

PIPE REHABILITATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- ~~A. Sliplining Pipe~~
- BA. Cured-in-place Pipe (CIPP) Main Lining**
- ~~C. Deformed/Reformed Pipe Lining~~
- ~~D. Folded/Formed Pipe Lining~~
- B. Cured-in-place Pipe (CIPP) Point Repair**
- C. Cured-in-place Pipe (CIPP) Service Repair**
- D. Pressure Testing and Grouting of Sewer Joints**
- E. Spot Repairs by Pipe Replacement

1.02 DESCRIPTION OF WORK

- A. Pipe **CIPP** Lining:
 - 1. **Mainline** ~~Resin impregnated, cured in place.~~
 - 2. **Service (Lateral) Repair** ~~Deformed/reformed polyethylene.~~
 - 3. **Point Repair** ~~Folded/formed polyvinyl chloride.~~
 - 4. ~~Sliplining.~~
- B. Pressure Testing and Grouting of Sewer Joints**
- ~~BC. Pipe spot repairs.~~
- D. Pre-rehabilitation cleaning and inspection is light sewer cleaning including an unlimited number of passes with a hydraulic flusher. Does not include root cutting or removal of deposits or protruding service connections.**
- E. Additional sewer cleaning is heavy sewer cleaning including an unlimited number of passes with high velocity hydro cleaning equipment / hydraulic spinner nozzle, cutting roots, removing deposits of attached encrustation (DAE), and removing deposits of attached grease (DAGS). Does not include lateral cuts.**

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants, **as well as the following:**

A. CIPP Rehabilitation:

- 1. **Thickness Design:** Submit design calculations for CIPP wall thickness based upon **ASTM F 1216, prepared and signed by a licensed Professional Engineer in the State of Iowa.**

1.03 SUBMITTALS (Continued)

- 2. Resin:** Certificate of compliance with ASTM F 1216 or D 5813.
- 3. Tube:** Certificate of compliance with ASTM F 1216 or F 2019. If glass fiber reinforcement is used, CIPP strain corrosion testing according to ASTM D 3681.
- 4. Wet Out and Curing:** Complete description of the manufacturer's recommended wet out procedure and curing method for the type of lining proposed.
- 5. Safety Procedures:** When required in the contract documents, submit documentation of National Institute of Occupational Safety and Health (NIOSH) testing, health hazard evaluation, and recommended safety procedures for CIPP workers and public.

B. Grouting Sewer Joints and Service Connections:

- 1. Grout:** Description of chemical grout materials to be used.
- 2. Additives:** Description of additives to be used including strengthening agents, shrinkage reducers, dye, viscosity modifiers, gel time modifier, freeze/thaw inhibitor, or others.
- 3. Root Inhibitor:** Description of chemical root deterrent.
- 4. Procedures:** Manufacturer's published recommendations for storing, mixing, testing, and handling chemical grouts.

C. Installer Information: When requested by the Contracting Authority, submit the following prior to the pre-construction meeting.

1. Installer name.
2. Completed project list for last five years including for each project and year completed, client name/address/contact person/phone number, footages installed by pipe diameter, and number of lateral reinstatements.
3. Detailed installation procedures, including estimated times for each task, lateral reinstatement methods, number of required excavations, and other items unique to each product.
4. Video of installation process, if available.
5. Evidence of properly trained personnel.
6. Related ASTM standards or any nationally recognized standards for product installation.
7. Available equipment list.
8. Detailed procedures for repairing the product in the event of future damage or failure and for tapping future service connections, including and required specialized equipment or training.
9. Videos of two rehabilitated sewer sections showing before and after conditions.
10. Additional information may be required. The submittal of prequalification information in no way implies that the product, manufacturer, or installer will be deemed to be qualified. The Contracting Authority, in its sole discretion, will determine whether a product, manufacturer, or installer does or does not qualify as an approved equal.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants, as well as the following:

Provide, as a minimum, the following information for evaluation.

A. Product Information:

1. Product name.
2. Year product first available in the United States.
3. Total footage or number of line segments installed in the United States.
4. Results of all available product testing, including but not limited to leakage, physical properties, pipe stiffness, chemical resistance, strain-corrosion, external loading, flow characteristics, infiltration/inflow reductions, structural capacity, and external hydrostatic loading capacity.
5. Samples of before and after product.
6. Design method.
7. Typical lining thickness for pipe sizes included in the project.

B. Manufacturer Information:

1. Manufacturer name.
2. Years of experience manufacturing the product.
3. Country of manufacture of all product components.
4. Quality control procedures for product manufacture, including inspection requirements, testing procedures, and allowable tolerance levels.
5. Related ASTM standards, or other nationally recognized standards for product manufacturing.

~~C. Installer Information:~~

- ~~1. Installer name.~~
- ~~2. Completed project list for last five years including for each project and year completed, client name/address/contact person/phone number, footages installed by pipe diameter, and number of lateral reinstatements.~~
- ~~3. Detailed installation procedures, including estimated times for each task, lateral reinstatement methods, number of required excavations, and other items unique to each product.~~
- ~~4. Video of installation process, if available.~~
- ~~5. Evidence of properly trained personnel.~~
- ~~6. Related ASTM standards or any nationally recognized standards for product installation.~~
- ~~7. Available equipment list.~~

- ~~8. Detailed procedures for repairing the product in the event of future damage or failure and for tapping future service connections, including and required specialized equipment or training.~~
- ~~9. Videos of two rehabilitated sewer sections showing before and after conditions.~~
- ~~10. Additional information may be required. The submittal of prequalification information in no way implies that the product, manufacturer, or installer will be deemed to be qualified. The Contracting Authority, in its sole discretion, will determine whether a product, manufacturer, or installer does or does not qualify as an approved equal.~~

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 - General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 - General Provisions and Covenants.

1.07 SPECIAL REQUIREMENTS

- A. Prior to start of work, notify all affected parties 24 hours in advance as to the length of time their service will be blocked.
- ~~B. Notify the Jurisdiction's water works to use meter.~~
- ~~CB. Unless otherwise specified, the Owner Jurisdiction will provide water at no cost for cleaning and installation of cured-in-place pipe from a nearby hydrant through a separate valve mounted on the hydrant. Utilize an approved double check backflow assembly or open gap.~~
- ~~DC. Establish a Public Information and Notification Program for contacting each home or business connected to the affected sanitary sewer, informing them of the work to be done and when the sewer will be off-line. The following specific steps are part of the Public Information and Notification Program.~~
- ~~1. Provide written notice to be delivered to each affected home or business describing work, schedule, how the work affects them, and a local telephone number of the Contractor they can call to discuss the project or their problems.~~
 - ~~2. Personally contact each home or business on the day lateral verifications using closed circuit video inspection are to be performed. The homeowner or business will be asked to run water down their drain to verify each lateral. If the homeowner is unavailable, attempt other arrangements (cleanouts) to drain water through the lateral to verify each connection.~~
 - ~~3. Provide written notice and personally contact the home or business the day prior to beginning inversion of the section of sewer to which they are connected.~~
 - ~~4. Personally contact all homes or businesses that cannot be reconnected within the time stated in the written notice.~~
 - ~~5. Furnish and service portable toilets for use by the home or business occupants if so required by any affected served business or homeowner.~~
 - ~~6. When required in the contract documents, comply with NIOSH recommendations for employee and public health during CIPP lining.~~

1.08 MEASUREMENT AND PAYMENT**A. Pipe Cleaning and Inspection for Rehabilitation:****1. Pre-Rehabilitation Cleaning and Inspection:**

- a. Measurement:** Measurement will be made for each diameter range of sewer main cleaned and inspected prior to rehabilitation. Diameter ranges: 4 to 12 inch, 15 to 24 inch, and 27 to 30 inch.
- b. Payment:** Payment will be made at the unit price per linear foot for each diameter of pre-lining cleaning and inspection.
- c. Includes:** Unit price includes, but is not limited to, pre-cleaning CCTV inspection, light sewer cleaning, debris removal and transport, post cleaning CCTV inspection for Engineer review, and identification and logging of active service taps. If specified in the contract documents, unit price also includes disposal and associated costs for all debris removed from sewer.

