

STANDARD SANITARY SEWER REHABILITATION SPECIFICATIONS

MATERIAL SPECIFICATIONS FOR SANITARY SEWER REHABILITATION

Unless superseded or modified in the Detailed Specifications, all materials, apparatus, supplies, methods of manufacture, or construction shall conform to the specifications contained in this section. National material standards (ASTM, ANSI, AWWA, NSF, etc.) referred to herein shall be considered to be the latest revisions only.

A. CURED-IN-PLACE PIPE LINING

1. Product Requirements: Cured-in-place pipe (CIPP) lining shall be one of the following products:
 - Invert-A-Pipe by Improved Technologies Group
 - National Liner by National EnviroTech Group, LLC
 - Inliner by Inliner Technologies, Inc.
 - Insituform by Insituform Technologies, Inc.
 - Diamond Lining Systems by Daystar Composites LLC
 - Premier-Pipe USA by J.W.M. Environmental, Inc.

The above products shall adhere to all requirements specified herein and shall be modified as necessary to meet these requirements.

The liner shall be composed of tubing material consisting of one or more layers of a flexible non-woven polyester felt with or without other additives such as fiberglass or other reinforcing additives. The felt tubing shall be impregnated with a thermosetting isothalic polyester resin and catalyst or vinyl ester and catalyst. The liner material and resin shall be completely compatible. The inside and/or outside layer of the tube shall be coated with an impermeable material compatible with the resin and fabric. The liner shall cure in the presence of water at the required temperature for the resin system. Steam-cure shall not be allowed unless approved by the Engineer in writing.

The felt material shall be manufactured by companies specializing in felt production for CIPP. The manufacturer shall have manufactured felt material for CIPP for at least 2 years as documented by references. The felt manufacturer, references and location of the manufacturing facility shall be submitted to the Engineer for review and approval. The felt material manufacturer and facility shall not change during construction unless specifically approved by the Engineer in writing.

The polyester or vinyl ester resin shall be PREMIUM, NON-RECYCLED resin only. Polyethylene Terephthalate (PET) resins, or those containing fillers, additives or enhancement agents shall not be used. The resin manufacturer shall not include any old resin or rework in the product shipped to the wet-out facility (i.e., where the liner

is impregnated with the resin). The resin shall be manufactured under ISO 9002 certified procedures. Such certification shall be submitted to the Engineer for each shipment of resin to the wet-out facility. The proposed resin shall equal or exceed the published properties of Reichhold PolyLite 33420 resin (for isothalic polyester resin) or Reichhold Atlac 580-20 (for vinyl ester resin).

The exact makeup of the resin shall be submitted to the Engineer including chemical resistance information, cure logs and temperatures. Polyester resins shall have a minimum Heat Distortion Temperature of 212°F per ASTM D648. Vinyl ester resins shall have a minimum Heat Distortion Temperature of 220°F per ASTM D648.

The exact mixture ratio of resin and catalyst shall also be submitted. The catalyst system shall be identified by product name. The resin/catalyst ratio shall be approved by the resin manufacturer in writing. 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 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. The resin/catalyst system shall be formulated so that the CIPP will cure as specified below. Quick-cure or accelerated resin systems that cure in half the specified time or substantially quicker than the minimum 3 hours specified below will not be allowed. Quick-cure resin systems include those formulated by substantially increasing the amount of catalysts from that specified above. Resins, catalysts and resin/catalysts mixing ratios shall not be changed during this Contract unless specifically approved by the Engineer in writing.

The cure schedules for the CIPP shall be submitted to the Engineer for review. The curing process/schedules shall be approved by the resin manufacturer in writing. The cure schedules shall include specific information on stepping the temperature up to “cooking” temperatures, “cooking” temperatures and durations, and cool-down procedures – all to be approved in writing by the resin manufacturer.

The resin shall be shipped directly from the resin manufacturer’s facility to the CIPP wet-out facility. The resin shall not be sent to any intermediate mixing facility. Copies of the shipment documents from the resin manufacturer shall be submitted to the Engineer showing dates of shipment, the originating location and the receiving location.

The resin shall be used to manufacture the CIPP as shipped. No fillers or additives shall be added at the wet-out facility except for the required catalyst as recommended by the resin manufacturer. The Contractor shall submit the catalyst product and quantity recommended by the resin manufacturer (submittal to include direct correspondence from the resin manufacturer). The Contractor shall also submit a Certificate of Authenticity from the resin manufacturer for each shipment to the wet-out facility (to include the date of manufacture and the Heat Distortion Temperature).

This information shall be submitted prior to manufacturing any CIPP.

The application of the resin to the felt tubing (i.e., wet-out) shall be conducted under factory conditions and the materials shall be fully protected against ultraviolet (UV) light, excessive heat and contamination at all times.

The Contractor shall identify the wet-out facility where all CIPP will be manufactured. All CIPP shall be manufactured from this designated wet-out facility unless specifically approved otherwise by the Engineer in writing. Multiple wet-out facilities shall not be allowed.

The Engineer, Owner and/or an agent of the Owner may inspect the CIPP during manufacturing (i.e., wet-out). The Contractor shall submit a schedule for manufacturing the CIPP to the Engineer every Friday for the following week. The Engineer and Owner must be given an opportunity to witness the manufacturing of all CIPP. If the CIPP is manufactured without providing the required notice to the Engineer, the CIPP will be marked as rejected prior to installation and will not be approved for installation.

If the Engineer and/or Owner decide to inspect the manufacturing of the CIPP, the Contractor shall provide full access to witness the wet-out process and shall provide any and all information related to the manufacturing as requested by the Engineer, Owner or the Owner's agent without delay and without claims of confidentiality or product privacy.

The Engineer or Owner may take samples of the resin from the wet-out facility for infrared (IR) analyses (i.e., IR Scan) throughout the duration of construction. This standard analytical test involves shining a beam of light in the IR frequency region through a thin sample of the subject resin. The frequency of light is then varied across the IR spectrum. Chemical functional groups present in the resin being analyzed will absorb IR light as specific frequencies and with characteristic absorption intensities.

The Owner will pay for all such IR analyses and resin testing. To allow the resin samples to be taken, the Contractor shall place a sampling valve in-line at a point prior to the resin/catalyst mixing stage and after the resin/catalyst mixing stage. These sampling valves shall remain in place throughout the duration of construction and shall always be accessible to the Engineer and Owner.

The IR analyses will be used to verify that the resin and resin/catalyst composition and mixture being used is the approved resin and resin/catalyst system. Payment will not be made for any CIPP manufactured with unapproved resin and resin/catalyst mixtures. The Contractor shall submit results of IR analyses of the proposed resin and resin/catalyst mixture, performed and certified by the resin manufacturer, prior to manufacturing any CIPP as a shop drawing. The results of these analyses (the resin's chemical fingerprint) will be used as the standard for verifying the resin and

resin/catalyst mixture being used throughout construction.

The Engineer will compare the submitted chemical fingerprint with the fingerprint of Reichhold PolyLite 33420 resin (for isothalic polyester resin) or Reichhold Atlac 580-20 (for vinyl ester resin) for a baseline comparison. The Contractor and resin manufacturer shall fully describe, explain and justify any differences between the Reichhold and proposed resin fingerprints without delay or claim to confidentiality.

When cured, the CIPP shall form a continuous, tight-fitting, hard, impermeable liner, which is chemically resistant to any chemicals normally found in domestic sewage. The liner shall be chemically resistant to trace amounts of gasoline and other oil products commonly found in municipal sewerage and soils adjacent to the sewer pipe to be lined.

The CIPP shall be fabricated to a size that will tightly fit the sewer being rehabilitated after being installed and cured. The liner shall be capable of fitting into irregularly shaped pipe sections and through bends and dips within the pipeline. Allowance for longitudinal and circumferential expansion shall be taken into account when sizing and installing the liner. All dimensions shall be verified in the field by the Contractor prior to fabrication of the liner. Field measurements shall be used to ensure maximum closure between the new liner and the existing sewer pipe. There shall be no leakage of groundwater between the existing pipe and the CIPP at the manhole connection or service lateral connections. Any leakage found shall be eliminated by the Contractor at no additional cost to the Owner.

The length of the liner shall be the length deemed necessary by the Contractor to effectively carry out the insertion of the liner and sealing of the liner at the outlet and inlet manholes. The required length of liner shall be verified in the field by the Contractor prior to fabrication of the liner.

