations. The End Seals must be in a tubular form which when installed will form a three-hundred-sixty degree (360°) seal between the host pipe and the newly installed liner and must be a minimum of three inches (3") wide. The use of caulking, rope or band type of an end seal will not be allowed. Acceptable End Seals are Insignia™ End Seals by LMK Enterprises, 1779 Chessie Lane, Ottawa, IL 61350 (815) 433-1275, or pre-approved equal.

Termination and Sealing of End Seals at Catch Basin Outlets shall be in accordance with Section 3.09 in this Specification.

B. Materials

1. The materials utilized for the INSIGNIA™ END SEAL shall be provided in kits that are designed to accommodate varying pipe diameters, catch basin depths, junction configurations, and pipe liner products. The INSIGNIA™ END SEAL kits are compatible with most rehabilitative pipe liner products, including cured-in-place, and fold-and-form Additionally, the INSIGNIA™ END SEAL kit may be used with many different pipe liner installation and curing methods, including inversion, pull-in-place, hot water curing, steam curing, ultra violet curing, and ambient curing methods. The components of the INSIGNIA™ END SEAL include a tubular sleeve, and a mechanical fastener.

2. Tubular Sleeve: The member that creates the end seal is a hydrophilic neoprene rubber of approximately 50 Shore A durometer. The tubular sleeve has a uniform wall thickness of approximately two millimeters (2mm), a length of approximately 3.5 inches, and a diameter slightly less than the interior pipe diameter. The hydrophilic neoprene rubber has the following characteristics:

Physical Property	Test Method	Unit	Minimum Value
Shore A Hardness	ASTM D 2240	Point	50 +/- 5
Tensile Strength	ASTM D 412	psi	1,177
Elongation at Break	ASTM D 412	%	523
Specific gravity	ASTM D 297		1.2
Swell capacity in water contact	GRCSC	%	200

3. Mechanical Fastener: There are several mechanical fasteners available for use with the INSIGNIA™ END SEAL product. A first option is a shape-

memory alloy that has been formed into a specific arcuate or other curvilinear configuration having an outer profile that is generally greater than the circumference of the pipe before insertion. This conformation allows the alloy to be bent into a configuration that fits inside of the tubular sleeve and the pipe. Once inside the pipe, the alloy is pressed against the wall of the tubular sleeve, thus pressing the tubular sleeve against the wall of the pipe.

The shape memory characteristic of the fastener urges the fastener to return to its original profile. The alloy remains in a strained configuration, pressing the tubular sleeve against the pipe wall. A second option for a mechanical fastener is a ratcheting retaining ring. The ratcheted retaining ring includes a strip of material having a total length generally greater than the pipe diameter. A ratcheting worm gear is attached to the strip and the strip is formed into a ring shape of variable diameter. The ratcheting retaining ring allows an operator to manually adjust the outer profile of the mechanical fastener, allowing for a small initial diameter before placement into the pipe. After the ratcheting retaining ring is placed within the pipe, the diameter of the retaining ring may be expanded by actuation of the worm gear to tightly hold the tubular sleeve in place.

4. Dual-sided Adhesive Tape: For some mechanical fasteners, a dual-sided adhesive tape may be used to affix the mechanical fastener to the tubular sleeve before installation within the pipe. This feature encourages the mechanical fastener to remain within the tubular sleeve during installation of the tubular sleeve and the pipe liner.

2.06 Preliner/Outer Film/Outer Liner

A. Contractor is to install preliner tube at all locations where the CIPP liner is inverted into a Spirolite host pipe, prior to inserting the CIPP liner or otherwise directed by the Owner or Engineer in cases of significant infiltration. Acceptable pre-liner tubes are Griffolyn® TX 1200 by Reef Industries, Inc. 9209 Almeda Genoa Rd., Houston, TX, 77075, 713-507-4251, or pre-approved equal.

B. Materials

1. The material of the Preliner Tube shall be a two (2) ply laminate combining two (2) layers of linear low density polyethylene and a high strength cord grid.

2. Physical Properties:

Property	Test Method	Value
Weight	ASTM D-751	38 lb/1000 ft^2
3" Load @ Yeild	ASTM D-882	90 lbf
3" Load @ Break	ASTM D-882	54 lbf or 2500 psi
3" Elongation @ Break	ASTM D-882	400%
Tongue Tear	ASTM D-4533	29 lbf
PPT Resistance	ASTM D-2582	29 lbf
Dart Impact Strength	ASTM D-1709	1.6 lbs
Cold Impact Strength	ASTM D-1790	-40 degrees F
Permeance	ASTM E-96	0.040 Grain/hr*ft^2*in.HG

2.07 CIPP Sectional Repair

A. The reconstruction will 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. When the launching device is properly positioned, the end is opened and the resin-saturated tube and bladder are inverted out of the launching device and through the damaged section using controlled air -pressure. Once the tube/resin composite is cured, the inversion bladder is re-inverted back into the launching device and removed from the pipe. The liner system shall be capable of repairing pipe defects in continuous lengths up to one-hundred feet (100'), ranging in diameters from six inches (6") to thirty-six inches (36").

B. Material

1. The tube will consist of one (1) or more layers of flexible non-woven needled felt or a reinforced non-woven. The tube will be continuous in length exhibiting a uniform minimum wall thickness based upon design calculations found in ASTM F1216. 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 will be capable of conforming to offset joints, bells, and disfigured pipe sections. The resin will be polyester, or vinyl-ester 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. Each end of the sectional liner should be tapered into the pipe for favorable hydraulic conditions.

2. The cured-in-place pipe shall meet or exceed the minimum test standards specified by the American Society for Testing Methods as described in ASTM F1216.

3. The tube should be outfitted with expanding hydrophilic O-rings at each end to form a compression end seal.

4. The installer shall be capable of viewing the beginning of the liner contacting the host pipe verifying the exact placement of the liner and that the liner has covered the entire damaged section. Video documentation of the placement, prior to curing, shall be provided to the Owner. No measurement from a Closed-Circuit Television (CCTV) counter or estimating will be allowed.

5. The liner must be installed at low pressure, not to exceed ten pounds-per-square-inch (10 psi), to prevent damage or further damage to the host pipe. The tube shall be held tightly in place against the wall of the host pipe by pressure until the cure is complete for the required time per manufacture's specifications.

Part 3 Execution

3.01 General

A. All reconstruction of existing stormwater sewers using an approved CIPP product and installer shall be performed in strict accordance with this Specification and the latest revision of ASTM F1216. Where discrepancies exist, or any latitude is either inferred or interpreted between this Specification and ASTM product and process standards, this Specification shall govern.

B. Pull-in and inflate methods of CIPP installations, (reference ASTM F1743), will not be acceptable.

C. The Contractor shall carry out his operations in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving work on an elevated platform and entry into a confined space.