2. Additional Sewer Cleaning:

- a. Measurement:** Measurement will be made on an hourly basis for additional pipe cleaning for each diameter range. Diameter ranges: 4 to 12 inch, 15 to 24 inch, and 27 to 30 inch.
- b. Payment:** Payment will be made at the unit price per hour for additional pipe cleaning.
- c. Includes:** Unit price includes, but is not limited to, heavy sewer cleaning; root cutting; deposit cutting; and removing, transporting, disposing, and paying associated costs for all debris removed from sewer.

B. Remove Protruding Service Connections:

- 1. Measurement:** Each protruding service connection removed will be counted. Quantity will be based on number of protruding service connections identified in the pre-rehabilitation CCTV inspection and removed from the post-rehabilitation CCTV inspection.
- 2. Payment:** Payment will be made at the unit price for each protruding service connection removed.
- 3. Includes:** Unit price includes, but is not limited to, removal of protruding service connections and debris removal.

C. CIPP Lining:**A1. CIPP Main Pipe Lining:**

- 1a. Measurement:** Each type and size diameter of main pipe lining will be measured in linear feet along the centerline of the pipe lining from center of manhole to center of manhole.
- 2b. Payment:** Payment will be made at the unit price per linear foot for each diameter type and size of pipe lining.
- 3c. Includes:** Unit price includes, but is not limited to, removal of internal obstructions, pipe cleaning, inspection, CCTV inspection immediately prior to lining, bypass pumping, sliding foil, post-lining CCTV inspection, and all costs associated with the public information and notification program.

B2. Building Sanitary Sewer Service Reconnection Reinstatement:

- 1a. Measurement:** Each active existing building sanitary sewer service reconnected to the pipe lining, including the services reconnected by excavating and reconnecting services or by trenchless reconnection methods, will be counted. Each active sanitary sewer service reinstated, including those reinstated by excavation, will be counted.

1.08 MEASUREMENT AND PAYMENT (Continued)

2b. Payment: Payment will be made at the unit price for each reconnection active sewer service reinstated.

3c. Includes: Unit price includes, but is not limited to, removal of internal obstructions, pipe cleaning, and all costs associated with the public information and notification program reinstating sanitary sewer service connections, removal of debris, and coordination with service owners.

3. CIPP End Seal:

a. Measurement: Each size of CIPP end seal installed will be counted.

b. Payment: Payment will be made at the unit price for each CIPP end seal installed.

c. Includes: Unit price includes, but is not limited to, end seal and installation.

D. CIPP Point Repair:

1. Measurement: Each diameter of CIPP point repair will be counted. Repairs in excess of 10 feet in length will be counted as multiple repairs.

2. Payment: Payment will be made at the unit price for each diameter of CIPP point repair.

3. Includes: Unit price includes, but is not limited to, bypass pumping, sewer cleaning, removal of obstructions, debris removal, pipe preparation, pre and post repair CCTV inspection, and installation of point repair.

E. CIPP Service Repair:**1. CIPP Service Pipe, Connection:**

a. Measurement: Each size combination of main and service connection diameters repaired will be counted.

b. Payment: Payment will be made at the unit price for each size combination of CIPP service pipe, connection.

c. Includes: Unit price includes, but is not limited to, bypass pumping, testing, documentation, and all costs associated with the public information and notification program.

2. CIPP Service Repair, Partial Pipe:

a. Measurement: Each size combination of main and service diameters and specified service length lined will be counted.

b. Payment: Payment will be made at the unit price for each size combination of CIPP service repair, partial pipe.

c. Includes: Unit price includes, but is not limited to, bypass pumping, testing, documentation, and all costs associated with the public information and notification program.

F. Pressure Testing and Grouting of Sewer Joints and Service Connections:**1. Pressure Testing of Mainline Sewer Joints:**

a. Measurement: Each mainline sewer joint tested will be counted. Separate measurement will be made for each diameter of sewer main. Visually leaking joints, whether tested or not, will be counted if they are grouted.

b. Payment: Payment will be made at the unit price for each sewer joint tested.

c. Includes: Unit price includes, but is not limited to, by-pass pumping, control testing, and documentation.

1.08 MEASUREMENT AND PAYMENT (Continued)**2. Injection Grouting of Mainline Sewer Joints:**

- a. **Measurement:** Each mainline sewer joint grouted will be counted. Separate measurement will be made for each diameter of sewer main.
- b. **Payment:** Payment will be made at the unit price for each sewer joint grouted.
- c. **Includes:** Unit price includes, but is not limited to, bypass pumping, material testing, pressure testing after grouting, re-grouting of failed joints, and documentation. Unit price does not include the quantity of chemical grout used.

3. Pressure Testing of Service Connections:

- a. **Measurement:** Each sewer service connection tested will be counted. Separate measurement will be made for service connections on each diameter of sewer main.
- b. **Payment:** Payment will be made at the unit price for each service connection tested.
- c. **Includes:** Unit price includes, but is not limited to, bypass pumping and documentation.

4. Injection Grouting of Service Connections:

- a. **Measurement:** Each service connection grouted will be counted. Separate measurement will be made for service connections on each diameter of sewer main.
- b. **Payment:** Payment will be made at the unit price for each service connection grouted.
- c. **Includes:** Unit price includes, but is not limited to, bypass pumping, material testing, pressure testing after grouting, and documentation. Unit price does not include the quantity of chemical grout used.

5. Chemical Grout:

- a. **Measurement:** Each gallon of chemical grout used for sealing mainline sewer joints and service connections will be counted.
- b. **Payment:** Payment will be made at the unit price for each gallon of chemical grout used.
- c. **Includes:** Unit price includes, but is not limited to, grout additives; root inhibitor; and supplying, mixing, and measurement of chemical grout.

CG. Spot Repairs by Pipe Replacement: Both of the following methods will be used for measurement and payment of spot repairs by pipe replacement.

1. Spot repairs by Count:

- a. **Measurement:** Each spot repair location will be counted.
- b. **Payment:** Payment will be made at the unit price for each spot repair.
- c. **Includes:** Unit price includes, but is not limited to, uncovering and removing existing pipe and **furnishing and** placing **bedding and** backfill material for replacement pipe, and restoring the surface.

and;

2. Spot Repairs by Linear Foot:

- a. **Measurement:** Each spot repair will be measured in linear feet along the centerline of the replacement pipe.
- b. **Payment:** Payment will be made at the unit price per linear foot of spot repair.
- c. **Includes:** Unit price includes, but is not limited to, furnishing and installing replacement pipe and connections.