The cured liner shall have the following minimum structural properties:

- Flexural Strength of 4,500 psi per ASTM D790
- Flexural Modulus of 250,000 psi per ASTM D790
- Tensile Strength of 3,000 psi per ASTM D638

The Contractor shall submit complete shop drawings of CIPP to demonstrate compliance with these specifications, to show materials of construction (including resins, catalysts, etc.) and to detail installation procedures. Installation procedures shall include acceptable inversion heads and pressures, heating (i.e., cooking) and cool-down procedures and temperatures, times for each stage of the process, and cure logs for the resin/resin system used. The Contractor shall provide this information without delay or claim to any confidentiality. Testing procedures and quality control procedures shall also be submitted.

Certifications that the CIPP was manufactured in accordance with these specifications

and the appropriate ASTM standards shall be submitted with each shipment. The certifications shall include a signed statement by the wet-out manager/supervisor that no fillers were added to the resin system during manufacture of the CIPP. In addition, wet-out forms documenting the wet-out shall be submitted for each section of CIPP manufactured. The wet-out forms shall be submitted prior to requesting payment and shall be provided without delay or claim to any confidentiality. The wet-out forms shall document the date and time of wet-out, the wet-out supervisor, the wet-out facility address, the location where the CIPP will be installed (by work order and manhole numbers), the CIPP diameter, the length of wet-tube and dry-tube, the thickness of the CIPP, the roller gap setting for establishing the liner thickness, the felt manufacturer, the resin used (by product name and batch/shipment number) and quantity, the catalyst(s) used (by product name) and quantity, any quality control samples taken, and all else pertinent to the wet-out process.

2. Liner Thickness: The Contractor shall submit liner thickness calculations to the Engineer for review. The CIPP shall be designed in accordance with the applicable provisions of ASTM F1216 and ASTM D2412 for “fully deteriorated gravity pipe conditions” and shall meet the following design conditions:
 - a. AASHTO H-20 Live Load with two trucks passing over CIPP in streets (16,000 lbs).
 - b. A soil modulus of elasticity of 1,000 psi, soil weight of 120 pounds per cubic foot and a coefficient of friction of $K_u = 0.130r$.
 - c. Short-term flexural modulus of 250,000 psi and long-term flexural modulus of 125,000 psi. Flexural strength of 4,500 psi.
 - d. Safety factor of 2.0 shall be used.
 - e. Groundwater elevation at the ground surface.
 - f. Pipe ovality of 2%.
 - g. Poisson’s ratio of 0.3.
 - h. Enhancement factor (K) of 7.
 - i. Service temperature range shall be 40°F to 140°F.
 - j. Maximum long term deflection shall be 5 percent.
 - k. The installed, cured thickness shall be the largest thickness as determined by calculations for deflection, bending, buckling and minimum stiffness. The minimum installed, cured liner thickness shall be as follows, regardless of what the calculations indicate as the required minimum thickness:

8" sewer:	6 mm up to 17 feet deep 7.5 mm up to 25 feet deep
10" sewer:	6 mm up to 11 feet deep 7.5 mm up to 18 feet deep 9 mm up to 25 feet deep
12" sewer:	7.5 mm up to 12 feet deep 9 mm up to 18 feet deep 10.5 mm up to 25 feet deep
15" sewer:	7.5 mm up to 10 feet deep 9 mm up to 14 feet deep 10.5 mm up to 20 feet deep

The installed thickness shall be measured as specified elsewhere herein. The Contractor shall submit his proposed plan for ensuring that the installed CIPP meets the above minimum thickness requirements. The plan shall include the proposed CIPP thickness to be installed (pre-installation thickness) and detailed inversion or pull-in procedures to reduce stretching and to reduce migration of resin.

3. Reference Standards: The following American Society for Testing and Materials (ASTM) standards are referenced herein:
 - a. ASTM D638 - Standard Test Method for Tensile Properties of Plastics
 - b. ASTM D790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - c. ASTM D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
 - d. ASTM D5813 – Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems
 - e. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
 - f. ASTM F1743 – Standard Practice of Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)

Where reference is made to one of the above standards, the latest revision shall apply.

B. MANHOLE LINING

1. Cementitious Manhole Lining System: The cementitious manhole lining system for the interior of manholes shall be a monolithic system suitable for use as a trowel or spray-applied monolithic surfacing in sewer manholes. The cementitious lining system shall be one of the following products or approved equal:

- Strong Seal MS-2A, MS-2C, or High Performance by Strong Seal Systems
- QM-1s Restore or Aluminaliner by Quadex
- Cemtec Silatec MSM or CAM by A.W. Cook Cement
- Sewpercoat PG by Kerneos, Inc.
- Permacast MS-10,000 or CR-5000 by Action Products Marketing Corp.
- PerpetuCrete MSC or CA by Protective Liner Systems
- Mainstay ML-72, ML-CA or ML-PF by Madewell
- Reliner MSP or Maximum CA Cement by Standard Cement Materials

Where hydrogen sulfide resistance is required and when specified by the Engineer, the cementitious lining system shall be a 100% calcium aluminate product (product comprised of calcium aluminate cement and calcium aluminate aggregate). Partial calcium aluminate products (or blended products) shall not be considered an equal and shall not be approved. The 100% calcium aluminate products shall be one of the following products or approved equal:

- High Performance by Strong Seal Systems
- Sewpercoat PG by Kerneos, Inc.
- Mainstay ML-PF by Madewell
- Maximum CA Cement by Standard Cement Materials

The cementitious lining system shall be a pumpable cementitious mortar product specifically for manhole rehabilitation and shall be installed via low-pressure application only. The materials shall be suitable for all the specified design conditions.

The cementitious lining shall be installed on the benches and walls of existing manholes as shown in the Details. All cementitious lining shall be troweled smooth after spray application. The cured cementitious lining shall be applied to a minimum total thickness of 1 inch.

The cured surfacing thickness shall be smooth, even (without ridges or bumps) and continuous with proper sealing connections to all unsurfaced areas.

The materials used in the cementitious lining systems shall be mixed on site in accordance with the manufacturer's recommendations. Water shall only be added to the materials during the mixing process and prior to material pumping or spray application. No water shall be added at the nozzle.

The cementitious liner when cured shall have the following minimum characteristics at 28 days as measured by the applicable ASTM standards referenced herein:

Minimum compressive strength of 6,000 psi
Minimum bond strength of 130 psi
Shrinkage of less than 0.05%

The cementitious lining shall provide a minimum service life of 25 years.

The cured cementitious lining shall be continuously bonded to all the brick, mortar, concrete, chemical sealant, grout, pipe and other surfaces inside the sewer manhole. Provide bond strength data on cured, cementitious lining based on ASTM test methods referenced herein.

Chemical sealants or grouts used to seal active manhole leaks, to patch cracks, to fill voids and to otherwise prepare the manhole surfaces for the lining installation shall be suitable for the intended purpose and shall be compatible with the lining as certified by the manufacturer.

When cured, the monolithic cementitious lining shall form a continuous, tight-fitting, hard, impermeable surfacing which is suitable for sewer system service and chemically resistant to any chemicals or vapors normally found in domestic sewage.

The monolithic cementitious lining shall cover the complete interior of the existing sewer manhole including the benches (shelves). The lining shall effectively seal the interior surfaces of the sewer manhole and prevent any penetration or leakage of groundwater infiltration.

The lining shall be compatible with the thermal condition of the existing sewer manhole surfaces. Surface temperatures will range from 20oF to 100oF. Provide test data on shrinkage of the cementitious lining based on the ASTM standards referenced herein.

All invert channels shall be coated with grout or cementitious mortar to build up the invert channel to the invert elevations of the new liner pipes; to fill all voids, cracks, holes, etc.; and to form a smooth flow channel. The entire channel shall be coated. The coating shall be a minimum ¼-inch thick.

The Contractor shall submit complete shop drawings of manhole lining system to demonstrate compliance with these specifications, to show materials of construction and to detail installation procedures. Testing procedures and quality control procedures shall also be submitted. Certifications that the manhole lining was manufactured in accordance with these specifications and the appropriate ASTM standards shall be submitted with each shipment.

2. Epoxy Manhole Lining System: In some applications, the Engineer may specify that

an epoxy product be installed for hydrogen sulfide protection in lieu of the specified 100% calcium aluminate products. The minimum thickness of the epoxy coating shall be 160 mils. The epoxy shall be Raven 405 by Raven Lining Systems, NPR-5300 by NeoPoxy International, or approved equal.

3. Outside Coating: Whenever the outside of exposed manholes walls are specified to be coated with a special exterior cementitious mortar product, the exterior mortar shall be HB2 Repair Mortar by ThoRoc, SikaTop 123 by Sika Corporation, or approved equal.