D. The contractor shall be responsible for coordinating payment and usage with the local owning utility of water withdrawn from fire hydrants and cure water disposal.

E. The Contractor shall be responsible for locating and accessing all catch basins needed to perform the work.

F. All surfaces, which have been damaged by the Contractor's operations, shall be restored to a condition at least equal to that in which they were found immediately prior to the beginning of the Contractor's operations. Suitable materials and methods, acceptable to the Engineer, shall be used for such restoration. The restoration of existing property or structures shall be performed as promptly as practicable and shall not be left until the end of the construction period. The cost for correcting damages resulting from the Contractor's actions shall be the responsibility of the Contractor.

G. The tube shall be fabricated to a size that, when installed, will neatly fit the internal circumference of the conduit(s) designated for CIPP. Allowance shall be made for the circumferential stretching during insertion of the tube.

H. The Contractor shall be responsible for determining the minimum length to effectively span the distance from the catch basin to catch basin and shall verify the length of the fabric tube in the field before the tube is either cut to length or wet-out with resin. The tube may run through one or more catch basins with the approval of the Engineer.

I. Traffic Control: The Contractor shall be responsible for traffic control during the course of each phase of the work. Prior to beginning work, Contractor shall submit a traffic control plan for each section of work for the review and approval. It is the intent that this work is to be accomplished with as little disturbance to traffic, private property, and the public as is reasonably possible, consistent with timely completion thereof.

The traffic control plan shall reflect such requirements where applicable. Signs, signals, and detours shall conform to the Tennessee Department of Transportation (TDOT) requirements for streets and highways, latest edition. The Contractor shall have and maintain on site a sufficient supply of traffic cones and other traffic signaling devices, including trained and properly equipped flagmen, to safely control all traffic through the work zone(s). Road closures and/or detours will require advance scheduling and prior approval by the Engineer.

3.02 Daily Work Schedule

Insofar as is possible, work shall be so scheduled that the lining of the pipe and curing of the tube can be accomplished in a single working day or shift. Prior approval must be obtained from the Engineer if work is to be performed at night or on weekends to minimize traffic disturbance. At the end of each working day, temporary tie connections shall be made between the relined section of pipe and the existing system and the plug in the upstream catch basin removed, but not before the section being lined has been properly cured in accordance with the manufacturer's instructions.

3.03 By-Pass Pumping

As required for acceptable completion of the work and/or to avoid damages due to spills or overflows, the Contractor shall provide for continuous flow maintenance around the section or sections of pipe designated for rehabilitation when necessary in accordance with Section 02530 of these Specifications. Contractor shall be responsible to limit the extent and duration of such blockages and back-ups so that overflows and spillage onto public or private property and into storm sewers, waterways, and streets does not occur. In the event that such spillage or overflows do occur during the course of or as a result of the Work, the Contractor performing the Work shall immediately eliminate the spillage or overflow and, as necessary, remove the blockage and eliminate the back-up.

On elimination of the spillage or overflow, the Contractor is to clean up and disinfect the area. Work to stop or contain such events is to be deemed emergency in nature and sufficient justification for total mobilization of resources, the use of overtime or double time, and any other reasonable measures to assure correction of the problem without delay. Damages arising from blockages, back-ups, spillage, or overflows of sewage during the course of the Work or because of the Work shall be the sole responsibility of the Contractor.

3.04 Preliminary Installation Requirements

A. Prior to CIPP installation, the pipe shall be cleaned to the satisfaction of the Engineer per Section 13315 of these Specifications.

B. Debris Disposal: All debris cleaned from the pipe shall be removed and disposed of properly. Debris shall not be allowed to wash into any other pipe segment either upstream or downstream from the pipe segment being cleaned.

C. Holes and Voids: All holes and voids visible in video inspection of the pipe shall be completely filled by the Contractor with flowable fill, cementitious grout, or equal approved by the Engineer, prior to CIPP Pre-Installation Video Inspection. All materials shall be installed according to the manufacturer's recommendations. The finished surface of any material used to fill holes and voids shall be smooth and shall conform to the interior surface of the host pipe and not be visible as a bulge or dimple in the finished CIPP.

D. Pre-Installation Video Inspection: The section of storm sewer designated for CIPP shall to be televised its full length using a remote television camera in accordance with Section 13320 of these Specifications and shall be submitted to the Engineer for review. Note: See Article 2.02 J.1 of these specifications regarding additional work to be performed during Pre-video inspection activities. Camera shall have rotation of plus/minus three hundred degrees (+/-300°) and equipped with a zoom lens.

3.05 Resin Impregnation of the CIPP Tube (Wet-Out)

A. The Contractor shall designate a location where the tube shall be impregnated or "wet out" with resin, using distribution rollers and a vacuum impregnation system to thoroughly saturate the tube's felt fiber prior to installation in the field. The impregnated tube shall be free of pinholes, resin voids, and other defects. The quality management system for the wet-out facility must be registered in accordance with ISO 9001:2008. The quality management system must ensure that proper materials and amounts are used in the resin saturation process and in liner shipping and storage. The quality control documentation shall include resin lot numbers, volumes of resin, catalyst, enhancers, date of wet-out, storage/transportation controls, and quality assurance procedures. A checklist must be included documenting that each critical step in the resin impregnation process is checked off and initialed.

B. Care shall be taken in shipping, handling, and storage to avoid damaging the liner. Any liner damaged in shipment shall be replaced as directed by the Owner at no

additional cost to the Owner.

C. If the cured-in-place pipe is impregnated at the manufacturing plant, it shall be delivered to the job site in a refrigerated truck, and remain refrigerated prior to installation to prevent premature curing.

D. The flexible tube shall be vacuum impregnated with resin under controlled conditions or by such other means provided such means can assure thorough resin impregnation to the full satisfaction of the Owner/Engineer. The volume of resin used shall be sufficient to fill all voids in the tube material at normal or design thickness and diameter. The volume of resin shall be adjusted by adding seven to ten percent (7% to 10%) excess resin for the change in resin volume due to polymerization and allow for any migration of resin into the cracks and joints in the original pipe.

3.06 Inversion of CIPP

A. The impregnated tube shall be inverted through an existing catch basin or other approved access point utilizing a hydrostatic water column until it has fully traversed the designated line length and the inversion face breaches the destination catch basin or termination point. The fluid column shall have been adjusted and maintained to be sufficient to cause the impregnated tube to hold tight against the existing pipe wall, produce dimples at side connections, and flared ends at the catch basins. Lubricant during inversion shall be used as necessary in accordance with the CIPP manufacturer's recommendations. Thermocouples shall be placed at the top and bottom interface of both ends of the liner for monitoring temperature during the cure cycle. Care should be taken during tube installation not to over-stress the fabric fiber.