H. Pavement Removal and Replacement: Comply with Section 7040.

I. Sod: Comply with Section 9020.

PART 2 - PRODUCTS**~~2.01 POLYETHYLENE AND POLYOLEFIN MANUFACTURED PIPE FOR SLIPLINING~~****~~A. Pipe:~~**

- ~~1. Comply with ASTM D 3035, minimum pipe stiffness of 46 psi.~~
- ~~2. Polyethylene complying with ASTM D 1248, Type III, Class C, Category 5, Grade P 34 or ASTM D 3350 Cell Classification PE 335434C.~~
- ~~3. Maximum outside diameter as specified in the contract documents.~~

~~B. Joints:~~

- ~~1. Joined into continuous length on job site.~~
- ~~2. Fuse butt joints according to the pipe manufacturer's recommendations with approved equipment and complying with ASTM D 2657.~~

~~2.02 POLYVINYL CHLORIDE PIPE (PVC) MANUFACTURED PIPE 12 INCH TO 36 INCH FOR SLIPLINING~~**~~A. Pipe:~~**

- ~~1. Comply with ASTM F 949, minimum pipe stiffness, 46 psi.~~
- ~~2. PVC plastic complying with ASTM D 1784, Cell Classification 12454.~~

~~B. Joints:~~ Gasketed joints complying with ASTM F 477 and ASTM D 3212.**~~2.03 POLYVINYL CHLORIDE PIPE (PVC) MANUFACTURED PIPE 21 INCH TO 48 INCH FOR SLIPLINING~~****~~A. Pipe:~~**

- ~~1. Comply with ASTM F 1803, minimum pipe stiffness, 46 psi.~~
- ~~2. PVC plastic complying with ASTM D 1784, Cell Classification 12364.~~

~~B. Joints:~~ Gasketed joints complying with ASTM F 477 and ASTM D 3212.**~~2.04 CENTRIFUGALLY CAST FIBERGLASS REINFORCED POLYMER MORTAR PIPE (CCFRPM) 18 INCH TO 48 INCH FOR SLIPLINING.~~****~~A. Pipe:~~** Comply with ASTM D 3262.**~~B. Joints:~~** Gasketed joints complying with ASTM D 4161.**~~2.05 RESIN-IMPREGNATED TUBE FOR CURED-IN-PLACE PIPE (CIPP) Lining~~****~~A. Pipe Lining:~~**

- ~~1. Comply with ASTM F 1216.~~
- ~~2. Use one or more layers of flexible needled felt or equivalent non-woven material.~~
- ~~3. Stretch material to fit irregular pipe and negotiate bends.~~

2.05 — RESIN-IMPREGNATED TUBE FOR CURED-IN-PLACE PIPE (CIPP) Lining (Continued)

4. ~~Outside layer plastic coated with a translucent flexible material. No delamination of plastic coating.~~
5. ~~Fabricated to a size that when installed tightly fits length without joints.~~
6. ~~Designed as per Equation X-1, ASTM F 1216.~~

B. Resin and Catalyst:

1. ~~Unsaturated, styrene-based, thermoset resin and catalyst system or an epoxy resin and hardener that is compatible with the inversion process.~~
2. ~~Cures in the presence of water with temperature greater than 150°F and less than 180°F.~~
3. ~~Initial structural properties complying with ASTM F 1216. Also comply with the following table.~~

Table 4050.01: CIPP Lining Properties

CIPP Properties	ASTM Test Method	Minimum Value
Flexural Strength	D-790	4,500 psi
Flexural Modulus of Elasticity	D-790	250,000 psi

C. CIPP Lining Dimensions:

1. ~~Use nominal internal diameter and length such that CIPP forms to internal circumference and length of original pipe.~~
2. ~~Field verify diameter and length.~~
3. ~~Use one continuous length without joints.~~

2.06 — DEFORMED/REFORMED HIGH DENSITY POLYETHYLENE PIPE LINING (DRP-HDPE)**A. Pipe Lining:**

1. ~~Manufactured in deformed shape from HDPE pipe compound complying with ASTM D 1248, Class C, Category 5 and Grade P 34.~~
2. ~~Comply with long term hydrostatic strength rating of 1600 psi or more according to ASTM D 2837.~~
3. ~~Environmental stress crack resistance (ESCR) less than 2,000 hours in 100% solution, Igepal CO-630 at 100°C before failure according to ASTM D 1693, Condition C.~~
4. ~~Comply with the following table for minimum DRP lining structural standards.~~

Table 4050.02: DRP-HDPE Lining Properties

FIPP Properties	ASTM Test Method	Minimum Value
Flexural Strength	D-790	3,300 psi
Flexural Modulus of Elasticity	D-790	136,000 psi
Tensile Strength	D-638	3,200 psi

**2.06 — ~~DEFORMED/REFORMED HIGH DENSITY POLYETHYLENE PIPE LINING (DRP-HDPE)~~
(Continued)****B. ~~DRP Lining Dimensions:~~**

- ~~1. Nominal internal diameter and length of existing pipe as specified in the contract documents.~~
- ~~2. Field verify diameter and length.~~
- ~~3. Outside diameter fabricated to fit tightly.~~
- ~~4. Use one continuous length without joints between manholes.~~
- ~~5. Minimum SDR wall thickness as specified in the contract documents.~~

2.07 — ~~FOLDED/FORMED POLYVINYL CHLORIDE PIPE LINING (FFP-PVC)~~**A. ~~Pipe Lining:~~**

- ~~1. Manufacture in deformed shape complying with ASTM D 1784, Cell Classification 12454
B. Compounds with different cell classifications because one or more properties are superior to those specified are acceptable.~~
- ~~2. Performance requirements complying with ASTM D 3034.~~
- ~~3. Comply with the following table for FFP lining structural properties.~~

Table 4050.03: FFP-PVC Lining Properties

FIPP Properties	ASTM Test Method	Minimum Value
Tensile Modulus of Elasticity	D-638	350,000 psi
Tensile Strength	D-638	6,000 psi

B. ~~FFP Lining Dimensions:~~

- ~~1. Nominal internal diameter and length of existing pipe as specified in the contract documents.~~
- ~~2. Field verify diameter and length prior to manufacturing.~~
- ~~3. Use one continuous length without joints between manholes.~~
- ~~4. Outside diameter fabricated to fit tightly.~~
- ~~5. Minimum SDR wall thickness as specified in the contract documents and complying with ASTM F 1216.~~

2.01 CIPP MAIN LINING

A. Fabric Tube and Resin: Comply with ASTM F 1219 for heat cure or ASTM F 2019 and D 5813 for UV light cure.

B. CIPP Lining Dimensions:

1. Use nominal internal diameter and length such that CIPP forms to internal circumference and length of original pipe.

2.01 CIPP MAIN LINING (Continued)

2. Field verify diameter and length.
3. Use one continuous length without joints.

C. Structural Requirements:

1. Design the CIPP liner according to ASTM F 1216.
2. Unless otherwise specified in the contract documents, assume fully deteriorated conditions and the following properties for design at each location:

Table 4050.01: CIPP Main Lining Design Values

Design Criteria	Value
Factor of safety, N	2.0
Soil modulus, E _s	1,000 psi
Soil density, ω	120 lb/ft ³
Live load, W _s	H20
Ovality reduction factor, C	As specified for each location
Height of soil above pipe, H	As specified for each location
Height of water above top of pipe, H _w	1/2 depth of cover
Long term flexural strength, σ _L	Use value for 50 year design

3. Set the long term (50 year extrapolated) creep retention factor at 50% of the initial design flexural modulus as determined by ASTM D 790 unless long term test data according to ASTM D 2990 substantiates a different retention factor.
4. Design for internal pressure or vacuum is not required.

D. CIPP Lubricant: Provide a non-toxic, oil based product that has no detrimental effects on the tube or boiler and pump system, will not support the growth of bacteria, and will not adversely affect the fluid to be transported.

E. CIPP End Seal:

1. **Hydrophilic Gasket Sleeve:** Provide a seamlessly molded gasket and retaining ring system complying with ASTM F 3240.
2. **Expansion Band System:**
 - a. Provide a one-piece rubber gasket and a pair of stainless-steel expansion bands in a system manufactured specifically for CIPP end seal applications.
 - b. Provide bands with positive locking mechanism permanently securing the bands in their expanded position after tightening.
 - c. Comply with material requirements of ASTM C 923 for rubber gasket and stainless steel.

2.02 CIPP POINT REPAIR

A. General: Utilize a repair system that complies with the following requirements.

1. Meet or exceed the material requirements of ASTM F 1216 or ASTM F 2019 and ASTM D 5813.
2. Provides a full wrap section sized to create a circular liner equal to the inner diameter of the pipe. Ensure one end of the CIPP point repair sheet overlaps the second end by a minimum of 10% to allow for variation in pipe diameter.