C. PIPE BURSTING

1. Product Requirements: Replacement pipe installed by pipe bursting shall be high density polyethylene (HDPE) pipe. The pipe shall be manufactured from a high density, high molecular weight polyethylene resin which conforms to ASTM D1248 and meets the requirements for Type III, Class A, Grade P34, Category 5 and has a Plastic Pipe Institute (PPI) rating of PE 3408 when compounded. The pipe produced shall have a minimum cell classification of 345434D or 345434E under ASTM D3350. The HDPE installed shall be minimum SDR 17 and shall be capable of supporting the full-bearing load. Contractor shall submit thickness calculations. Sections of HDPE shall be butt-fused in accordance with the HDPE manufacturer's specifications.
2. Service Connections: Connection of the new service lateral to the mainline shall be accomplished by means of a compression-fit service connection saddle or an electrofuse saddle. The service connection shall be specifically designed for connection to the sewer main being installed, and shall be Romac CB Saddle as manufactured by Romac Industries, Inc., Central Plastics Electrofuse Saddle, or approved equal.
3. Reference Standards: The following American Society for Testing and Materials (ASTM) standards are referenced herein:
 - a. ASTM D1248 Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
 - b. ASTM D3350 Standard Specification for Polyethylene Plastic Pipe and Fittings Materials

Where reference is made to one of the above standards, the latest revision shall apply.

D. INJECTION GROUTING

1. Product Requirements: The grout used to completely stop identified leaks shall be Hydro Active Cut by DeNeef Construction Chemicals or approved equal.

The grout shall be suitable for injection and shall expand to seal identified leaks. The grout shall be installed per the manufacturer's recommendations. The material shall be suitable for all the specified design conditions.

The grout shall provide a minimum service life of 25 years. When cured, the grout shall be suitable for sewer system service and chemically resistant to any chemicals or vapors normally found in domestic sewage. The grout shall be compatible with the thermal condition of the existing sewer manhole surfaces. Surface temperatures will range from 20°F to 100°F.

The grout shall effectively seal the identified leak in the sewer manhole and prevent any penetration or leakage of groundwater infiltration at this location or other nearby locations or within the same pre-cast manhole joint as a direct result of the injected grout.

The Contractor shall submit complete shop drawings of the injectable grout to demonstrate compliance with these specifications, to show materials of construction and to detail installation procedures. Testing procedures and quality control procedures shall also be submitted.

DETAILED SPECIFICATIONS FOR SANITARY SEWER REHABILITATION

A. CURED-IN-PLACE PIPE LINING

1. Qualifications: The Contractor performing the CIPP lining work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be certified and/or licensed as an installer by the CIPP manufacturer. The Contractor shall have installed a minimum of 300,000 feet of CIPP for a minimum of five years. The full-time, on-site superintendent/foreman that will supervise the CIPP installation shall have installed at least 150,000 feet of a cured-in-place pipe lining system for a minimum of two years. The total footage claimed shall be supported by Owner references. The Contractor shall submit information to document his experience and the experience of the proposed superintendent/foreman.
2. Delivery, Storage and Shipping: Care shall be taken in shipping, handling and laying to avoid damaging the CIPP. Extra care shall be taken during cold weather construction. Any CIPP damaged in shipment shall be replaced as directed by the Engineer. Any CIPP showing a split or tear or has been mishandled shall be marked as rejected and removed at once from the work site. The liner shall be maintained at a proper temperature in refrigerated facilities to prevent premature curing at all times prior to installation. Any liner showing evidence of premature curing will be rejected for use and will be removed from the work site immediately.
3. Cleaning and Television Inspection of Main Sewers Prior To Installing CIPP Lining: The Contractor shall first thoroughly clean and televise the sewer and submit one copy of the final television inspection videos to the Engineer for review as specified herein.

The Contractor's cleaning operations shall fully clean the sewers and remove all roots, grease and debris to facilitate the CIPP lining installation. The cleaning shall be performed prior to the pre-rehabilitation television inspection. No cleaning equipment shall be in the sewers while the pre-rehabilitation CCTV inspections are being performed. Acceptance of the cleaning portion of the work shall be dependent upon the results of the pre-rehabilitation television inspection. Lines not acceptably clean as to permit television inspection or the subsequent lining installation shall be re-cleaned, re-inspected and re-submitted to the Engineer for review at no additional cost to the Owner.

The equipment used for the cleaning operations shall be specifically designed for cleaning sewers. The Contractor shall use the appropriate equipment to clean all debris, roots and grease from each sewer segment thoroughly. The required equipment may be high velocity water jet cleaning equipment with various attachments or mechanical cleaning equipment such as power buckets or power rodders. The Contractor shall select the cleaning equipment and procedures based on the conditions of the sewers at the time the work commences. All solids shall be removed at the downstream manhole of the section being cleaned - passing material

from one sewer segment to another will not be permitted. Cleaning operations shall begin at the most upstream sewers and proceed downstream. The solids shall be removed from the site and properly disposed of at approved locations provided by the Contractor. A Vehicle Mounted Permit from CMUD will be required to obtain water from fire hydrants for cleaning operations.

The Contractor shall take precautions to avoid damage or flooding to public or private property being served by the line being cleaned. The Contractor shall be responsible for all flooding and pay for cleanup from flooding to the satisfaction of the property owner. The Contractor shall document all backups and submit documentation to the Engineer including the reason for the backup, the time and date of the backup, the property owner's name, address and phone number, the resolution to problem, the time and date the problem was resolved, and any special cleanup work that had to be performed. This required documentation shall be submitted for all backups regardless of when they occur.

All cleanup shall be completed within 4 hours of the backup. The Contractor shall take care in cleaning older sewers and shall protect existing sewers from damage caused by improper use of cleaning equipment.

After the sewers are completely cleaned, the sewers shall be inspected via closed circuit television (CCTV). The purposes of the CCTV inspections are to verify that the sewers have been thoroughly cleaned, to document the condition of the existing sewers and the locations of service connections, to locate sewer defects requiring repair prior to lining, and to confirm that the lining can be properly installed and cured. The Contractor shall use extreme caution during all cleaning and television inspection work, as the sewer mains are likely old and may be in poor structural condition.

Upon completion of the cleaning and television inspection work, the Contractor shall submit one copy of the final CCTV inspection videos to the Engineer. The videos shall be clearly labeled as to their contents. The final inspection shall mean that the sewer has been completely cleaned (no roots, debris or grease), the inspection is complete from manhole to manhole without the need for a reverse setup unless otherwise approved, and all protruding service connections have been cut flush with the existing pipe wall. If point repairs, service lateral replacements or manhole replacements are performed after the inspections are submitted, it shall be the Contractor's responsibility to confirm that the work was performed properly, including proper alignment, grade and connection to the existing sewer (no offset joints) and that no debris has entered the sewer. Any problems with the work shall be corrected by the Contractor prior to CIPP installation or such corrections will be required after the liner installation if the problems are evident from the post-rehabilitation CCTV inspections.

4. Removal of Protruding Service Connections: Service connections that are protruding into the main sewer shall be cut flush with the pipe wall prior to installing the CIPP.

The cutting shall be accomplished using an internal robotic cutter specifically designed for such work. The internal remote cutter shall be capable of cutting PVC, vitrified clay, cast iron, ductile iron and orangeburg pipe. All cut pieces of the service connection shall be removed from the main sewer pipe. The Engineer will not approve payment for excavating protruding services in lieu of cutting them internally unless there is a specific reason or circumstance in which the lateral cannot be cut.

5. Installation: The Contractor shall clean and televise each length of pipe to be lined as specified. Prior to lining the main sewer and the pre-rehabilitation television inspection, protruding service lateral connections shall be internally cut/ground down flush with the pipe wall with a robotic cutter specifically designed for this purpose and all required point repairs shall be completed. The internal cutter shall be capable of cutting cast iron, PVC, vitrified clay pipe, ductile iron pipe and orangeburg pipe.

The Contractor shall notify all property owners that will be affected by the work 72 hours in advance of the work, giving the date, start time and estimated completion time for the work being conducted and the expected impacts to the property owner.

The Contractor shall bypass pump sewage flows around the lining work while it is being performed. The Contractor will be required to submit, for approval by the Engineer, a detailed plan of the method the Contractor proposes in order to maintain the existing flow during construction. The plan must include a provision for handling the existing peak flow by pumping. When pumping is used, an identical standby pump(s) shall be on site in the event of failure of the primary pump(s).

If, at any time during construction, effluent from the existing sewer is not fully contained by the bypass system, gravity service will be restored and work shall be suspended until the problem is resolved to the satisfaction of the Engineer. This includes wastewater flow into trenches during excavation work. Sewer system overflows will not be tolerated. All fines imposed on the Owner associated with overflows caused by the Contractor's work shall be paid by the Contractor.