B. The Contractor shall maintain pressure requirements as defined by the manufacturer. The pressure used during the installation process shall be sufficient to hold the liner tight to the pipe wall and prevent wrinkles in the cured liner. The same pressure shall be great enough to prevent any infiltration from entering the pipeline during the curing process. The pressure shall be maintained for a time sufficient to allow any pockets of water to exfiltrate the host pipe, and to prevent lifts in the liner and resin washout.

Pressurized air may be used in the place of a hydrostatic water column as determined by manufacturer recommendations. The Contractor shall provide documentation for each segment as part of the submittal process. Should one or the other of the installation methods utilized by the contractor prove not to be successful, as determined at the sole discretion of the Engineer/Owner, the Engineer/Owner may eliminate the option of that method.

C. Air over water pressure vessels or pressure head simulators may be used with prior approval from the Engineer. Approval for the use of this type apparatus may be considered on a "case by case" basis. Pull-In and Inflate methods of CIPP installations, (i.e., ASTM F1743), will not be acceptable. Before the inversion begins, the tube manufacturer shall submit to the Contractor, and the Contractor to the Engineer, the minimum pressure required to hold the tube tight against the host

pipe and the maximum allowable pressure so as not to damage the tube.

C. Pull-In and Inflate methods of CIPP installations, (i.e., ASTM F1743), will not be acceptable. Before the inversion begins, the tube manufacturer shall submit to the Contractor, and the Contractor to the Engineer, the minimum pressure required to hold the tube tight against the host pipe and the maximum allowable pressure so as not to damage the tube.

D. When using pressurized air, particular attention should be given to the maintenance of the minimum required "finished and installed" thickness of the CIPP. Once the inversion has started, pressure shall be maintained between the minimum and maximum pressures until the inversion has been accomplished.

E. Prior to any inversion, the Contractor shall submit a Post-Cure Hold Time and Temperature Table. This table shall indicate the minimum time and temperature the inverted tube will be held at in order to achieve desired physical properties. The resin manufacturer shall certify both the time and temperatures presented in the table. The Time and Temperature Table submitted for using steam curing shall be identical to time and temperature hold times when curing with heated, circulated water.

3.07 Curing

A. Follow the submitted cure schedule in curing the CIPP liner. Initial cure shall occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the thermocouples indicate that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature shall be raised to the post-cure temperature recommended by the resin manufacturer. Post-Cure temperature should be held for a period as recommended by the resin manufacturer, during which time the recirculation of the water and cycling of the heat source to maintain the temperature continues.

B. Curing must take into account the existing pipe material, the resin system, and the ground conditions (temperature, moisture level, and thermal conductivity of the soil).

C. Circulated Heated Water Method: A suitable heat source and water recirculation equipment is required to circulate heated water throughout the pipe. The equipment shall be capable of delivering hot water throughout the inverted tube to uniformly raise the temperature required to affect a cure of the resin.

D. Controlled Steam Method: Suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment shall be capable of delivering steam throughout the inverted tube to uniformly raise the temperature required to affect a cure of the resin.

E. Curing must take into account the existing pipe material, the resin system, and the ground conditions (temperature, moisture level, and thermal conductivity of the soil).

3.08 Cool-Down

Cool-down of the cured pipe liner shall be in accordance with the manufacturer's recommendations. Care should be taken during the cool-down process so as to minimize shrinkage of the CIPP. Cure water shall not be released downstream.

3.09 Termination and Sealing at Catch Basin Outlets

A. Termination of the cured-in-place pipe at the catch basin shall be completed by trimming the inverted pipe end back in accordance with the CIPP manufacturer's recommendations. If, in the judgment of the Engineer, the CIPP does not fit tightly against the storm sewer pipe at its termination point(s), the void between the host pipe and the CIPP shall be sealed by filling it with a resin mixture compatible with the CIPP at no additional cost to the Owner.

B. The Cured-in-place pipe inverts of lined-through catch basins shall remain in place as part of the finished CIPP. The finished CIPP shall be trimmed to match the profile of the existing interface between the pipe and catch basin wall or bench. The annular space between the CIPP and the host structure(s) shall be sealed with a Hydrotite™ style SS-0215 hydrophilic waterstop seal or Engineer approved equal. Any water entering or exiting the annular space between the catch basin and the finished CIPP after installation must be stopped by the Contractor by a method approved by the Engineer.

3.10 Testing of CIPP

A. The Engineer may, at its discretion, direct the Contractor to collect samples of the cured CIPP for laboratory determination of flexural strength, flexural modulus, and wall thickness for each test sample. These three (2) individual analyses shall comprise one completed test. All samples shall be collected per the sampling protocols set forth in ASTM F1216.

B. For each line segment, the Contractor shall remove one restrained sample of the installed liner at least twelve inches (12") in length for testing. The sample shall be removed from the point most distant from the heat source. The sample submitted shall be the exact same I.D. as the host pipe, samples caught in smaller diameter pipe shall not be acceptable. For storm sewers fifteen inches (15") and larger, plate samples may be taken and cured in the same water as the installed CIPP. For each sample taken, the Contractor shall cut and deliver a twelve inches (12") in length representative sample (taken at least two inches [2"] from the end of the specimen) to the Engineer. The sample delivered to the Engineer shall be labeled and removed from any restraining mold. The samples shall be taken in the presence of the Engineer. (NOTE: Any preliner tube material must be removed from the sample by the contractor before delivering the sample to the Engineer.)

C. The tests shall be used to verify that the installed CIPP meets these Specifications. CIPP thickness shall be measured in accordance with ASTM D5813. Flexural properties shall be determined per ASTM D790. The Contractor shall label and date all samples and deliver the samples directly to the Engineer.

C. Any liner that does not meet the specified strength and/or thickness requirements, regardless of the amount below the specified requirements, shall be corrected by the Contractor in a manner approved by the Engineer at no additional cost to the Owner. The Engineer's decision on how to correct deficient CIPP installations shall be final. Options for correcting deficient liners that may be considered by the Engineer include removing the liner and re-lining the storm sewer, excavating and replacing the storm sewer from catch basin to catch basin, or providing the Owner with a credit. The primary option that will be considered will be to re-line the storm sewer.

Credits will only be authorized for CIPP that does not meet required thickness. If a credit is acceptable to the Owner, the credit shall be calculated by multiplying the bid price by the percent that the liner thickness is below the required installed thickness as follows:

Credit = (1 – Installed CIPP thickness/required CIPP thickness) x bid price

The Contractor shall not assume a credit will be acceptable to the Owner under any circumstance. This would be the Owner's sole discretion.

E. Leakage Testing of CIPP Storm Sewer Main: Leakage testing of all finished CIPP-lined storm sewer mains shall be conducted in the presence of the Engineer in accordance with the exfiltration test method for gravity pipes described in Section 02530 of these Specifications. The Contractor shall furnish all equipment and personnel necessary to conduct all of the leakage tests.