2.02 CIPP POINT REPAIR (Continued)

3. Sufficient strength to bridge missing pipe segments and ability to stretch to fit irregular pipe sizes.
 4. Uniform thickness and 10% extra resin.
 5. Utilizes a thermoset resin system comprised of a base resin and hardener that cure at ambient temperatures.
 6. Has a shrinkage value of less than 0.05% when measured according to ISO 2577 or ASTM D 6289.
 7. Designed against corrosion and typical chemicals found in domestic sewage.
- B. Liner Length:** Minimum length as specified in the contract documents. Lengths beyond 10 feet may be completed with multiple liners.
- C. Structural Requirements:** Design the CIPP point repair according to the structural requirements for CIPP main lining described herein. Assume an ovality of 2% unless otherwise specified in the contract documents.

2.03 CIPP SERVICE REPAIR

- A. General:** Utilize a repair system that provides the following.
1. Full circumferential CIPP liner inside the main pipe and a tube that extends continuously from the sewer main into the service for the distance specified in the contract documents.
 2. Installation of system from within the sewer main without the need for excavation or access through a clean out.
 3. The ability to seal a combination of tees and wyes of varying angles.
 4. The ability to seal the connection of the service to the mainline in a continuous, tight fitting, watertight pipe within a pipe that eliminates infiltration and root intrusion between the liner and host pipe.
- B. Liner Length:**
1. **CIPP Service Connection Repair:** Provide service liner with a length of 4 to 6 inches to seal the connection between the main line and the wye or tee.
 2. **Partial Service Pipe:** Provide service liner with a length between 12 and 36 inches, as specified in the contract documents, to seal the connection from the main line to the first service pipe joint.
 3. **Main Pipe Liner Length:** Provide main pipe liner with a length of 18 inches minimum.
- C. Fabric Tube:**
1. Provide a fabric tube consisting of one or more layers of absorbent non-woven felt fabric, felt/fiberglass, or fiberglass complying with the requirements of ASTM F 1216 or ASTM F 2019 and ASTM D 5813.

2.03 CIPP SERVICE REPAIR (Continued)

2. Provide nominal fabric tube wall thickness to the nearest 0.5 mm increment as required by the thickness design. Ensure the wet-out fabric tube has a uniform thickness that, when compressed at installation pressures, meets or exceeds the design thickness after cure.
3. Coat inside (after installation) of fabric tube with an impermeable, flexible membrane that will contain the resin and facilitate vacuum impregnation.
4. Mark the fabric tube with the name of the lining system manufacturer and manufacturing lot or production footage. Ensure print is visible during final CCTV inspection.

D. Resin:

1. Provide a chemical-resistant thermoset (heat or UV light) resin and catalyst system or epoxy resin and catalyst / hardener system that, when cured within the fabric tube, complies with requirements of ASTM F 1216 or ASTM F 2019 and ASTM D 5813.
2. Method of cure may be by heat source, UV light, or ambient temperature.
3. Provide resin to tube ratio as recommended by the manufacturer.

E. System Seal:

1. For systems using a polyester or vinylester resin:
 - a. Provide a hydrophilic brim to seal the connection between the main and the lateral and a hydrophilic ring at the end of the lateral liner to seal the end of the liner.
 - b. Submit documentation that sealing method was tested by simulating groundwater pressure and verified by a third party.
2. For systems that use silicate or epoxy resin, provide third party testing of the bond strength between the resin and the surface it is to bind to.

F. Structural Requirements:

1. Design the cured-in-place service liner according to ASTM F 1216 utilizing the following assumptions, unless otherwise specified in the contract documents:

Table 4050.02: CIPP Service Design Values

Design Criteria	Value
Factor of safety	2.0
Soil modulus	1,000 psi
Soil density	120 pcf
Live load	H20
Depth of cover	As specified for each location
Groundwater	1/2 depth of cover
Ovality	2%

2. Set the long term (50 year extrapolated) creep retention factor at 50% of the initial design flexural modulus as determined by ASTM D 790 unless long term test data according to ASTM D 2990 substantiates a different retention factor.

2.03 CIPP SERVICE REPAIR (Continued)

3. Comply with the following minimum structural properties:

Table 4050.03: Minimum Structural Properties for CIPP Service

Property	Test Method	Minimum Value
Flexural modulus of elasticity	ASTM D 790	250,000 psi
Flexural strength	ASTM D 790	4,500 psi

4. Do not consider the bond to the existing pipe in determining the structural performance of the lining system.

2.04 CHEMICAL GROUT

- A. Grout:** Provide a chemical grout (chemical sealing material) complying with ASTM F 2304 or ASTM F 2454.
- B. Additives:** Strengthening agents, shrinkage reducers, dyes, viscosity modifiers, gel time modifiers, and freeze/thaw inhibitors, are allowed at the Contractor's discretion. Provide additives compatible with the chemical grout and complying with chemical grout manufacturer's requirements.
- C. Root Inhibiter:** When specified in the contract documents, provide a root deterrent chemical to control root regrowth. Ensure root inhibitor is compatible with chemical grout and additives and complies with grout manufacturer's requirements.

2.05 SEWER DYE

Provide tracer dye complying with NSF/ANSI 60.

2.086 PIPE REPAIR COUPLINGS FOR SPOT REPAIRS BY PIPE REPLACEMENT

- A. Style:** Full circle, fully lined, bolted.
- B. Length:** As recommended by the manufacturer for pipe diameter; 12 inches, minimum.
- C. Materials and Manufacturer:**
- Shells, armors, side bars, lugs, Turner lifting bars, ~~bolts and nuts~~, complying with ASTM A 240, Type 304 stainless steel.
 - MIG welds, fully passivated.
 - Rubber gasket complying with ASTM D 2000, AA415 with full coverage and a grid pattern.
 - Stainless steel armor bonded to gasket to bridge lug area.
- D. Nuts and Bolts:** 1/2 inch or 5/8 inch diameter, complying with ASTM A 240, Type 304 stainless steel, and Teflon coated threads.

2.097 SEWER MAIN PIPE (FOR SPOT REPAIRS)

- A. Comply with Section 4010.
- B. Use materials for pipe replacement as specified in the contract documents or approved by the Engineer.

PART 3 - EXECUTION**3.01 EXAMINATION****A. Cleaning**

1. Clean and remove soil, grit, debris, and obstructions according to Section 4060 prior to video inspection and/or insertion of pipe lining.
2. Do not flush debris to downstream sections.
3. Deposit removed material at an approved site.

B. Video Inspection:

1. Furnish the Jurisdiction with a recording of sewers: 1) before the lining process and while the flow is being bypassed; and 2) after the lining process and service reconnections have been completed.
2. Provide an on-screen numerical display of the camera location, indexed from the starting manhole, in feet.

C. Service and Obstruction Location:

1. Coordinate and cooperate with the Engineer for service and obstruction location.
2. Locate the active sewer services by one of following:
 - a. Use video inspection to observe service locations, breaks, obstructions, and structural failures.
 - b. Insert a sounding device through the service, noting its location on the ground surface.
 - c. Dye testing

3.01 SEWER CLEANING AND INSPECTION FOR REHABILITATION**A. General:**

1. Provide equipment specifically designed and constructed for sewer cleaning and inspection.
2. Use sewer cleaning equipment manufacturer's recommended size tools for various pipe sizes.
3. Utilize equipment recommended by the manufacturer to protect the manhole and pipe during cleaning and inspection operations.
4. Perform all cleaning and removal operations under CCTV observation to monitor the progress of the work and to monitor the sewer line for damage.
5. Flush all debris to downstream manhole. Screen, collect, and remove debris from sewer.
6. Dispose of all sanitary sewer debris and material at a location directed by the Owner. If specified in the contract documents, pay for all disposal fees.

B. Pre-Cleaning Inspection:

1. Complete CCTV inspection of sewer prior to initiating cleaning.

3.01 SEWER CLEANING AND INSPECTION FOR REHABILITATION (Continued)

2. Inspect each pipe segment between manholes or access points in a single, continuous run where possible.
3. If line is impassable due to debris or obstructions, reverse setup and inspect from opposite manhole or access point.