The Contractor shall furnish and install the CIPP lining in the full length of sewer. The installation of the CIPP shall be in complete accordance with the applicable provisions of ASTM F1216 or ASTM F1743, these specifications and the manufacturers' specifications.

Water shall be used to invert CIPP installed via ASTM F1216 or to invert the calibration hose through CIPP installed via ASTM F1743. Air shall not be used to invert the CIPP or calibration hoses under any circumstances. The water inversion of the CIPP and calibration hoses shall be accomplished by using natural water pressure (head) only. Natural water pressure shall be achieved by erecting platforms or scaffolding to an elevation determined by the Contractor necessary to provide adequate inversion heads (pressure). CIPP installation vessels/units of any kind used to create water pressure shall not be used. Water pressure shall not be varied by any means throughout the inversion process except by increasing the height of the

platform/scaffolding when approved by the Engineer. The Contractor shall submit required inversion heads for each installation as a shop drawing without delay and claim to confidentiality or product/installation privacy.

Where possible, the Contractor shall line multiple sewer segments at one time as determined by the Contractor. When this is done, the top one-half of the liner in the intermediate manhole shall be neatly removed, and the void behind the liner pipe shall be filled with non-shrink grout. The manhole bench shall be reconstructed if necessary to make a smooth transition at no additional cost to the Owner.

There shall be no leakage of groundwater into the manhole between the CIPP and existing sewer pipe and between the existing sewer pipe and manhole wall. A hydrophilic waterstop (non-bentonite) comprised of modified chloroprene rubber shall be installed 6 inches from each manhole wall prior to processing the liner to provide additional waterstop protection. As the CIPP is expanded, the waterstop shall be pressed tightly between the liner and existing sewer to provide a leak-tight seal. The waterstop shall be Hydrotite as manufactured by Greenstreak (St. Louis, Missouri) or a pre-approved equal. The Contractor shall submit detailed drawings of the pipe-manhole connections to the Engineer for approval, including termination points in manholes and transitions with manhole linings where installed.

The CIPP shall cure in the presence of water only. The minimum cure (i.e., cook) time shall be 3 hours at 180°F. The cure time shall be increased as deemed necessary by the Contractor/resin manufacturer, including but not limited to, longer CIPP installations, active ground water infiltration into the existing sewers, pipe type, pipe location, etc.

The CIPP shall be neatly cut 2 inches from the manhole walls after installation and cure to facilitate the application of the 1-inch thick cementitious manhole coating where required.

The Contractor shall fully reopen all of the existing active service connections in each length of sewer following lining. The service connections shall be reopened from inside the sewer by means of a CCTV camera controlled cutting device appropriate for the CIPP. All openings shall be clean and neatly cut and shall be flush with the lateral pipe. The openings shall also be buffed with a wire brush to remove rough edges and provide a smooth finish. The bottom of the openings shall be flush with the bottom of the lateral pipe to remove any lip that could catch debris. Openings shall be 100% of the service lateral pipe. The Contractor shall re-open any service lateral that does not meet this requirement as evidenced by the post-rehabilitation inspections at no additional cost to the Owner. The Contractor shall be fully responsible for all backups and damage caused by not fully opening a lateral connection, including paying all costs associated with repairing damage as required by the Engineer, Owner and/or property owner.

Installation reports shall be generated for each segment of liner installed. The reports

shall document installation, including manhole numbers, street names/sewer location, project number, date, time, temperature, curing temperature, curing time, liner thickness, etc. A sample report shall be submitted to the Engineer for approval prior to installing any lining. The reports shall be submitted to the Engineer prior to requesting payment.

6. Post-Rehabilitation Television Inspection: Following installation of the CIPP, reopening and brushing the service connections, and completion of all manhole rehabilitation work including vacuum testing, the Contractor shall conduct a final post-rehabilitation television inspection of the completed work to verify that the liner installation is acceptable as defined in the Sanitary Sewer Rehabilitation Material Specifications.

Payment will not be made for the installed CIPP or the cementitious coating of the manholes until the post-rehabilitation CCTV inspections are submitted and approved by the Engineer.

The Owner will consider payment of the installed CIPP prior to completion of the manhole rehabilitation work and the above specified final post-rehabilitation CCTV inspections if the Contractor performs preliminary CCTV inspections of the installed liner. The preliminary inspections must be performed after all service connections are fully opened and brushed and must be submitted to the Engineer for review. The inspections must clearly show the installed CIPP from manhole to manhole and each service connection to demonstrate that the installed CIPP meets the requirements of the Material Specifications of the Design Manual.

Logs must be submitted with the preliminary inspections. The submittal and approval of preliminary CCTV inspections does not waive the requirement for the final post-rehabilitation inspections specified above. Payment will not be made for cementitious coating of manholes until the final post-rehabilitation CCTV inspections are submitted and approved by the Engineer.

7. Acceptance Tests: For every sewer segment that is lined (sewer segment is defined as the sewer between two manholes), the Contractor shall remove one restrained sample of the installed liner at least 12 inches in length for testing of installed CIPP flexural properties and thickness. The CIPP testing shall include determining flexural strength, flexural modulus, tensile strength and thickness of each sample. These four separate individual tests make up one completed CIPP test. Payment will be made for each completed CIPP test at the unit price bid after the test results are submitted to the Engineer.

For sewers 12 inches in diameter and smaller, the sample shall be captured by installing the lining through a section of PVC pipe (same diameter as the existing sewer diameter) within the most downstream manhole of the installation and at all intermediate manholes if multiple sewer segments are lined at the same time. For sewers 15 inches in diameter and larger, plate samples shall be taken and cured in the

same water as the installed CIPP.

The Contractor shall be responsible for capturing the samples and preparing the samples for testing (i.e., cutting the samples to the required dimensions, removing the PVC pipe, etc.). The testing laboratory shall specify the dimensions for the samples. In addition, the Contractor shall cut a 1-inch wide representative sample (taken at least 2 inches from the end of the specimen) for the Engineer's records. The Contractor shall label all samples including writing on the samples where they were taken (manhole numbers and work orders) and the date they were taken.

Each day, the Contractor shall submit the samples taken that day to the Engineer. The Engineer will forward the samples to the testing laboratory. The Contractor shall select the independent testing laboratory and shall pay the laboratory for all tests. The Engineer will copy the Contractor on all submittals to the testing laboratory. The testing laboratory shall submit all test results directly back to the Engineer with a copy to the Contractor. The test results shall be returned to the Engineer within 21 days from the laboratory receiving the samples. If the results are not received in this timeframe, payment will be withheld. It shall be the Contractor's responsibility to ensure that the laboratory meets the specified schedule.

All testing shall be performed by an independent, ASTM-certified testing laboratory. The Contractor shall submit the name and location of the testing laboratory along with a certified statement from the laboratory that they are independent from and not associated with the Contractor in any way for approval. The testing laboratory shall also submit their ASTM certification. The Contractor shall consider utilizing a local testing laboratory for these services.

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. Tensile strength shall be determined per ASTM D638.

Any lining that does not meet the specified installed 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 liner that will be considered by the Engineer include removing the liner and re-lining the sewer, excavating and replacing the sewer from manhole to manhole, re-lining sewers completely from manhole to manhole, installing a sectional CIPP patch to repair the defective area.

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

$$\text{Credit} = (1 - (\text{installed CIPP thickness}/\text{min required thickness})) \times \text{Bid Price}$$

The Contractor shall not assume that a credit will be acceptable to the Engineer or Owner.

If a CIPP patch is approved as a repair method, the Owner will not pay the full bid price for that sewer segment (manhole to manhole). The price reduction (credit) shall be negotiated with the Contractor and shall be acceptable to the Owner. The credit shall be equal to at least 25% of the unit price bid for the CIPP installation and shall apply to the entire CIPP lining from manhole to manhole. The Owner shall have the final decision on the amount of the credit.

In addition, there shall be no groundwater leakage through the CIPP or between the liner and the existing pipes. Any leakage shall be completely eliminated in a manner approved by the Engineer. Options for eliminating leaks that will be considered by the Engineer include installation of specialized grout by injection methods and sealing leaks with specialized waterstop materials.

Following installation of the CIPP, reopening and brushing of all active service lateral connections, and completion of all manhole rehabilitation including vacuum testing, the Contractor shall conduct a final post-rehabilitation CCTV inspection of the completed work to verify that the liner installation is acceptable as defined herein. The sewers shall be thoroughly cleaned prior to performing the CCTV inspections, and the pipe shall be dry so that the entire CIPP can be seen. This will require that temporary plugging or bypass pumping be provided for all post-rehabilitation CCTV inspections.