3.11 Final Acceptance

A. Post-installation videos shall be conducted and submitted to the Engineer in accordance with Section 13320 of these Specifications. The finished CIPP shall be continuous over the length of pipe between two (2) catch basins and shall be an impermeable, joint-less conduit, free from visual defects such as foreign inclusions, dry spots, pin holes, lifts, or delamination. Camera shall have rotation of plus/minus three hundred degrees (+/-300°) and equipped with a zoom lens. In order to be considered for payment, the post installation videos MUST include the pipe connections at both ends of the pipe.

B. Wrinkles in the CIPP, (other than minor, longitudinal pressure wrinkles) will not be acceptable. The Engineer shall determine as to the acceptability of pressure wrinkling with that decision being final. In the event the finished liner does not fit tightly against the original pipe at its termination point(s), the space between the liner and the pipe shall be made watertight, utilizing catch basin end seals, hydro-tite gaskets, or approved equal.

C. After curing of the resin is completed, the hardened CIPP shall extend from catch basin to catch basin of the section designated providing a structurally sound, corrosion-resistant, watertight conduit that excludes exfiltration and infiltration, is tight-fitting within the existing pipe, and is free of voids or annular spaces between the CIPP and the existing pipe walls. K-Factor for tightness shall equal 7.0 or greater. All

terminations into catch basin walls shall be watertight at the time of final inspection. No annular space shall be visible between the CIPP and catch basin wall. In the event that an annular space is present, it shall be completely filled with epoxy or other suitable material to the satisfaction of the Engineer.

D. The finished pipe must be such that when the thermosetting resin cures, the total wall thickness will be a homogeneous, monolithic felt and resin composite matrix that will be chemically resistant to withstand internal exposure to domestic sewage. When cured, the CIPP must form a mechanical bond with the host pipe.

END OF SECTION

Part 1 General

1.01 Scope

A. Furnish all labor, material, and equipment to provide for the reconstruction of existing stormwater pipes using an approved ultraviolet light Cured-In-Place Pipe (UV-CIPP) method by forming a new pipe within an existing pipe.

B. The storm sewer reconstruction shall be accomplished by the installation of a resin-impregnated flexible tube into the existing stormwater sewer, expanding the tube against the host pipe, and curing the tube to form a hard, impermeable pipe liner. The UV-CIPP shall extend the full length of the original pipe segment and shall provide a structurally sound, joint-less, close fitting and corrosion resistant cured-in-place pipe. Curing shall be accomplished by applying ultraviolet light to obtain the desired cure throughout the tube, extending from catch basin to catch basin.

C. It is the intent of this Specification to provide for the reconstruction of existing storm sewers by the UV-CIPP method in pipes which have generally maintained their original shape. The UV-CIPP shall provide flow capacity not less than one-hundred percent (100%) of the original pipe's flow capacity when new.

D. The Contractor shall utilize the services of specialty subcontractors on those parts of the Work which, under normal contracting practices, are best performed by specialty subcontractors, as required by the Engineer in Engineer's sole discretion, at no additional cost to the Owner.

If the Contractor desires to perform specialty work, the Contractor shall submit a request to the Owner, accompanied by evidence that the Contractor's own organization has successfully performed the type of work in question, is presently competent to perform the type of work, and the performance of the work by specialty subcontractors will result in materially increased costs or inordinate delays.

1.02 Reference Standards

Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), or other recognized standards. The latest revisions of all standards in effect on date of advertisement are applicable. Where discrepancies exist between this Specification and referenced product/process standards, this Specification shall govern.

1.03 Quality Assurance

A. In order to establish minimum product quality and Installer capability, the following minimum requirements shall be met. The purpose for these submittals is to allow the Owner/Engineer the opportunity to conduct a complete, thorough and objective evaluation of proposed UV-CIPP products and the Installing Contractor and to determine if the submitted products and Installer meet all experience, quality and

utility standards required by the specification.

B. UV-CIPP System Manufacturer: The UV-CIPP system must have a minimum proven performance record of three-hundred-and-fifty-thousand linear feet (350,000 LF) installed of the exact name-brand product bid in the United States. Documentation shall be submitted to the Engineer during the submittal review process. Any exceptions to this footage requirement must be approved in writing by Engineer.

C. Contractor/Installer Experience: The Installing Contractor for the cured-in-place reconstruction of storm sewers must have a minimum of three (3) years' experience using the exact named product proposed and, have installed at least two-hundred-thousand linear feet (200,000 LF) of the exact named proposed product including at least ten-thousand linear feet (10,000 LF) of twenty-four inch (24") diameter (or larger) cured-in-place product. Documentation, along with contact names and telephone numbers, from the last ten (10) projects shall be submitted as part of the bid package. Any exceptions to this footage requirement must be approved in writing by Engineer.

D. On-Site Field Superintendent: The Qualifying Superintendent must have a minimum of five (5) years' experience with cured-in-place pipe products. In addition, the Qualifying Superintendent must have supervised jobs in which at least twenty-thousand linear feet (20,000 LF) of pipe has been reconstructed using the exact named product proposed, including a minimum of five-thousand linear feet (5,000 LF) of twenty-four inch (24) diameter (or larger) cured-in-place product. The Contractor shall submit information to document his experience as part of the bid package. The superintendent for the job shall be on-site during all phases of the work involving any pre and post-installation video inspection, storm sewer cleaning, or insertion and processing of the CIPP.

E. Resin Class

1. The Contractor shall designate a wet-out facility and shall provide wet-out liner tubes from this designated facility only. Multiple facilities to supply wet-out liner tubes for the duration of this Contract may not be used without prior approval of the Engineer.

2. The Contractor shall place a sampling valve in-line at a point in the resin/catalyst mixing stage so that a sample of non-catalyzed resin may be taken. A second sampling valve shall be placed in-line at a point after the resin/catalyst mixing stage, but prior to catalyzed resin injection into the liner, so that a resin sample may be taken. Both sampling valves shall be left in place for the duration of the Contract.

3. The Engineer shall have the right to inspect the designated wet-out facility and draw samples from one or both sampling valves without prior notice to the Contractor for the duration of the Contract.

4. Infrared Analysis

   a. The Engineer reserves the right to subject resin samples to an infrared analysis (IR Scan). This standard analytical test involves shining a beam

of light in the infrared frequency region through a thin sample of subject resin. The frequency of light is then varied across the infrared spectrum. Chemical functional groups present in the resin being analyzed will absorb infrared light as specific frequencies and with characteristic absorption intensities.

b. A spectrum created from the measurement of light transmitted through the sample across the range of infrared frequencies shall be used to determine the resin's chemical fingerprint. An overlaid IR spectrum of Reichhold Polylite® 33420 shall be used as a baseline comparison for the purpose of a polyester test. The baseline comparison for vinyl ester shall be Reichhold Dion® 9800.

c. The Engineer may perform random Infrared Scans (IR Scans) and/or Composite Burn-offs to ensure resin quality and consistency throughout the duration of the Contract.