C. Pre-Rehabilitation Sewer Pipe Cleaning:

1. Perform light cleaning with hydraulic flusher or high velocity cleaning equipment to remove loose debris.
2. Complete up to three passes in an attempt to remove all debris from line.
4. If the pre-rehabilitation light cleaning fails to leave the sewer line in a condition ready for lining, contact Engineer for authorization to proceed with additional sewer cleaning.

D. Additional Sewer Cleaning:

1. Perform heavy cleaning as required to remove obstructions, grease, rock, sticks, deposits settled (DS), deposits attached grease (DAGS), deposits attached encrustation (DAE), and roots, so the sewer is ready for lining. This item does not include cutting/grinding protruding service lines.
2. Utilize rotating nozzles, saws or cutters, or high velocity hydro-cleaning equipment.
3. Notify Engineer prior to use of mechanical/hydraulic spinner nozzle, chain flail, or other devices that may damage pipe or service connections.
4. If deposits and obstructions cannot be removed by tools normally used in the sewer cleaning industry, notify Engineer immediately.
5. Maintain a log of time spent performing additional pipe cleaning on each line segment.

E. Remove Protruding Service Connection:

1. Grind or cut services that protrude more than 1/2 inch into the sewer main.
2. Utilize a remote grinding/cutting device specifically designed to remove concrete, vitrified clay, PVC, and other types of pipe materials.
3. Notify Engineer if ductile iron, steel, cast iron, or other non-typical service materials are encountered to review the ability and risks of removing the protruding services.
4. Grind or cut protruding service flush to the main sewer pipe without scouring or damaging the main sewer or service connection.
5. Notify the Engineer immediately if the sewer main or service pipe are not structurally sound.

F. Post-Cleaning CCTV Inspection:

1. Complete CCTV inspection of sewer upon completion of all sewer cleaning, obstruction removal, and protruding service removal activities.
2. Inspect each pipe segment between manholes or access points in a single, continuous run.

3.01 SEWER CLEANING AND INSPECTION FOR REHABILITATION (Continued)

- 3. Inspect all service connections at right angles utilizing pan and tilt capabilities of the camera.
- 4. Identify active and inactive service connections by the following:
 - a. Observe each service connection and identify active connections by active sewage flow or evidence of recent sewage flow.
 - b. If the status of the connection is inconclusive, run water down adjacent services to verify the location of each service.
 - c. Dye test connections if necessary to verify active status.
 - b. Accurately measure and log the location and clockwise position of all active service connections.

G. Groundwater: If significant groundwater infiltration is present, which could result in resin loss, resin contamination, reduction in CIPP thickness, or inadequate curing, notify the Engineer prior to installing CIPP liner.

H. Inspection Reporting:

- 1. Provide a copy of the pre-cleaning and post-cleaning video inspections. Include on-screen continuous footage, pipe diameter, direction of viewing, manhole number, and street location reference in the recording. Affix labels to the recording media to include the name of the project, the date, and the location of the inspection.
- 2. Provide a written report of the inspections. Include true to scale drawings of all sewer defects and observation locations. Reference the time stamp on each line item entry on the written report.

3.02 BYPASSING SEWAGE

- A. Submit a bypassing plan to the Engineer for review.
- B. When sewer line flows exceed the values in Table 4050.04, or the depth recommended by the manufacturer of the sewer rehabilitation practice being implemented, reduce flows to acceptable levels.
 - 1. Plug the line at a point upstream of pipe to be rehabilitated if bypassing is required.
 - 2. Pump flow to a downstream point or adjacent system as directed by the Engineer.
 - a. Provide pump and bypass lines of adequate capacity to handle all flows.
 - b. Provide adequate reserve pumps on-site for emergency use and for storm flows.
- C. Rehabilitation and inspection work may be completed without bypassing in certain situations including low flow conditions, adequate upstream storage, use of a flow-through packer, or other situations approved by the Engineer. If proposed work will be completed without bypassing, have equipment and plan of action available to implement bypass pumping in the event the work is delayed or sewage levels in the upstream line are in danger of causing backups.

Table 4050.04: Maximum Depth of Flow During Inspection, Testing, and Rehabilitation

Main Diameter	CCTV Inspection	Joint Testing/Sealing
6" to 10"	20% of pipe diameter	25% of pipe diameter
12" to 24"	25% of pipe diameter	30% of pipe diameter
27" and up	30% of pipe diameter	35% of pipe diameter

3.03 — OBSTRUCTIONS

- A. ~~Remove all obstructions.~~
- B. ~~If an obstruction is encountered that cannot be removed by equipment operating within the pipe, excavate and remove the obstruction upon approval of the Engineer.~~
- C. ~~Place backfill, compact, and restore the surface according to the contract documents.~~

3.04 — TEMPORARY SEWER SERVICE

~~If full normal sewer service is not re-established within the times stated, provide temporary facilities or hotel accommodations for affected residents and businesses.~~

3.05 — SLIPLINING**A. — Excavation:**

1. ~~For sliplining insertions, excavate at or near one structure and work from the existing manhole at the other end of the section to be pulled.~~
2. ~~Insertion Pit:
 - a. ~~For sliplining with segmented pipe (one pipe section at a time), construct the insertion pit as required to accommodate the length of individual pipe sections.~~
 - b. ~~For sliplining with pipe that is to be welded together above ground and pulled into the sewer, dig a pit length 12 times the inside pipe diameter and slope the pit end back to the ground surface at a rate of 2.5 (horizontal) to 1.0 (vertical).~~~~

B. — Test Head:

1. ~~Pull the pulling head with one short section of sliplining pipe through the sewer before inserting the pipe to test for taps or obstructions protruding too far into the sewer.~~
2. ~~Attach cables to both ends of the test head to allow for removal if an obstruction is encountered.~~

C. — Installation: ~~Push segmented pipe into the host pipe according to the manufacturer's recommendations, or pull in a continuously welded pipe according to ASTM F 585.~~

D. — Service Reconnection:

1. ~~Allow the sliplining pipe to recover according to the manufacturer's recommendations.~~
2. ~~Do not leave the sanitary service unconnected for more than 24 hours.~~
3. ~~Complete reconnections involving excavation of service lines according to the local plumbing codes.~~
4. ~~Reconnect excavated service connections according to the local plumbing code, except that the annular space between the host pipe and the sliplining pipe is to be filled with grout.~~

E. — Grouting:

1. ~~Before trimming the ends of the pipe and sealing, allow for the pipe to recover its original length according to the manufacturer's recommendations. Recovery time is at least equal to the time required to pull the pipe into place.~~

2. ~~Fill the space between the sliplining pipe and the host pipe with CLSM complying with Section 3010, 2.05 or other material approved by the Engineer. Pump filler in from the lower end of the sliplining pipe.~~

3.063 CIPP MAIN LINING RESIN IMPREGNATED CIPP LINING

- A. ~~Install according to the manufacturer's recommendations for this lining process and ASTM F 1216 unless otherwise specified.~~
- B. ~~Use a resin impregnated tube, hydraulically inverted in place with an approved lubricant, and cured in place according to ASTM F 1216, Section 7.~~
- C. ~~Make the tube continuous between manholes. The tube may span several manhole reaches as allowed by the equipment, properties of the CIPP, and the size and condition of the sewer.~~
- D. ~~Ensure the tube is free of uncured spots, lifts (spots cured away from the sewer), and delaminations. Remove and replace deficient sections.~~
- E. ~~Service Reconnections~~
 1. ~~Do not leave sanitary service unconnected for more than 24 hours.~~
 2. ~~Complete reconnections involving excavation of service lines, according to the local plumbing code.~~

A. General:

1. Clean, prepare, and inspect the repair point according to Section 4050, 3.01
2. Install liner according to the manufacturer's published recommendations, ASTM F 1216, and ASTM F 2019.