The Contractor shall submit a sample television inspection after the final inspection of the first section of sewer is performed so that the Contractor and Engineer can agree on performance and quality of the inspections which must be met throughout the Contract. Sewers not inspected to the Engineer's satisfaction shall be re-inspected by the Contractor at no additional cost to the Owner.

One copy of the final post-rehabilitation videos shall be submitted to the Engineer for review and approval. The videos must be clearly labeled as to their contents. In addition, they must be in order or they will be returned to the Contractor. If post-rehabilitation inspections on the submitted videos are not approved by the Engineer, the videos will be returned to the Contractor. The Contractor shall remove all unapproved sewers from the videos so that the final videos submitted to the Engineer include only those sewers approved and acceptable. The Contractor shall provide correct counter numbers on the videos after all such editing is performed.

Payment will not be made for any sewer lining until the Engineer has reviewed and approved the final videos. As mentioned previously, the Owner will consider payment of the CIPP lining based on preliminary television inspections. In either

case, the Contractor shall submit the required videos a minimum of 10 days in advance of any payment request to provide the Engineer ample time to review the information.

There shall be no holes, dry spots, lifts, ribs, wrinkles, ridges, splits, bulges, cracks, delaminations or other type defects in the CIPP lining unless predicted in writing by the Contractor prior to lining. Defective lining or groundwater leakage shall be repaired in a manner suitable to and approved by the Engineer at no additional cost to the Owner.

B. MANHOLE LINING

1. Qualifications: The cementitious product and epoxy product shall have been manufactured for installation specifically in manholes for at least five years. The cementitious and epoxy product shall have been installed in at least 5,000 manholes. References that are documented and that can be verified shall be submitted to demonstrate that the cementitious product meets these requirements. Contact names and numbers shall be included with the references.

In addition, the Contractor performing the work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be an approved installer as certified and licensed by the manufacturer. The Contractor shall have held such certification by the manufacturer to install the specific product being used for a minimum of one year prior to the bid date. The Contractor, as a company, must have at least three years of experience coating manholes with cementitious mortar and/or epoxy product (whichever product is being applied) and shall have successfully installed a cementitious lining and/or epoxy product (whichever product is being applied) in a minimum of 1,000 manholes as documented by verifiable Owner references. Further, the Contractor's proposed superintendent/foreman for the work under this Contract shall have successfully installed a cementitious lining product and/or epoxy product (whichever product is being applied) in a minimum of 500 manholes as documented by verifiable Owner references. The Contractor shall submit information to demonstrate that he meets the experience requirements.

2. Delivery, Storage and Shipping: Care shall be taken in shipping, handling and placing to avoid damaging the lining products. Any lining product damaged in shipment, showing deterioration, or which has been exposed to any other adverse storage condition that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work. While stored, the lining products shall be adequately packaged and protected. The lining products shall be stored in a manner as recommended by the manufacturer.
3. Installation: The Contractor shall clean each sewer manhole to be surfaced and shall dispose of any resulting material. The cleaning shall be performed using a high power jet wash at a minimum of 3500 psi water pressure to remove all dust,

biological growths, grease, oil, paint or any other surface contaminants or coatings. Coatings that cannot be removed shall be sanded with coarse sand paper to rough the surface sufficient to obtain and insure adequate bonding of the cementitious lining. Roots shall be removed by manually cutting the roots from inside the manhole.

The Contractor shall conduct a visual inspection of each manhole after it is cleaned. All active, hydrostatic infiltration leaks shall be plugged or sealed with an appropriate grout compatible with the cementitious or epoxy lining. Injection grouting may be required to seal active leaks including leaks in existing invert channels and benches. All loose mortar and rubble of existing walls, benches and inverts shall be removed. The Contractor shall prepare the manhole to receive cementitious or epoxy lining as necessary by reshaping and repairing benches, inverts, and walls where required including smoothing out irregular shaped corbel and chimney sections prior to spray application. All interior surfaces shall be prepared as recommended by the manufacturer. Minimum requirements are as listed below.

- a. All cracks and other voids must be repaired and filled with suitable non-shrinking cements, sealants or grouts, including all voids between the existing sewer pipes and manhole walls. All patches shall be smooth and even with the manhole wall.
- b. All voids around existing manhole rungs/steps shall be filled.
- c. All surfaces shall be suitably prepared for the required bonding of the Cementitious or epoxy lining as recommended by the manufacturer.

The Contractor shall notify all property owners who discharge sewage directly to the manhole being rehabilitated 72 hours in advance, giving the date, start time and estimated completion time for the work being conducted and the impacts to the property owner.

The Contractor shall bypass pump sewage flows around the manhole when the work is being performed. Contractor shall submit a detailed bypass pumping plan to the Engineer prior to starting any work.

The Contractor shall furnish and place cementitious and/or epoxy lining in each manhole as shown in the Details. The installation of the lining shall be in complete accordance with the applicable provisions of ASTM and the manufacturers' specifications. The Contractor is advised that a number of manholes will surcharge during rain events.

Prior to installing the lining, the Engineer along with the Contractor must inspect and approve the surface preparation work. The Contractor shall notify the Engineer when the manholes are ready for inspection. The Contractor is responsible for ensuring proper preparation and installation conditions including temperature and moisture regardless of the findings by the Engineer during his inspection. The manhole lining

shall be completed immediately after the inspection, or the manhole may need to be re-cleaned prior to spraying to remove accumulated debris on the benches and walls.

For cementitious lining applications, the walls and benches shall be coated monolithically to the required thickness by spray-on methods in one pass or application. Spray-applied cementitious linings shall be troweled smooth after application. The invert channel shall be coated with an appropriate quick-set grout product in complete accordance with the manufacturer's instructions.

All epoxy coatings shall be spray-applied in one or two passes. Hand-applied applications (trowel-applied) shall not be allowed. When epoxy is specified, the Contractor shall install one of the specified cementitious mortar products (minimum 1" thick) followed by a minimum 160 mil thickness epoxy coating to provide the required hydrogen-sulfide resistance. The cementitious product and epoxy shall be completely compatible as documented by the material manufacturers. In this case, payment will be made separately for the cementitious mortar lining and the epoxy lining under the corresponding bid items.

In some situations, the Engineer may specify that an epoxy coating (minimum thickness of 160 mils) be applied directly to the manhole instead of placed over a cementitious mortar product (when the manhole walls are satisfactory and do not need to be re-built). In this situation, all preparatory work will be as specified by the epoxy manufacturer and as outlined herein for preparing the manhole for a cementitious mortar product. Payment will be made for the epoxy lining only under the corresponding bid item. Testing shall be as specified herein.

All other requirements specified herein for cementitious mortar lining installation shall also be met for epoxy coating, including preparation and installation.

A complete, watertight seal shall be provided at pipe and manhole wall connections. Contractor shall submit details of how the watertight connections will be made to the Engineer for review and approval.

The manhole lining shall not be installed until all required main sewer rehabilitation and other manhole rehabilitation work are complete.

4. Acceptance Tests: Field acceptance of the manhole lining shall be based on the Engineer's field inspections and evaluation of the appropriate installation and curing test data. The lining shall provide a continuous monolithic surfacing with uniform thickness throughout the manhole interior. If the thickness of the lining is not uniform or is less than specified, it shall be repaired or replaced at no additional cost to the Owner.

If the Engineer has to enter the manholes to inspect the work, the Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, confined space entry permits, etc. for the Engineer or Owner to enter the manhole and perform

the inspection in complete accordance with OSHA requirements at no additional cost to the Owner.

- Cementitious Mortar Lining: Samples shall be taken of the installed liner each day that cementitious lining is installed as follows: one sample if one to five manholes were coated that day, two samples if six to ten manholes were coated that day, three samples if eleven to fifteen manholes were coated that day, and four samples if sixteen or more manholes were coated that day. Samples shall be taken at equally spaced intervals throughout the day. The frequency of tests may be increased by the Engineer and performed by the Contractor at no additional cost to the Owner when the required tests show that the installed lining does not meet the specifications.

Samples shall be cube samples. At least six cubes shall be taken for each sample for testing. All cube samples shall be taken in the field from the material being sprayed. The Contractor shall show the samples to the Engineer each day and the Engineer shall initial the samples for delivery to the testing laboratory. The Contractor shall properly take and store the samples and shall deliver the samples to the testing laboratory. The laboratory shall document that they received the initialed samples. The tests shall be performed by an independent testing laboratory. All costs associated with the tests shall be paid for by the Contractor. The test results shall be submitted to the Engineer immediately when available, no later than 30 days after the lining is installed or payment will be withheld.

The samples shall be tested in accordance with the applicable ASTM standards to verify that the installed liner meets the compressive strength requirements specified herein and the lining manufacturer's published data on the product. Tests shall include 7-day and 28-day strength tests (3 tests/cubes for each time period for each sample). Shrinkage and bond strength tests shall be performed on each batch or lot of material shipped to the Contractor.