1.04 Submittals

A. Submit shop drawings in accordance with the requirements of Section 01300 of these Specifications. Specific submittal information shall include the following:

1. The Contractor shall furnish design calculations for each pipe establishing the structural capabilities, chemical composition, thickness, and other mechanical properties of the liner system proposed.

2. The Contractor shall furnish a Summary Table of CIPP material properties, including short-term flexural modulus of elasticity, fifty (50) year flexural modulus of elasticity, short-term flexural strength, fifty (50) year flexural strength, and chemical resistance. Certified test reports shall be submitted verifying each value.

3. The Contractor shall furnish independent third-party certified laboratory test reports demonstrating that the exact resin/liner combination to be used for the project meets the requirements for initial structural properties per ISO 178 with wall thickness measured per DIN EN 13566-4, and for chemical resistance with testing performed in accordance with ASTM F1216-Appendix X2.

4. The Contractor shall furnish independent third-party certified laboratory test reports demonstrating the exact resin/liner combination to be used for the project has been tested for long-term flexural modulus of elasticity and long term flexural strength in accordance with ASTM 2990

5. The Contractor shall furnish copies of the manufacturer's brochures giving a complete description of the product proposed, its physical and chemical composition, the same for the thermosetting resin or epoxy hardener.

6. Pre- and post-installation videos and logs per Article 3.04 shall be submitted during the course of work.

7. Catalyst system and resin/catalyst ratio.

8. The proposed curing schedules/process shall be approved by the resin manufacturer in writing. Cure schedules shall include specific information on "step curing" procedures, "cooking times", duration and "cool down" procedures – all to be approved by the resin manufacturer and the Engineer in writing.

9. The Contractor shall submit a Certificate of Authenticity from the resin manufacturer for each shipment to the wet-out facility to include the date of manufacture. This information shall be submitted before the manufacture or installation of any CIPP.

10 The Contractor shall submit a written Contingency Plan, including methods and equipment to be used to repair unacceptable liner defects and for removing failed liners. The Contingency Plan should account for availability and accessibility of backup equipment.

B. The manufacturer shall submit a CURRENT written certification that the lining system complies with all applicable requirements of these Specifications.

Part 2 Products

2.01 Resins

A. Polyester Resins

1. The resin for CIPP installed under this Contract shall be a Standard Polyester Resin unless otherwise directed by the Engineer due to site-specific field conditions and/or design requirements. Only premium, non-recycled resin shall be used. The resin must be manufactured under ISO 9002 certified procedures.

2. The resin vendor must be able to reference the corrosion scale with the resin itself having a heat deflection temperature greater than two-hundred-twelve degrees Fahrenheit (212° F).

3. The resin shall have been tested according to ASTM D2990, D5813, and F1216 by accredited, third-party testing facilities. Results of these tests shall be made available to Engineer upon request.

B. Resins shall be shipped directly from the resin manufacturer's facility to the CIPP wet-out facility. Resins shall not be sent to any intermediate mixing facility. Copies of the shipping documents from the resin manufacturer shall be submitted to the Engineer indicating dates of shipment, originating and receiving locations.

2.02 Liner Tube

A. The tube shall consist of one (1) or more layers of fiberglass laminate and meet the requirements of ASTM F2019. In the event of a discrepancy between the referenced

ASTM requirement and this Specification, this Specification will govern.

B. The acceptable liner tube shall be constructed under ISO 9002 certified procedures. Proper certification shall be provided prior to the manufacture or installation of any CIPP.

C. Gliding Foil – A continuous heavy gauge (10mm) plastic sheet shall be pulled into the entire length of host pipe, covering 1/3 to 1/2 the diameter of lower portion of the host pipe, protecting the liner during the pull in process.

D. The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe, and stretch to fit irregular shaped pipe sections.

E. The wet-out tube shall have a uniform thickness that when compressed at installation pressures shall meet or exceed design thickness.

F. The tube shall be manufactured to a size that when installed shall tightly fit the internal circumference and length of the original pipe. No more than one (1) splice per two-thousand linear feet (2,000 LF) shall be allowed. In the event that under-sized pipe is present, the liner tube shall be manufactured so that overlap folds or wrinkles do not occur. Allowances shall be made for circumferential stretching during inversion.

G. The outside layer of the tube, before installation, shall have an impermeable coating. This coating shall be an impermeable, flexible membrane. The liner shall include an outer layer which inhibits the release of steam, styrene, odors, or other pollutants into the stormwater system.

H. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated layers. No material may be included in the tube that may cause de-lamination in the cured liner, and no dry or unsaturated areas or layer shall be evident. Liners with delamination and/or blistering will be cause for rejection.

I. The wall color of the interior liner surface after installation shall be a light-reflective color so that a clear, detailed inspection with closed-circuit television (CCTV) equipment may be conducted.

J. The outside of the tube shall be marked for distance at regular intervals not to exceed ten feet (10'). Such markings shall include the manufacturer's name or identifying symbol.

K. The minimum length necessary to effectively span the distance between catch basin sections of the segment to be lined shall be deemed by the Contractor unless otherwise specified. The line lengths shall be verified in the field before impregnation of the tube with resin. The minimum length should include and make allowance for samples of eighteen-inches (18") on each segment as required and requested by Owner and Engineer.

1. The Internal Diameter (I.D.) of the host pipe shall be measured from twelve (12) to six (6) o'clock and from nine (9) to three (3) o'clock. The average of these two

(2) numbers shall be considered the I.D. of the host pipe. The host pipe shall be measured during pre-TV by placing a "Fat-Boy" or equivalent tape measure at the mouth of the host pipe so that the camera records a true measurement of the host pipe from the twelve (12) to six (6) o'clock position in the pipe.