B. Resin Impregnation:

1. Vacuum impregnate tube with resin (wet-out) at manufacturer's plant under quality controlled conditions or on-site in mobile wet-out unit.
2. Fill all voids in the tube material, adding 5% to 10% excess resin to allow for migration of resin into the voids and cracks.

C. Insertion:

1. General:

- a. Perform pre-lining video inspection immediately prior to insertion of the wet-out tube.
- b. Insert the wet-out tube through an existing manhole or approved access.
- c. Ensure the tube is continuous between manholes with no joints. A single tube may span several manhole reaches as allowed by the equipment, properties of the CIPP, and time limits imposed by sewage flows to the host pipe.
- d. Insertion of CIPP indicates acceptance of the host pipe conditions and the suitability of the liner inserted into the host pipe. Repair any failure of CIPP liner due to inadequate cleaning, groundwater infiltration, or defects in the liner system at no additional cost to the Contracting Authority.

2. Inverted Heat-Cured Liner:

- a. Prior to installation of the liner, place a temperature sensor on the bottom of the host pipe to monitor the temperature of the outside of the liner during the curing process. Place sensor at the termination point or location most distant from the heat source.

3.03 CIPP MAIN LINING (Continued)

- b. Insert the wet-out tube into the inversion device or standpipe with the impermeable plastic liner on the outside of the tube.
- c. Turn back the end of the liner to form a cuff and secure the cuff to the inversion device or standpipe.
- d. Apply air pressure or hydrostatic head as required to invert the tube into the host pipe with the impermeable liner on the inside of the pipe.
- e. Apply lubricant directly to the tube or pour lubricant into the standpipe during the inversion process to reduce friction.
- f. Maintain and adjust pressure as necessary to invert the tube from the point of insertion to the point of termination and to hold the tube tight against the wall, producing dimples at service connections.

3. Pull-In UV Light Cured Liner:

- a. If CIPP manufacturer recommends the use of a sliding foil for the existing pipe conditions, provide sliding foil which covers the lower third to lower half of the pipe circumference. Pull sliding foil into place.
- b. Fold the wet-out liner in half and pull into place through an existing manhole. Monitor pulling speed and tension to avoid exceeding the manufacturer's recommendations.
- c. Pull 1 to 2 feet of excess liner into the termination manhole.
- d. If the product is sensitive to elongation, measure the overall elongation of the tube after pull-in. Ensure the elongation of the tube is less than 2% of the overall length of the segment specified by the manufacturer.
- e. Expand the resin-impregnated tube as necessary to hold the tube tight against the wall, producing dimples at service connections.
- f. Perform CCTV inspection of the inflated liner prior to initiating cure. Confirm alignment and fit prior to initiating cure. Make corrections as necessary to provide a finished liner free of wrinkles and defects.

D. Curing:**1. Heat Cured:**

- a. Maintain consistent pressure, as recommended by the liner manufacturer, until curing is complete. Increase pressures to compensate for external ground water, if present.
- b. Cure liner using circulating heated water or steam. Ensure the temperature is sufficient to affect a cure in all sections of the pipe.
- c. Monitor and log the temperature from the sensor placed between the impregnated tube and the host pipe.
- d. Initial cure will occur during heat up and is achieved when exposed portions of the new pipe appear to be hard and sound and the temperature sensor indicates the liner has reached the temperature necessary to effect a cure in the resin.
- e. After initial cure is reached, raise the temperature to post-cure temperatures and hold for a period of time as recommended by the resin manufacturer.
- f. Cool the new pipe to a temperature of 100°F for water cure and 113°F for steam cure before relieving the internal pressure within the section.

2. UV Light Cured:

- a. Automatically record the time, rate of travel of the ultraviolet assembly, pressures, and amount of lamps in operation for each CIPP segment as documentation of correct curing of the fabric tube.
- b. Maintain consistent pressure, as recommended by the liner manufacturer, until curing is complete.
- c. Draw the multi-lamp ultraviolet curing assembly through the pipe at a consistent, predetermined, speed that allows for cross-linking/polymerization of the CIPP resin.
- d. Adjust air pressure during curing as necessary to hold liner tight to the wall. Maintain pressure by adjustment of the outlet valve.

3.03 CIPP MAIN LINING (Continued)

- e. Remove the temporary internal calibration hose installed by the manufacturer after curing is complete.

G. CIPP End Seal Installation:

- 1. Hydrophilic Gasket Sleeve:** Install sleeve according to ASTM F 3240, sleeve manufacturer's published recommendations, and the following:
 - a. Do not install sleeve in host pipe more than 24 hours prior to CIPP lining.
 - b. Clean the first 6 inches of the main pipe to remove debris and visible grease deposits.
 - c. Install metal retaining clip at the leading edge of the sleeve. The metal clip may be held in place with adhesive tape if desired.
 - d. Install the sleeve in the main pipe so the leading edge is no more than 6 inches inside the end of the main pipe as measured from the manhole wall.
 - e. If the main pipe has a diameter of 18 inches or larger, utilize anchor screws to hold the sleeve in place.
- 2. Expansion Band System:** Install system according to manufacturer's published recommendations and the following:
 - a. After installation of the CIPP liner, trim the end of the liner squarely a distance of 2 to 6 inches from the inside face of the manhole.
 - b. Clean the exposed face of the main pipe to remove debris and loose resin.
 - c. Slide the rubber gasket into the pipe, centering it over the end of the liner. Ensure one expansion band will seat against the liner and the other will seat against the main pipe.
 - d. Expand the expansion bands using a hydraulic expansion tool approved by the band manufacturer.

H. Service Reinstatement:

1. Do not leave sanitary service blocked for more than 24 hours.
2. Reinstatement active service lines from within the main with a CCTV camera and remote cutting tool. Do not reinstate inactive service connections.
3. Machine the opening to at least 90% of the service connection opening area. Ensure the bottom of the liner opening and service line are flush.
4. Ensure the opening does not have pipe fragments or CIPP fragments that may obstruct flow or snag debris.
5. In the event that service reinstatement results in a liner opening greater than 100% of the service connection opening, or damage to the service connection occurs, install a CIPP service repair to cover the over-cut service connection at no additional cost to the Contracting Authority.
6. If service connection cannot be reinstated remotely and requires excavation complete according to the local plumbing code at no additional cost to Contracting Authority.

I. Inspection:

1. Perform CCTV video inspection of completed CIPP lining, including observance of reinstated service connections. Provide copy of video inspection to Jurisdiction.
2. Ensure the tube is free of dry spots, lifts (spots cured away from the sewer), and delaminations. Remove and replace deficient sections.

3.03 CIPP MAIN LINING (Continued)

3. If the CIPP does not fit tight against the original pipe at its termination point, seal the space between the pipes by filling with a resin mixture or hydrophilic seal compatible with the CIPP.

3.04 CIPP POINT REPAIR

A. Preparation: Clean, prepare, and inspect the repair point according to Section 4050, 3.01.

B. Bypass Pumping: Develop a plan for flow diversion or stoppage. Review with Engineer prior to initiating repair.

C. Installation:

1. Bypass mainline flow according to the submitted bypass plan.
2. Install CIPP point repair according to system manufacturer's published recommendations.
3. Wet-out the liner with the entire volume of resin recommended by the manufacturer.
4. Load the wet-out liner onto the packer and secure in place. Ensure the ends of the packer extend beyond the ends of the liner.
5. Pull the packer into position within the pipe. Verify position with CCTV observation.
6. Apply air pressure to the packer to expand the CIPP point repair liner against the host pipe.
7. Maintain consistent pressure for the duration of the curing period.

D. Inspection:

1. Perform CCTV video inspection of completed CIPP point repair. Provide copy of video inspection to Jurisdiction.
2. Ensure the tube is free of foreign inclusions, dry spots, pinholes, wrinkles greater than 2% of the pipe diameter, and delamination. Remove and replace deficient sections.
3. If the CIPP does not fit tight against the original pipe at its termination point, seal the space between the pipes by filling with a resin mixture or hydrophilic seal compatible with the CIPP.