- Epoxy Lining: A wet film thickness gage meeting ASTM D4414 or approved equal shall be used to ensure a monolithic coating and uniform thickness during application. After the coating has set hard to the touch, it shall be inspected with high-voltage holiday inspection equipment. The spark tester shall be initially set at 20,000 volts minimum and shall be increased as deemed necessary by the Engineer. The Engineer may require the Contractor to create a "test" holiday in the coating to determine the minimum/maximum voltage to be used. All detected holidays shall be marked and repaired as approved by the Engineer. The manhole shall then be re-tested as specified.

All manholes (cementitious and epoxy coatings) shall be tested via vacuum testing when all manhole rehabilitation work to that manhole is complete. Manholes shall not be vacuum tested until at least 7 days after the cementitious or epoxy lining was installed. Vacuum testing shall be performed in accordance with ASTM C-1244,

CMUD standard specifications and the Details, except that the minimum test time shall be 1 minute. The testing shall be paid for by the Contractor and be included in the bid price for manhole lining. The Engineer or Owner shall be present for all testing. The Contractor shall notify the Engineer 48 hours prior to testing. The Contractor shall submit test reports of the testing which include the project name, manhole tested, data on testing (vacuum pressure, test duration, etc.), and whether the manholes passed or failed the test. Test reports must be submitted for failed tests with the reason for failure noted on the report. The Engineer shall sign all test reports to document that he was present for the testing. Any manhole that fails the vacuum test shall be repaired and retested immediately by the Contractor at no additional cost.

There shall be no groundwater infiltration or other leakage (active or previously active) through the manhole walls, benches, inverts or pipe connections at the manholes after it has been lined. If leakage is found, it shall be eliminated with an appropriate cement mortar, grout or sealant as recommended by the manufacturer and approved by the Engineer at no additional cost to the Owner. Injection grouting may be required to stop leaks around the pipe connections or in the invert channel or benches. The Engineer's decision on how defective lining is repaired shall be final. If any defective lining is discovered after it has been installed or during the warranty period, it shall be repaired or replaced in a satisfactory manner at no additional cost to the Owner. Repaired manholes including those repaired during the warranty period shall be vacuum tested at no additional cost to the Owner.

Payment shall not be made for the installed cementitious lining and/or epoxy until (1) the manhole passes the vacuum test and (2) the final post-rehabilitation television inspections of the installed CIPP connecting to the manhole as specified elsewhere in these Special Provisions are approved by the Engineer (where applicable).

5. Reference Standards: The following American Society for Testing and Materials (ASTM) standards are referenced herein:

ASTM C78 Standard Test Method for Flexural Strength of Concrete

ASTM C94 Standard Test for Ready Mix Concrete

ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars

ASTM C234 Standard Test Method for Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel

ASTM C267 Standard Test Method for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing

ASTM C321 Standard Test Method for Bond Strength of Chemical- Resistant Mortars

ASTM C496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

ASTM C596 Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement

ASTM C666 Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

ASTM C827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

ASTM C882 Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear

ASTM C952 Standard Test Method for Bond Strength of Mortar to Masonry Units

ASTM C1072 Test Method for Measurement of Masonry Flexural Bond Strength

ASTM C1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test

C. PIPE BURSTING

1. Qualifications: The Contractor shall be fully experienced in installing HDPE via pipe bursting methods. The pipe bursting equipment and method of installation shall be the Grundocrack and Grundoburst Systems as manufactured by T.T. Technologies, Inc.; the InneReam Pipeline Replacement System by Nowak Pipe Reaming, Inc.; or approved equal.

Contractors must obtain all licensing required to use the particular technology proposed for this work. Proof of licensing must be provided prior to any pipe bursting taking place. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the HDPE pipe. Training shall be performed by a qualified representative.

The Contractor shall be experienced with installing HDPE pipe using the pipe bursting method and shall be certified by the particular Pipe Bursting System Manufacturer that the Contractor is a fully trained user of the pipe bursting system.

Contractor shall provide proof to the Engineer of having successfully installed a cumulative footage of replacement sewer by means of pipe bursting equal to or greater than 10,000 linear feet of HDPE pipe using the particular Pipe Bursting System Manufacturer proposed on the Bid Form.

The Contractor shall hold harmless and defend the City and the Engineer in any legal action resulting from patent infringements by the Contractor. The Contractor shall be solely responsible for obtaining any necessary licenses and paying any applicable patent fees.

2. Submittals: The Contractor will submit the following information:
 - a. Shop drawings, catalog data, and manufacturer's technical data showing complete information on material composition, physical properties, dimensions of new pipe and fittings and calculations and assumptions used to support the proposed pipe wall thickness design. Include manufacturer's recommendations for handling, storage, installation and repair of damaged pipe and fittings.
 - b. Method of construction and restoration of existing sewer service connections if different from the details in the Plans.
 - c. Pipe installation training certification for employees installing and fusing pipe on the project.
 - d. Plans and procedures for wastewater flow control supplying temporary sewer service including but not limited to withdraw/discharge points, type and size of pumps and temporary piping, proposed fittings, security measures, etc.
 - e. CCTV inspection reports and color videos made after new pipe installation.
3. Installation: The Contractor shall perform the pipe bursting in strict accordance with the equipment and HDPE manufacturers' specifications and recommendations. The Contractor shall locate all utilities in the area prior to performing the pipe bursting and shall be responsible for all restoration and damage caused by the installation, including upheaval of the ground and damage to adjacent utilities.

Before any excavation is done for any purposes, the Contractor shall contact the various utility companies (via NC One Call) for determining field location of existing utilities. All work is to be completed within existing street rights-of-way or easements. Any damage to adjacent properties that are not part of the work shall be repaired and property restored to its original condition at the Contractor's expense.

For main sewer replacement, the Contractor shall disconnect existing service laterals from the main sewer prior to pipe bursting to prevent excessive damage to the lateral. After the bursting is complete, the Contractor shall connect all active service laterals to the HDPE with a CMUD-approved strap-on saddle or connection fitting, replace the laterals to the edge of the sewer right-of-way and install a cleanout. Reconnection of laterals shall only occur after the HDPE replacement pipe has passed the initial air test.

All joints shall be inspected by the Engineer before insertion. The HDPE sewer line will be joined on site in appropriate working lengths near the launching pit.

The new HDPE pipe shall be connected to the existing manholes in accordance with the Standard Details for connecting liner pipes to existing manholes. The connection shall be leak-tight. The manholes shall be rehabilitated after the pipe bursting work is completed in accordance with the manhole lining requirements in this section of the specifications.

Where the HDPE pipe is connected with ductile iron fittings, an HDPE flange adapter shall be fused to the end of the pipe and the connection made with bolted flange components, in accordance with the manufacturer’s recommended procedures. Prior to installation, the Contractor shall submit to the Engineer for review and approval, information from the manufacturer including detailed drawing and description of the flanged system, design capabilities/limitations, and installation procedures.

- 4. Testing: After installation of the replacement pipe and subsequent to connections at manhole inlets and outlets and at service laterals, the replacement pipe shall be air tested under low pressure as follows:

The pipe shall be plugged at each manhole with pneumatic plugs. The design of the plugs shall be such that they will hold against the test pressure without requiring external blocking or bracing. One of the plugs shall have three air hose connections: one for inflating of the plug, one for reading the air pressure in sealed line, and one for introducing air into the sealed line.

Low pressure air shall then be introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure resulting from any ground water that may be over the pipe. At least two minutes shall elapse to allow the pressure to stabilize.

The time required for the internal pressure to decrease from 3.5 to 2.5 psig greater than the average back pressure resulting from any ground water that may be over the pipe, shall not be less than the time shown for a given pipe diameter in the following table:

Carrier Pipe Diameter (Inches)	Minimum Elapsed Time (Minutes)
8	4
10	5
12	6
15	7
18	8

After the replacement pipe has been secured and finished at manhole inlets and outlets and service lateral connections, lateral lines, and cleanouts have been installed, the Contractor shall perform leak testing in accordance with the CMUD Design Manual.