2.03 Light System

A. When inserting the curing equipment in the liner, care should be taken to not damage the inner film material.

B. Approved UV light systems shall have the ability to record specific parameters during the curing process utilizing an integrated CCTV system on the light assembly to ensure the liner is properly cured, recording parameters will include the following:

1. Project name
2. Line Section
3. Date and Time
4. Curing Speed
5. Light Source working and wattage
6. Inner Air pressure
7. Inner Temperatures
8. Length of liner

2.04 CIPP Design

A. Liner Thickness

1. The CIPP shall be designed in accordance with the applicable provisions of ASTM F2019 for fully deteriorated host pipe conditions and shall meet the following design conditions:

   a. American Association of State Highway and Transportation Officials (AASHTO) HS20-44 Live Load, whether under streets or not. The live load will vary based on depth of pipe.

   b. A dead load based on the depth of pipe shown in the Master Spreadsheet. A soil modulus of elasticity of one-thousand pounds per square inch (1,000 psi), soil weight of one-hundred-twenty pounds per cubic foot (120 lbs/ft^3), and a coefficient of friction of Ku'=0.130r.

   c. Long-term Flexural Strength and Long-term Flexural Modulus when tested in accordance with ASTM D2990.

      i. 50-Year Flexural Strength: 4,500 psi minimum
      ii. 50-Year Flexural Modulus: 200,000 psi minimum

   d. Safety Factor of 2.0 shall be used.

e. Groundwater elevation at the ground surface.

f. Pipe Ovality of 5%.

g. Poisson Ratio of 0.3.

h. Enhancement factor (K) of 7.

i. Service temperature range shall be forty to one-hundred forty degrees Fahrenheit (40° F to 140° F).

j. Maximum long-term deflection shall be 5%.

2. Minimum Acceptable Pipe Thickness

a. The minimum cured liner thickness shall be as follows, regardless of what the calculations indicate as the required minimum thickness:

Pipe Diameter (Inches)	Depth to Invert (Feet)	Minimum Thickness (Installed) (mm)
18	0-15	6.0
24	0-15	7.5
30	0-15	9.0
36	0-15	10.5

b. The above table is in regards to **MINIMUM** installed liner thicknesses only. It is the Contractor's responsibility to determine the site specific external loads on the liner and increase its thickness as required. The Contractor shall submit his proposed plan for ensuring that the finished and installed CIPP meets the above minimum thickness requirements. The plan shall include detailed inversion procedures to reduce stretching and resin loss.

c. **Any liner that does not meet the specified strength and/or thickness requirements, regardless of the amount below the specified requirements, shall be corrected by the Contractor in a manner approved by the Engineer at no additional cost to the Owner. The Engineer's decision on how to correct deficient CIPP installations shall be final.**

d. All references to cured liner thickness shall be defined as total thickness after installation and after curing is complete.

B. The finished CIPP shall provide a uniform smooth, interior wall surface and will have at least one-hundred percent (100%) of the flow capacity of the original pipe before rehabilitation. In lieu of measurements, calculated capacities may be derived using a Manning "n" coefficient of 0.013 for the original pipe material and a Manning "n" coefficient of 0.010 for a joint-less smooth-wall cured-in-place pipe.

2.05 Hydrophilic End Seals

A. Contractor is to install Hydrophilic End seal at all catch basin penetrations. The End Seals must be in a tubular form which when installed will form a three-hundred-sixty degree (360°) seal between the host pipe and the newly installed liner and must be a minimum of three inches (3") wide. The use of caulking, rope, or band type of an end seal will not be allowed. Acceptable End Seals are Insignia™ End Seals by LMK Enterprises, 1779 Chessie Lane, Ottawa, IL 61350 (815) 433-1275, or pre-approved equal.

Termination and Sealing of End Seals at Catch Basin Outlets shall be in accordance with Section 3.09 in this Specification.

B. Materials

1. The materials utilized for the INSIGNIA™ END SEAL shall be provided in kits that are designed to accommodate varying pipe diameters, catch basin depths, junction configurations, and pipe liner products. The INSIGNIA™ END SEAL kits are compatible with most rehabilitative pipe liner products, including cured-in-place, and fold-and-form. Additionally, the INSIGNIA™ END SEAL kit may be used with many different pipe liner installation and curing methods, including inversion, pull-in-place, hot water curing, steam curing, ultra violet curing, and ambient curing methods. The components of the INSIGNIA™ END SEAL include a tubular sleeve, and a mechanical fastener.

2. Tubular Sleeve: The member that creates the end seal is a hydrophilic neoprene rubber of approximately 50 Shore A durometer. The tubular sleeve has a uniform wall thickness of approximately two millimeters (2mm), a length of approximately 3.5 inches, and a diameter slightly less than the interior pipe diameter (ID). The hydrophilic neoprene rubber has the following characteristics:

Physical Property	Test Method	Unit	Minimum Value
Shore A Hardness	ASTM D 2240	Point	50 +/- 5
Tensile Strength	ASTM D 412	psi	1,177
Elongation at Break	ASTM D 412	%	523
Specific gravity	ASTM D 297		1.2
Swell capacity in water contact	GRCSC	%	200

3. Mechanical Fastener: There are several mechanical fasteners available for use with the INSIGNIA™ END SEAL product. A first option is a shape-memory alloy that has been formed into a specific arcuate or other curvilinear configuration having an outer profile that is generally greater than the circumference of the pipe before insertion. This conformation allows the alloy to be bent into a configuration that fits inside of the tubular sleeve and the pipe. Once inside the pipe, the alloy is pressed against the wall of the tubular sleeve, thus pressing the tubular sleeve against the wall of the pipe.

The shape memory characteristic of the fastener urges the fastener to return to its original profile. The alloy remains in a strained configuration, pressing the tubular sleeve against the pipe wall. A second option for a mechanical fastener is a ratcheting retaining ring. The ratcheted retaining ring includes a strip of material having a total length generally greater than the pipe diameter. A ratcheting worm gear is attached to the strip and the strip is formed into a ring shape of variable diameter. The ratcheting retaining ring allows an operator to manually adjust the outer profile of the mechanical fastener, allowing for a small initial diameter before placement into the pipe. After the ratcheting retaining ring is placed within the pipe, the diameter of the retaining ring may be expanded by actuation of the worm gear to tightly hold the tubular sleeve in place.

4. Dual-sided Adhesive Tape: For some mechanical fasteners, a dual-sided adhesive tape may be used to affix the mechanical fastener to the tubular sleeve before installation within the pipe. This feature encourages the mechanical fastener to remain within the tubular sleeve during installation of the tubular sleeve and the pipe liner.

2.06 CIPP Sectional Repair

A. The reconstruction will 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 storm sewer pipe. When the launching device is properly positioned, the end is opened and the resin-saturated tube and bladder are inverted out of the launching device and through the damaged section using controlled air - pressure. Once the tube/resin composite is cured, the inversion bladder is re-inverted back into the launching device and removed from the pipe. The liner system shall be capable of repairing pipe defects in continuous lengths up to one-hundred feet (100'), ranging in diameters from six inches (6") to thirty-six inches (36").

B. Material

1. The tube will consist of one (1) or more layers of flexible non-woven needled felt or a reinforced non-woven. The tube will be continuous in length exhibiting a uniform minimum wall thickness based upon design calculations found in ASTM F2019, Appendix X1. 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 will be capable of conforming to offset joints, bells, and disfigured pipe sections. The resin will be polyester, or vinyl-ester 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. Each end of the sectional liner should be tapered into the pipe for favorable hydraulic conditions.