3.05 CIPP SERVICE REPAIR

A. Preparation:

1. Prior to installation of the system, clean and prepare the interior of the host and service pipe in according to the manufacturer's written instructions.
2. Remove all debris and obstructions.
3. Perform a post cleaning CCTV inspection in preparation for installation of the lining system.

3.05 CIPP SERVICE REPAIR (Continued)

4. If any obstructions, joint misalignments, broken or collapsed pipe, or other conditions are identified that will prohibit proper installation of the system, notify the Engineer immediately.

B. Installation:

1. Install CIPP service repair according to system manufacturer's published recommendations.
2. Bypass main line flow according to the submitted bypass plan. Coordinate installation with service owner to prevent service line flows.
3. Wet-out the entire liner, including lateral and mainline portions, using vacuum impregnation.
4. Load the lining system inside or on a pressure apparatus and move into position in the mainline pipe at the service connection.
5. Align and verify the position of liner and service line via CCTV prior to initiating installation.
6. Apply air pressure to invert or expand the resin impregnated CIPP into the lateral pipe and push the main-line portion of the system against the main pipe. Maintain pressure until the curing process is complete.
7. Apply heat or UV light as required by the manufacturer to property cure the liner.
8. If liner is heat cured, follow manufacturer's recommendations for cool-down before relieving pressure.
9. If liner is ambient cured, maintain pressure according to the manufacturer's recommendations before relieving pressure.
10. Remove frayed ends of the system.

C. Inspection and Documentation:

1. Provide Jurisdiction with video documentation of pre-installation conditions and post-installation conditions showing the repair.
2. Ensure the finished CIPP service repair is free of any leakage and visual defects including foreign inclusions, dry spots, lifts, pinholes, major wrinkles, and delamination. Repair any defects that could affect the structural integrity of the system or allow leaks.
3. Maintain a written log of installation conditions according to system manufacturer's recommendations. At a minimum, include time of wet out, time and location of insertion, time of inflation, bladder pressure requirements, required cure time, actual cure time, and cool down duration.
4. Submit documentation of test results for CIPP liner material to Jurisdiction.

3.06 CIPP TESTING

A. General: Unless otherwise specified in the contract documents, sampling and testing of CIPP main lining and CIPP service lining are required and are the responsibility of the Contractor. Provide testing of CIPP material using the services of an independent testing laboratory approved by the Engineer.

B. Sampling:**1. Main Lining:**

- a. Obtain samples from each section of CIPP installed. Document the location and time each sample was obtained.
- b. Cut samples from a section of cured CIPP that has been inverted or pulled through a like diameter section of pipe at the termination point. For heat cured lining, surround sampling point with a suitable heat sink such as sandbags.
- c. Obtain samples of sufficient size to produce five specimens with a minimum width of 2-inches, measured along the axial length of the pipe, for testing.
- d. On pipelines greater than 18 inches, the Jurisdiction may require plate samples cured with the CIPP or designate a location in the newly cured CIPP for samples to be taken. Repair opening produced according to manufacturer's recommendations.

2. Service Repair: Obtain one flat plate sample for every 25 service repairs, with a minimum of 2 samples per project.

C. Testing:**1. Main Lining:**

- a. The Jurisdiction will identify approximately 20% of the locations lined for testing.
- b. Submit selected samples to testing laboratory for analysis.
- c. Test each sample for short-term flexural properties, tensile properties, and CIPP wall thickness according to ASTM F 1216 or F 2019 as applicable for the type of lining installed.

2. Service Repair: Continuing to investigate.

3.07 ~~DRP-HDPE OR FFP-PVC LINING INSTALLATION~~

~~Install according to the manufacturer's recommendations for particular lining material and process, unless otherwise specified.~~

~~A. Lining Installation:~~

- ~~1. Designate location where insertion is to begin, subject to the Engineer's approval.~~
- ~~2. Transport lining to the site in one continuous length on spools compatible with the manufacturer's designated process.~~
- ~~3. Heat lining material at the job site as necessary for insertion. Pull lining into the sewer with appropriate pulling heads, cables, and heat distribution equipment.~~
- ~~4. Ensure lining is continuous between manholes as allowed by the tensile properties of lining and the size and condition of the sewer.~~
- ~~5. Connect fully inserted lining to the heat source distribution equipment.~~
- ~~6. Round and expand by uniformly distributed heat, steam, and pressure and by mechanical devices.~~

- ~~7. After lining has been expanded to a tight fit, cool gradually under pressure until the process is complete.~~
- ~~8. Provide a continuous pipe lining, without joints, over the entire length of pipe.~~
- ~~9. Ensure the lining is free of all material defects, pits, pinholes, cracks, crazing, folds, or unrounded sections.~~
- ~~10. Repair all defects at no additional cost to the Jurisdiction.~~

~~B. Service Reconnections:~~

- ~~1. Do not leave sanitary service unconnected for more than 24 hours.~~
- ~~2. Complete reconnections involving excavation of service lines according to the local plumbing code.~~

3.07 PRESSURE TESTING AND GROUTING OF SEWER JOINTS

A. General:

1. Clean, prepare, and inspect the repair point according to Section 4050, 3.01
2. Complete sewer joint and service connection testing and grouting according to the grout supplier and equipment manufacturer's published recommendations, ASTM F 2304, and ASTM F 2454.

B. Equipment:

1. **Joint Testing Device:** Provide a joint testing device (packer), with means for introducing air under pressure into the void area created by the expanded ends of the packer against the host pipe and a means of continuously measuring, viewing, and recording the static pressure of the test medium and grout within the void area only. Provide packer constructed in a manner to allow a limited amount of sewage to flow through at all times.
2. **Service Connection Testing Device:** Provide a service connection testing device with inflatable mainline end elements and a service line grouting plug that creates a void area extending beyond the main connection. Use a service line grouting plug sized to match the diameter of the service being grouted with an effective sealing length of at least 18 inches, unless otherwise specified in the contract documents.
3. **Pumping Equipment:**
 - a. Provide positive displacement metering grout pump and hose delivery system capable of supplying a mixed volume of grout at a minimum of 3 gallons per minute and 30 gallons of uninterrupted flow within 10 minutes.
 - b. Ensure pump system has sufficient discharge pressure (in excess of system pressure losses and groundwater) to deliver grout volume to fill void space within the gel set time of the chemical grout.
4. **Grout Tanks:** When using non-soluble additives, ensure grout tanks have mechanical mixing devices to keep additives in suspension.
5. **Measuring Equipment:** Provide means of measuring and recording the volume of mixed grout pumped for each grouted joint or service connection.

3.07 PRESSURE TESTING AND GROUTING OF SEWER JOINTS (Continued)**C. Control Tests:**

1. Prior to beginning testing and grouting, perform a demonstration test in an above ground 8 inch nominal diameter test cylinder suitable to contain the full length of the packer and sustain the void test pressure. For service line testing, provide an 8 inch test cylinder with 6 inch service tee to receive the lateral bladder.
2. Equip the test cylinder with a pressure gauge to monitor internal pressure and a release valve to exercise a controlled release of pressurized air from the void area to test the packer under both sound and leaking conditions.
 - a. With the void release valve closed, inflate the packer and air test the void at 7 to 10 psi. Ensure the observed void pressure at the test cylinder pressure gauge is within $\pm 1/2$ psi of the test monitoring equipment.
 - b. Crack open the release valve to simulate a small leak. Ensure the pressure drop of the cylinder gauge is within $\pm 1/2$ psi of the test monitoring equipment.
2. After entering each pipeline segment, but prior to commencement of joint testing, position the packer on a section of sound and clean sewer between two consecutive pipe joints and perform a pressure test. Pressurize packer to between 7 and 10 psi and hold for a period of 15 seconds with a pressure drop of less than 1.0 psi. Deflate packer and ensure that void pressure monitoring equipment drops $\pm 1/2$ psi of initial reading.
3. If any of the control tests are unsuccessful, clean equipment of excess grout or make necessary repairs and retest.