D. INJECTION GROUTING

1. Qualifications: The Contractor performing the work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner. The Contractor, as a company, must have at least three years of experience with the product and shall have successfully installed a grout product in a minimum of 250 manholes as documented by verifiable Owner references. Further, the Contractor's proposed superintendent/foreman for the work under this Contract shall have successfully installed the product in a minimum of 100 manholes as documented by verifiable Owner references. The Contractor shall submit information to demonstrate that he meets the experience requirements.
2. Delivery, Storage and Shipping: Care shall be taken in shipping, handling and placing to avoid damaging the product. Any product damaged in shipment, showing deterioration, or which has been exposed to any other adverse storage condition that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work. While stored, the products shall be adequately packaged and protected. The products shall be stored in a manner as recommended by the manufacturer.
3. Installation: The Contractor shall clean each sewer manhole to be treated as appropriate and shall dispose of any resulting material. The cleaning shall be performed using a high power jet wash at a minimum of 3500 psi water pressure to remove all dust, biological growths, grease, oil, paint or any other surface contaminants or coatings. As appropriate, roots shall be removed by manually cutting the roots from inside the manhole.

The Contractor shall notify all property owners who discharge sewage directly to the manhole being rehabilitated 72 hours in advance, giving the date, start time and estimated completion time for the work being conducted and the impacts to the property owner.

The Contractor shall bypass pump sewage flows around the manhole when the work is being performed if necessary. Contractor shall submit a detailed bypass pumping plan to the Engineer prior to starting any work.

The Contractor shall furnish and place grout in each manhole as identified by the Engineer. The installation of the grout shall be in complete accordance with the manufacturers' specifications.

4. Acceptance Tests: Field acceptance of the grout shall be based on the Engineer's visual inspections, the Engineer's evaluation of the appropriate installation, and the absence of any visible active leaks in the general area of the original leak location or within the same pre-cast manhole joint.

If the Engineer has to enter the manholes to inspect the work, the Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, confined space entry permits, etc. for the Engineer or Owner to enter the manhole and perform the inspection in complete accordance with OSHA requirements at no additional cost to the Owner.

There shall be no groundwater infiltration or other leakage (active or previously active) at or near the original leak location or within the same the pre-cast manhole joint after it has been repaired. If leakage is found and deemed to be a direct result of the original repair as determined by the Engineer, it shall be eliminated as approved by the Engineer at no additional cost to the Owner. The Engineer's decision on how additional leak(s) are repaired shall be final. If any additional leaks are discovered after it has been installed or during the warranty period, they shall be repaired in a satisfactory manner at no additional cost to the Owner.

VIDEO INSPECTION OF SANITARY SEWER SYSTEM

The purpose of this section is to provide the Contractor with specific guidelines pertaining to the closed circuit television (CCTV) inspection of CMUD sanitary sewer mains and manholes. The Contractor shall fully comply with the provisions of this section, and with any provisions pertaining to CCTV inspections contained in the project-specific special provisions (if any). In the event of conflicting requirements, the more restrictive shall apply.

A. CCTV DIGITAL VIDEO INSPECTIONS

The camera equipment used for the CCTV inspections shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture for the entire periphery of the pipe. The camera shall be a color, pan-and-tilt camera. The Contractor shall submit a sample television inspection so that the Contractor and Engineer can agree on performance and quality of the inspections which must be met. Sewers not inspected to the Engineer's satisfaction shall be re-inspected by the Contractor at no additional cost to the Owner.

All cameras shall move through the main sewers via self-powered tractor assemblies – no skid assemblies shall be permitted. The tractor assemblies used for the inspections shall be the appropriate size assembly for the pipe being televised according to the manufacturer of the television equipment. For example, an 8-inch tractor assembly shall be used to televise 8-inch-diameter sewers.

The camera shall move through the sewers in either direction at a uniform rate but not greater than 30 feet per minute. The camera shall be stopped at major defects and service connections and shall be panned, tilted and rotated to fully view the defects and connections. All such inspections shall be documented on computer-generated logs. Particular attention should be paid to service connections and whether the services are active or plugged.

The inspections shall be complete from manhole to manhole without the need for reverse setups unless approved otherwise by the Engineer. If, during the work, the CCTV inspection is blocked by debris, a protruding lateral or sewer system defect, the Contractor shall remove the blockage or repair the defect as authorized by the Engineer and then continue the inspection.

If the Contractor's cleaning or television equipment becomes lodged in the sewers during the work, the Contractor shall be responsible for removing the equipment, including excavation of the sewer, and paying all costs associated with the removal unless otherwise agreed to by the Engineer (for example, if the equipment is hung in pipe with major structural damage that definitely needs to be repaired, the Engineer may agree to pay for removing the equipment).

The inspections shall begin at the center of the manhole, shall clearly show the pipe connection of the sewer to be inspected at the manhole and shall pan and tilt around the

manhole to provide a clear view of the manhole and all pipe connections. At every downstream manhole, the camera shall be panned and tilted within the manhole to provide a clear view of the manhole and all pipe connections.

The television inspection shall include video documentation and computer generated logs to document the inspection. The camera shall be panned, tilted and rotated at any defects and at service lateral connections for a complete video documentation. Footages and locations of any defects and service laterals shall be documented. The entire lateral opening shall be clearly shown.

The accuracy of the measurements cannot be stressed too strongly. Daily calibration of measuring devices shall be performed. Sewer lengths shown and reported on the CCTV inspection tapes and logs shall be within 3 feet (plus or minus) of the actual sewer length as measured above ground from center of manhole to center of manhole. CCTV inspections that do not meet this criteria shall be re-performed and re-submitted to the Engineer at no additional cost to the Owner.

The maximum flow depth for CCTV inspection work is 25% of the pipe diameter or as approved by the Engineer. The Contractor may be required to perform inspections during off-peak hours (night inspections) if specifically requested by the Engineer to achieve this maximum flow standard.

B. DIGITAL VIDEO FORMAT

All televised sewer inspections performed (including sewer laterals) shall be submitted to the Engineer in electronic (digital) format. All inspections performed will be imported into CMUD's I.T.pipes inspection software. The import tools used by CMUD will not function properly if data is not submitted in the exact format required below.

All inspections shall be performed using I.T.pipes software in the field. I.T.pipes must be installed in the truck that is performing the television inspections and used for the live field inspections. If I.T.pipes with the specific CMUD template is not in the truck(s), the work shall immediately cease until it is installed in the truck(s) to be used during the inspection process.

The contractor must use the I.T.pipes CMUD template available from I.T.pipes. This template contains all correct data entry fields, all observation inputs and required parameters, template settings for overlay control and setup, and other settings. The Contractor shall obtain the template prior to performing any CCTV inspections. Inspections performed without using the CMUD template will be rejected, and the Contractor will have to re-perform the inspections at no cost to the City.

WMV recording with embedded meta-data is required. Each submittal to the Engineer shall include the I.T.pipes software database file within the approved structure along with the WMV video files. The Contractor shall make all adjustments necessary to adhere to the required format specified herein including performing the work using the required

software at no additional cost to the City. After the first submittal, the Engineer will notify the Contractor of any required changes in the data and file format, and the Contractor shall make such modifications at no additional cost.

The digital recording shall include both audio and video information that accurately reproduces the original picture and sound of the video inspection. The video portion of the digital recording shall be free of electrical interference and shall produce a clear and stable image. The audio portion shall be sufficiently free of background and electrical noise as to produce an oral report that is clear and discernible.

1. Video Overlay: The video shall include overlay/text display with an initial display screen and with a continuous running screen. Each inspection start shall include overlay display of section details including at a minimum:

1. Owner Name
2. Project Name
3. Contractor Name
4. Street Name (if applicable)
5. Date/Time of Inspection
6. MH Start #/MH End #
7. Pipe Material
8. Pipe Size
9. Direction of Video
10. Weather or Flow Level
11. Pipe Identifier Number

The continuous running screen shall include a constant display of the street name, MH start #/MH End #, date and distance shall appear on screen. The CCTV inspector shall move or remove overlay display accordingly so it does not interfere with the inspection review of particular observations/defects as the inspection is occurring.

As an observation/defect is noted by the inspector, a text display shall appear with the text describing the observation/defect. Text shall display for 4-5 seconds.

Distance shall appear continuously in the lower right corner of the video image as the camera is traveling down the line.

It is imperative that distance is accurate. The CCTV inspector shall calibrate/test footage at the beginning of each day as incorrect footage will result in return of inspections.

2. Video Format: Completed work shall consist of WMV video files captured live off the inspection camera.

Each pipe inspection's observations shall be related to a time point within the video.

Each pipe inspection WMV file shall have a related text file, with an identical name

but different extension on the file. This file shall contain the distances of each observation and the related time point for that observation.

During the inspection, the video file recording shall pause as the operator selects the observation/defect notation, eliminating “on hold” video.

The WMV files shall be named as follows:

EXAMPLE:

Pipe ID is GM-31619 and manhole numbers are (Upstream) MH-249417 to (Downstream) MH-249341

Then, the video filename = **GM-31619_249417_249341.wmv**

The video file resolution shall be 640 x 480

The audio shall be included within the WMV and not as a separate file.