2. The cured-in-place pipe shall meet or exceed the minimum test standards specified by the American Society for Testing Methods as described in ASTM F1216.

3. The tube should be outfitted with expanding hydrophilic O-rings at each end to form a compression end seal.

4. The installer shall be capable of viewing the beginning of the liner contacting the host pipe verifying the exact placement of the liner and that the liner has covered the entire damaged section. Video documentation of the placement, prior to curing, shall be provided to the Owner. No measurement from a CCTV counter or estimating will be allowed.

5. The liner must be installed at low pressure, not to exceed ten pounds-per-square-inch (10 psi), to prevent damage or further damage to the host pipe. The tube shall be held tightly in place against the wall of the host pipe by pressure until the cure is complete for the required time per manufacture's specifications.

Part 3 Execution

3.01 General

A. All reconstruction of existing stormwater sewers using an approved UV-CIPP product and installer shall be performed in strict accordance with this Specification and the latest revision of ASTM F2019. Where discrepancies exist, or any latitude is either inferred or interpreted between this Specification and ASTM product and process standards, this Specification shall govern.

B. The Contractor shall carry out his operations in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving work on an elevated platform and entry into a confined space.

C. The contractor shall be responsible for coordinating payment and usage with the local owning utility of water withdrawn from fire hydrants.

D. The Contractor shall be responsible for locating and accessing all catch basins needed to perform the work.

E. All surfaces, which have been damaged by the Contractor's operations, shall be restored to a condition at least equal to that in which they were found immediately prior to the beginning of the Contractor's operations. Suitable materials and methods, acceptable to the Engineer, shall be used for such restoration. The restoration of existing property or structures shall be performed as promptly as practicable and shall not be left until the end of the construction period. The cost for correcting damages resulting from the Contractor's actions shall be the responsibility of the Contractor.

F. The tube shall be fabricated to a size that, when installed, will neatly fit the internal circumference of the conduit(s) designated for CIPP. Allowance shall be made for the circumferential stretching during insertion of the tube.

G. The Contractor shall be responsible for determining the minimum length to effectively span the distance from the catch basin to catch basin and shall verify the length of the fabric tube in the field before the tube is either cut to length or wet-out with resin. The tube may run through one or more catch basins with the approval of the Engineer.

H. Traffic Control: The Contractor shall be responsible for traffic control during the course of each phase of the work. Prior to beginning work, Contractor shall submit a traffic control plan for each section of work for the review and approval. It is the intent that this work is to be accomplished with as little disturbance to traffic, private property, and the public as is reasonably possible, consistent with timely completion thereof. The traffic control plan shall reflect such requirements where applicable. Signs, signals, and detours shall conform to the Tennessee Department of Transportation (TDOT) requirements for streets and highways, latest edition. The Contractor shall have and maintain on site a sufficient supply of traffic cones and other traffic signaling devices, including trained and properly equipped flagmen, to safely control all traffic through the work zone(s). Road closures and/or detours will require advance scheduling and prior approval by the Engineer.

3.02 Daily Work Schedule

Insofar as is possible, work shall be so scheduled that the lining of the pipe and curing of the tube can be accomplished in a single working day or shift. Prior approval must be obtained from the Engineer if work is to be performed at night or on weekends to minimize traffic disturbance. At the end of each working day, temporary tie connections shall be made between the relined section of pipe and the existing system and the plug in the upstream catch basin removed, but not before the section being lined has been properly cured in accordance with the manufacturer's instructions.

3.03 By-Pass Pumping

As required for acceptable completion of the work and/or to avoid damages due to spills or overflows, the Contractor shall provide for continuous flow maintenance around the section or sections of pipe designated for rehabilitation when necessary. Contractor shall be responsible to limit the extent and duration of such blockages and back-ups so that overflows and spillage onto public or private property, waterways, and streets does not occur. In the event that such spillage or overflows do occur during the course of or as a result of the Work, the Contractor performing the Work shall immediately eliminate the spillage or overflow and, as necessary, remove the blockage and eliminate the back-up.

On elimination of the spillage or overflow, the Contractor is to clean up the area. Work to stop or contain such events is to be deemed emergency in nature and sufficient justification for total mobilization of resources, the use of overtime or double time, and any other reasonable measures to assure correction of the problem without delay. Damages arising from blockages, back-ups, spillage, or overflows during the course of the Work or because of the Work shall be the sole responsibility of the Contractor.

3.04 Preliminary Installation Requirements

A. Prior to CIPP installation, the pipe shall be cleaned to the satisfaction of the Engineer per Section 13315 of these Specifications.

B. Debris Disposal: All debris cleaned from the pipe shall be removed and disposed of properly. Debris shall not be allowed to wash into any other pipe segment either upstream or downstream from the pipe segment being cleaned.

2. Holes and Voids: All holes and voids visible in video inspection of the pipe shall be completely filled by the Contractor with flowable fill, cementitious grout, or equal approved by the Engineer, prior to CIPP Pre-Installation Video Inspection. All materials shall be installed according to the manufacturer's recommendations. The finished surface of any material used to fill holes and voids shall be smooth and shall conform to the interior surface of the host pipe and not be visible as a bulge or dimple in the finished CIPP.

D. Pre-Installation Video Inspection: The section of storm sewer designated for CIPP shall to be televised its full length using a remote television camera in accordance with Section 13320 of these Specifications and shall be submitted to the Engineer for review. Note: See Article 2.02 J.1 of these specifications regarding additional work to be performed during Pre-video inspection activities. Camera shall have rotation of 300° (+/-) and equipped with a zoom lens.

3.05 Resin Impregnation of the CIPP Tube (Wet-Out)

A. The Contractor shall designate a location where the tube shall be impregnated or "wet out" with resin. The impregnated tube shall be free of pinholes, resin voids, and other defects. The quality management system for the wet-out facility must be registered in accordance with ISO 9001:2008. The quality management system must ensure that proper materials and amounts are used in the resin saturation process and in liner shipping and storage. The quality control documentation shall include resin lot numbers, volumes of resin, catalyst, enhancers, date of wet-out, storage/transportation controls, and quality assurance procedures. A checklist must be included documenting that each critical step in the resin impregnation process is checked off and initialed.

B. Care shall be taken in shipping, handling, and storage to avoid damaging the liner. Any liner damaged in shipment shall be replaced as directed by the Owner at no additional cost to the Owner.

3.06 Installation of CIPP

A. The liner material shall be inserted through a catch basin or other access point by a means and method authorized by the manufacturer until it has fully traversed the designated line length and the inversion face breaches the destination catch basin or termination point. Lubricant during inversion shall be used as necessary in

accordance with the CIPP manufacturer's recommendations. Care should be taken during tube installation not to over-stress the tube.