D. Sewer Main Joint Pressure Testing:

1. Test joints at a target pressure equal to $1/2$ psi per vertical foot of pipe depth plus 2 psi (not exceeding 10 psi).
2. Position the packer within the pipe so the packer straddles the pipe joint to be tested. Verify location via CCTV monitoring.
3. Expand the packer ends to isolate the joint from the remainder of the pipe and to create a void area between the pipe joint and testing device.
4. Pump air into void space until the pressure reaches the required test pressure.
5. Stop the flow of air into the void space and observe the void pressure for 15 seconds.
6. If the pressure is maintained with a drop of less than 1 psi, the joint will be considered as having passed the test.
7. If the pressure drops more than 1 psi during the test period, the joint will be considered as having failed and sealing will be required.
8. Deflate packer and verify the void pressure monitor drops to within $\pm 1/2$ psi of 0 psi. Clean equipment if pressure fails to return to 0 psi.

E. Service Line Pressure Testing:

1. Test service lines at a target pressure equal to $1/2$ psi per vertical foot of pipe depth plus 2 psi (not exceeding 10 psi).
2. Position the testing device within the line segment to straddle the service connection. Verify location via CCTV.

3.07 PRESSURE TESTING AND GROUTING OF SEWER JOINTS (Continued)

3. Align the service bladder with the service connection.
4. Apply air pressure to invert or inflate the bladder from the mainline assembly into the service pipe.
5. Expand the packer ends to isolate the section of the service connection to be tested.
6. Introduce air into the void area until a pressure equal to or up to 10% greater than the required test pressure is observed.
7. Stop the flow of air into the void space and observe the void pressure for 15 seconds.
8. If the pressure is maintained, with a pressure drop of less than 2 psi, the connection will be considered as having passed the test.
9. If the pressure drops more than 2 psi during the test period, the connection will be considered as having failed and sealing will be required.
10. Deflate packer and bladder and verify the void pressure monitor drops to within $\pm 1/2$ psi of 0 psi. Clean equipment if pressure fails to return to 0 psi.

F. Sewer Main Joint Sealing by Injection Grouting: Perform joint sealing according to ASTM F 2304, equipment manufacturer, grout supplier, and the following:

1. Position packer over the faulty joint and expand packer ends, isolating the joint with a tight seal.
2. Pump two-part chemical sealant material into the ratio specified by the grout supplier.
3. Continue to pump grout, in stages if necessary, until "refusal" is achieved.
 - a. Refusal indicates the grout has flowed throughout the void, into the surrounding soil, forming a cohesive seal stopping further flow of grout.
 - b. Under pumping conditions, void pressure will slowly rise as grout is forced into the surrounding soil and begins to set. When void pressure spikes an additional 8 psi or more in a short pumping period of 1 to 5 seconds, the point of refusal is achieved.
 - c. If a quantity of grout equal to 1/2 gallon per inch diameter of pipe size is pumped without reaching the point of refusal, staging may be required. Staging is accomplished by repetitive cycles of pumping and curing until refusal is achieved. Notify Engineer for approval before staging is attempted.
 - d. If joint cannot be sealed by staging, abandon sealing operations at that joint and notify Engineer.
4. Upon reaching refusal, stop grout pumps and allow grout to cure for 30 to 40 seconds.
5. Deflate packer to break away the ring of gel formed in the void and move at least one packer length away from the joint in either direction.
6. Ensure pressure gauge reads zero pressure $\pm 1/2$ psi. If gauge does not return to zero clean equipment.
7. Reposition packer over joint and retest at a pressure equal to the initial test pressure.
8. If joint fails pressure test, repeat grouting and pressure testing procedure until the joint is sealed or Engineer determines grout consumption is too high and continued attempts to seal joint are abandoned.

3.07 PRESSURE TESTING AND GROUTING OF SEWER JOINTS (Continued)

9. Remove residual sealing materials that extend into the pipe or restrict the flow. Ensure sealed joint surfaces are left flush with existing pipe surface. Remove residual grout material from manhole; do not allow grout to be flushed down the sewer.

G. Service Connection Sealing by Injection Grouting: Perform service sealing according to ASTM F 2454, equipment manufacturer, grout supplier, and the following requirements.

1. Pump two-part chemical sealant material at the ratio specified by the grout supplier.
2. Continue to pump grout, in stages if necessary, until refusal is achieved.
 - a. Under initial pumping conditions, the void pressure will slowly rise to a range of approximately 2 to 4 psi.
 - b. Continue pumping until there is a sudden increase to over 8 psi in a few seconds, indicating refusal.
 - c. If a quantity of grout equal to 1 gallon per foot of service line bladder plus 3 gallons is pumped without reaching the point of refusal, staging may be required.
 - d. Stage grouting by pumping additional grout equivalent to 1 gallon plus 0.25 gallons per foot of bladder, waiting 1 full minute and retesting. Do not exceed two stages unless approved by Engineer
3. Upon reaching refusal, stop grout pumps and allow grout to cure for 1 full minute.
4. Deflate service packer, re-inflate, and repeat service line pressure testing.
5. If the service connection test fails, repeat injection grouting and pressure testing procedures until service is sealed or Engineer determines grout consumption is too high and continued attempts to seal service are abandoned.
6. Confirm flow after sealing of each service. If a grout blockage exists, immediately clear the service of the blockage.
7. A thin film of residual grout inside the service, which does not significantly impede flow, is a normal result of sealing and is not considered a blockage.

H. Inspection and Reporting: Comply with ASTM F 2304 Section 12.9 as noted below.

1. **Inspection:**
 - a. Perform CCTV observation and recording of initial pressure testing, sealing operations (if required), and final pressure testing (if required) for each joint or service.
 - b. Perform final CCTV video inspection of sewer main rehabilitated by injection grouting after all grouting work is completed. Provide copy of video to the Jurisdiction.
2. **Reporting:** Upon completion of each pipe segment, submit a report showing the following information for each joint and service connection tested, grouted or both.
 - a. Identification of sewer pipe section tested.
 - b. Type of pipe material, diameter, and depth of pipe to surface at manholes.
 - c. Length of pipe sections between joints.
 - d. Test pressure used before and after sealing and duration of test.
 - e. Location of each joint or service connection tested and any joints or service connections not tested with and explanation for not testing.
 - f. Pass/fail results for each joint or service connection tested.
 - g. Volume of grout material used on each joint or service connection.
 - h. Grout mix record of the batches mixed including amount of grout and catalyst, additives, temperature of the grout solution in the tanks, and gel set time used.

3.08 SPOT REPAIRS BY PIPE REPLACEMENT

- A. Excavate trench according to Section 3010.
- B. Remove existing pipe to the extent required and disconnect affected sewer services.
- C. Install replacement pipe of the same nominal size as the existing pipe.
 - 1. Use the materials as specified in the contract documents that comply with Section 4010.
 - 2. Place bedding material according to Section 3010.
- D. Install pipe repair coupling.
 - 1. Cut pipes to length required allowing no more than a 1/2 inch gap between butted pipe ends at coupling location. Cut pipes perpendicular to centerline.
 - 2. Clean the outside surface of the existing and replacement pipes as required to provide a positive seal with the pipe repair coupling.
 - 3. Wrap coupling around pipes, centered on butt joint, and tighten bolts according to manufacturer's recommendations.
- E. Reconnect sewer services.
- F. Place backfill in trench according to Section 3010.

3.09 CLEANUP AND CLOSEOUT

- A. Verify that the services are reconnected and fully operable, with at least 90% of original capacity.
- B. Submit initial and final video tapes, CDs, or DVDs to the Engineer.
- C. Remove all equipment and debris.

END OF SECTION