3. Video Media: The database file and the corresponding video files shall be submitted to the Engineer on DVD, flash drive or portable external hard drives. One copy of the printed logs (in color) that correspond to the inspections shall be submitted to the Engineer. The Engineer will return the hard drive to the Contractor after the inspections have been reviewed.

Each submittal to the Engineer shall include a transmittal letter, listing the file names and all sewer segments and video files included on the hard drive.

4. Customized Data Fields: CMUD has developed customized data fields for its viewing software. The Contractor will be required to use these data fields, without any modifications, to enter project information for each inspection. These data fields are available for download from I.T.pipes.

Observations for each inspection shall include:

- Observation distance (part of the CMUD catalog)
- Observation defect/description (part of the CMUD catalog)
- Counter time observation occurs within digital video (part of the CMUD catalog)
- Severity rating for each observation/defect (part of the CMUD catalog)
- Infiltration rating (part of the CMUD catalog)

5. PACP: All work submitted by the Contractor shall be completed by PACP Certified professionals. A current PACP certification number shall be included for each person creating/gathering inspection reports. All work shall be performed using CMUD’s PACP format. The Contractor shall use CMUD’s template in I.T.pipes so the format is correct. Note that CMUD’s module is different from the standard PACP module.

CHEMICAL ROOT CONTROL

The purpose of this section is to provide the Contractor with specific guidelines pertaining to the use of chemical root control within Charlotte-Mecklenburg Utilities sanitary sewer system. The goal of chemical root control is to kill the root growth present in the mains and to inhibit re-growth, without damaging the vegetation producing the roots. The Contractor shall fully comply with the provisions of this section, and with any provisions pertaining to chemical root control contained in the project-specific special provisions. In the event of conflicting requirements, the more restrictive shall apply.

A. POLLUTION LIABILITY INSURANCE

In addition to all other insurance required in these General Conditions or by law, the Contractor shall purchase and maintain with a company acceptable to the City and authorized to do business in the state of North Carolina, pollution liability insurance for limits of not less than \$2,000,000. This coverage shall protect against claims for damages for bodily or personal injury, sickness or disease, including death, and from claims for damages to property and/or the environment, which may arise directly out of the use of chemicals and/or pollutants.

B. PRODUCT REQUIREMENTS

The chemical root control treatment material shall be EPA registered and labeled for use in sewer lines and acceptable to the State agency having jurisdiction over its use. The Contractor shall submit a specimen product label of the material to be used in treatment process to the Engineer. The chemical agent shall be non-systemic, which will not permanently affect parts of trees distant from the treated roots. Diquat dibromide is the accepted chemical root control agent. Razorooter II, or approved equal, is the accepted root control product.

C. QUALIFICATIONS

Chemical root control shall be performed by a company with not less than five years of experience in providing the required root control services, employing experienced workers and experienced supervisory personnel. Supervisory personnel shall have not less than three years of experience in providing the required services, backed up with project references, and shall be present at the jobsite during all work related to the required services.

The Contractor, as well as the specific individual(s) mixing and applying the chemicals, shall be licensed in the State of North Carolina to apply the approved chemical agents for the purpose of sanitary sewer root control. Supervisory personnel shall have treated a minimum of 500,000 lf of sanitary sewer lines using the approved products within the last 3 years, backed up with project references and shall remain on site at all times while the mixing and application process is under way.

The Contractor is directed to ensure compliance with all Federal, State and Local ordinances pertaining to chemical root control. Particular attention shall be paid to those laws and ordinances relating to transportation of material (DOT), the application of sewer chemical root control herbicides (US EPA), and traffic safety regulations. The Contractor's Federal DOT number and material EPA registration number must be submitted with bid.

D. APPLICATION AND TREATMENT

The Contractor shall carry out all preparatory work, flow control, mixing and application procedures as described below:

1. Preparatory Procedures: At the beginning of each day, the Contractor shall bring equipment, chemicals and supplies to the project site (area to be treated). The Contractor shall not use streets, right-of-ways, individual property owner lands, or easements as staging areas. At the end of each day, Contractor shall remove all equipment, chemicals and supplies from the project site.

No cleaning is allowed in lines prior to chemical root treatment unless extensive grease, root masses, or debris preclude proper application of the material.

2. Flow Control: Generally, sewer service shall not be interrupted during root control treatment. In situations where it is necessary to shut down upstream pumping stations or block/bypass upstream flows, the Contractor shall coordinate his activities with the Engineer and do the work at night or during periods of low flow. The entire procedure of maintaining existing flows shall be fully discussed with the Engineer well in advance of the interruption of any flow. Sewer system overflows will not be tolerated. All fines imposed on the Owner and associated with overflows caused by the Contractor's work shall be paid by the Contractor
3. Mixing Procedures: All materials shall be delivered to the site in undamaged, unopened containers bearing the manufacturer's original label. Mixing of the root treatment material shall be done at the time of application. The water used shall be clear and free of acid, alkali, oxidizing agent, oil, or other organic materials. Mixing water temperature shall be between 40°F and 80°F. Mixing of root treatment with water must be accomplished immediately before injection of foam into sewer line.
4. Application Procedures: Where conditions permit, the volume of foam shall be sufficient to completely fill the air space above the flow, manhole to manhole. In all cases, the volume of foam delivered to the sewer line shall be sufficient to attach to and permeate all root masses. The foam shall be applied at sufficient pressure to penetrate several feet into service connections. The hose insertion method is the most common and preferred of foam application. Use of any other method must be approved by the Engineer.
5. Protection of Wastewater Treatment Plans: The Contractor shall take all steps

necessary and appropriate to prevent adverse effects on wastewater treatment plant operations during the application process.

Notwithstanding the requirement that the active ingredient shall not adversely effect wastewater treatment plant operations, in the event that a wastewater treatment plant experiences any reduction in operating efficiency during the execution of the contract, the Contractor shall immediately suspend all applications, at the direction of the Engineer. The Contractor shall continue operations only after problems at the wastewater treatment plant have been corrected to the satisfaction of CMUD's Environmental Division. CMUD reserves the right to suspend or terminate the chemical root control contract at any time for any reason.

The Contractor shall be limited to the amount of line footage treated per day in any one treatment plant basin and shall adhere to the following production schedule:

Diquat Dibromide Basin Limits

Irwin Creek WWTP Basin – 6,800 ft/day

Mallard Creek WWTP Basin – 6,800 ft/day

Sugar Creek WWTP Basin – 8,000 ft/day

McAlpine Creek WWTP Basin – 13,600 ft/day

McDowell Creek WWTP Basin – 2,250 ft/day

CMUD reserves the right to reduce or add to these production limits if deemed necessary or appropriate.

All CMUD wastewater treatment plants are required to perform toxicity testing on a quarterly basis, more often if any of these tests fail. If directed by the Engineer, the contractor may be required to suspend treatment during the testing periods. The testing schedules for the various plants are as follows:

Irwin Creek and McDowell Creek WWTPs – January, April, July and October

Sugar Creek and Mallard Creek WWTPs – February, May, August and November

McAlpine Creek WWTP – March, June, September and December

If needed, CMUD will make every effort to provide ample work in the various basins as to not impact production during testing periods.

The Contractor shall maintain daily contact through e-mail with the CMUD's Environmental Division representative Shannon Sypolt at ssypolt@charlottenc.gov and shall communicate to Mr. Sypolt the dosing concentration and quantities, the area being treated, as well as linear footage treated for the day. The Contractor shall also provide Mr. Sypolt with a schedule of areas to be treated, which shall be updated as needed.

E. POST-TREATMENT INSPECTION AND WARRANTY

The Contractor shall provide a written guarantee that meets or exceeds any claims or warranties made by the manufacturer in published advertising. As a minimum, the Contractor shall guarantee that no blockages due to roots will occur in pipes treated by the Contractor for a period of three years, from the date that treatment is performed on the pipe. The Contractor shall also guarantee that the chemical treatment foam likewise kills all roots in the service laterals, at least past the tee connection point of the lateral to the main line. Any treatment foam entering a building is unacceptable and will not be tolerated. The Contractor shall also guarantee no adverse impacts to plants and trees as well as wastewater treatment facilities operations.

No less than 3% of the total length of sanitary sewer lines treated shall be inspected via closed circuit television (CCTV). CCTV inspection shall occur no sooner than six months following treatment of the sanitary sewer. The Engineer shall choose which sanitary sewer mains are to be inspected and provide system maps identifying those mains to the Contractor. If any section of the sanitary sewer mains inspected is unacceptable to the Engineer, the Contractor shall retreat the section and inspect another main by CCTV of equal length at no charge.