B. The Contractor shall maintain pressure requirements as defined by the manufacturer. The pressure used during the installation process shall be sufficient to hold the liner tight to the pipe wall and prevent wrinkles in the cured liner. The same pressure shall be great enough to prevent any infiltration from entering the pipeline during the curing process. The pressure shall be maintained for a time sufficient to allow any pockets of water to exfiltrate the host pipe, and to prevent lifts in the liner and resin washout.

C. When using pressurized air, particular attention should be given to the maintenance of the minimum required "finished and installed" thickness of the CIPP. Once the inversion has started, pressure shall be maintained between the minimum and maximum pressures until the inversion has been accomplished.

D. Liner Installation – The liner shall be securely attached to a winch and pulled into place taking care not to exceed pulling forces as stated in the manufacturer's installation protocol.

E. Liner Inflation – Liner shall be inflated per manufacturer's inflation process. Once inflate to working pressures, the liner shall fit tightly against the host pipe.

F. Pre-Curing Inspection – Once working inflation pressures are reached, the liner shall be inspected by an integrated CCTV on the light assembly. The entire length of the pipe shall be checked for proper fit and expansion of the liner system.

3.07 Curing

A. Follow the submitted cure schedule in curing the CIPP liner.

B. Curing must take into account the existing pipe material, the resin system, and the ground conditions (temperature, moisture level, and thermal conductivity of the soil).

C. Continuously monitor liner temperatures throughout the curing process. Continue curing uninterrupted until the CIPP liner is thoroughly cured from access-point to access-point.

D. Initial curing speeds will begin at a sufficient speed to ensure the first fifteen feet (15 ft) of the liner is cured properly. The working speed shall be increased to properly cure the remainder of the liner per the manufacturer's protocol. The same process will be reversed for the last fifteen (15 ft) of the liner, whereby the speeds and curing speeds will be slowed to allow the liner to cure properly.

3.08 Cool-Down

Cool-down of the cured pipe liner shall be in accordance with the manufacturer's recommendations. Care should be taken during the cool-down process so as to minimize shrinkage of the CIPP.

3.09 Termination and Sealing at Catch Basin Outlets

A. Termination of the cured-in-place pipe at the catch basin shall be completed by trimming the inverted pipe end back in accordance with the CIPP manufacturer's recommendations. If, in the judgment of the Engineer, the CIPP does not fit tightly against the storm sewer pipe at its termination point(s), the void between the host pipe and the CIPP shall be sealed by filling it with a resin mixture compatible with the CIPP at no additional cost to the Owner.

B. The Cured-in-place pipe inverts of lined-through catch basins shall remain in place as part of the finished CIPP. The finished CIPP shall be trimmed to match the profile of the existing interface between the pipe and catch basin wall or bench. The annular space between the CIPP and the host structure(s) shall be sealed with a Hydrotite™ style SS-0215 hydrophilic waterstop seal or Engineer approved equal. Any water entering or exiting the annular space between the catch basin and the finished CIPP after installation must be stopped by the Contractor by a method approved by the Engineer.

3.10 Testing of CIPP

A. The Engineer may, at its discretion, direct the Contractor to collect samples of the cured CIPP for laboratory determination of flexural strength, flexural modulus and wall thickness for each test sample. These three individual analyses shall comprise one completed test. All samples shall be collected per the sampling protocols set forth in ASTM F1216.

For each line segment, the Contractor shall remove one restrained sample of the installed liner at least twelve inches (12") in length for testing. The sample submitted shall be the exact same I.D. as the host pipe, samples caught in smaller diameter pipe shall not be acceptable. For each sample taken, the Contractor shall cut and deliver a twelve inches (12") in length representative sample (taken at least two inches [2"] from the end of the specimen) to the Engineer.

The sample delivered to the Engineer shall be labeled and removed from any restraining mold. The samples shall be taken in the presence of the Engineer. (NOTE: Any preliner tube material must be removed from the sample by the contractor before delivering the sample to the Engineer.)

B. The tests shall be used to verify that the installed CIPP meets these Specifications. CIPP thickness shall be measured in accordance with ASTM D5813. Flexural properties shall be determined per ASTM D790. The Contractor shall label and date all samples and deliver the samples directly to the Engineer.

C. Any liner that does not meet the specified strength and/or thickness requirements, regardless of the amount below the specified requirements, shall be corrected by the Contractor in a manner approved by the Engineer at no additional cost to the Owner. The Engineer's decision on how to correct deficient CIPP installations shall

be final. Options for correcting deficient liners that may be considered by the Engineer include removing the liner and re-lining the storm sewer, excavating and replacing the storm sewer from catch basin to catch basin, or providing the Owner with a credit. The primary option that will be considered will be to re-line the storm sewer. Credits will only be authorized for CIPP that does not meet required thickness. If a credit is acceptable to the Owner, the credit shall be calculated by multiplying the bid price by the percent that the liner thickness is below the required installed thickness as follows:

Credit = (1 – Installed CIPP thickness/required CIPP thickness) x bid price

The Contractor shall not assume a credit will be acceptable to the Owner under any circumstance. This would be the Owner's sole discretion.

3.11 Final Acceptance

A. Post-installation videos shall be conducted and submitted to the Engineer in accordance with Section 13320 of these Specifications. The finished CIPP shall be continuous over the length of pipe between two (2) catch basins and shall be an impermeable, joint-less conduit, free from visual defects such as foreign inclusions, dry spots, pin holes, lifts, or delamination. Camera shall have rotation of 300° (+/-) and equipped with a zoom lens. In order to be considered for payment, the post installation videos MUST include the pipe connections at both ends of the pipe.

B. Wrinkles in the CIPP, (other than minor, longitudinal pressure wrinkles) will not be acceptable. The Engineer shall determine as to the acceptability of pressure wrinkling with that decision being final. In the event the finished liner does not fit tightly against the original pipe at its termination point(s), the space between the liner and the pipe shall be made watertight, utilizing catch basin end seals, hydro-tite gaskets, or approved equal.

C. After curing of the resin is completed, the hardened CIPP shall extend from catch basin to catch basin of the section designated providing a structurally sound, corrosion-resistant, watertight conduit that excludes exfiltration and infiltration, is tight-fitting within the existing pipe, and is free of voids or annular spaces between the CIPP and the existing pipe walls. K-Factor for tightness shall equal 7.0 or greater. All terminations into catch basin walls shall be watertight at the time of final inspection. No annular space shall be visible between the CIPP and the catch basin wall. In the event that an annular space is present, it shall be completely filled with epoxy or other suitable material to the satisfaction of the Engineer.

D. The finished pipe must be such that when the thermosetting resin cures, the total wall thickness will be a homogeneous, monolithic composite matrix that will be chemically resistant to withstand internal exposure to domestic sewage. When cured, the CIPP must form a mechanical bond with the host pipe.

END OF SECTION