1.0 SCOPE

This section of the specifications covers the reconstruction of sanitary and/or storm sewer lines by the cured-in-place-pipe (CIPP) method. The CIPP method is defined as the reconstruction of a host pipe by the installation of a (thermosetting) resin impregnated tube into the host pipe without trenching. The tube is constructed to have an impermeable inner coating to protect the resin and shall be formed to the host pipe by means of a water column, air or steam pressure system. The cured-in-place-pipe shall extend the full length of the pipe being rehabilitated, and shall provide a structurally sound, impermeable, joint-less, and close-fitting pipe within a pipe when cured.

2.0 GENERAL

2.01 Description of Work

The work required by the project shall consist of furnishing all labor, equipment, materials, plant and supervision, and performing all work necessary to rehabilitate the gravity sewer lines. The work shall consist of, but not necessarily be limited to, performing the following work tasks:

1. Sewer line cleaning
2. Sewer flow control
3. Closed circuit television inspection
4. Cured-in-place-pipe rehabilitation
5. Lateral reinstatement

2.02 Reference of Specifications

This specification references American Society for Testing and Materials (ASTM) standard specifications, which are made a part of hereof by such reference and shall be the latest edition and revision thereof.

F1216-07b  Standard Practice for rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin Impregnated Tube.

F1743-08  Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).

D5813-04  Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe.

D638-08  Test Method for Tensile Properties of Plastics.
2.03 Submittals

Design:

The contractor shall submit designs for each manhole to manhole section of pipe with the bid. These designs shall be made in accordance with Section X1 of ASTM F1216 and the project specifications. Designs shall include any assumptions made in addition to those specified herein, all calculations and inputs, and design output.

Materials Certification:

Joint certification of materials from the manufacturer and contractor shall state with the bid that the materials supplied for this project will meet or exceed the requirement of the specification once installed under field conditions. The certification must include a statement indicating that physical properties of 95% or more of field samples of the composite will meet or exceed properties used as input for the designs submitted for this project.

3.0 CURED-IN-PLACE-PIPE MATERIALS

3.01 Tube Materials

The tube shall be supplied by the system licensor to the licensed contractor according to ASTM F1216, F1743 and D5813. The standard tube consists of one or more layers of flexible, needled polyester felt or an equivalent woven and/or non-woven material capable of carrying resin, withstanding installation pressures and curing temperatures, and compatible with the resin system used. No single layer of the felt tube system will be less than 1.5mm in thickness. The liner manufacturer shall determine the felt content. Alternative tube designs consisting of one or more layers of oriented high strength fibers (such as fiberglass), which may also be used in combination with layers of non-woven fibers or polyester felt may be specified. All specialized liners fabricated with high strength and/or high modulus fibers must be capable of carrying resin, withstanding installation.
pressures and curing temperatures, and be compatible with the resin system used. Regardless of the materials of construction, the outside layer of the tube should be plastic coated with a material that is compatible with the resin system used.

3.02 Resin/Catalyst

The contractor shall furnish an unsaturated polyester, vinylester, or epoxy resin compatible with the approved liner and a compatible catalyst or curing system as specified by the resin manufacturer. The resin manufacturer shall provide the contractor with their recommended curing cycle and shall submit the same to the project engineer for his approval. All resin systems shall be capable of curing in the presence of water. The resin may contain one or more specialized fillers or additives that provide viscosity control, fire resistance, flexural modulus enhancement, chemical resistance, or extension of pot life. Thixotropic agents that will not interfere with visual inspection may be added for viscosity control. Resins may contain pigments, dyes, or colors that do not interfere with the CIPP or it’s required structural properties. Standard and enhanced unsaturated polyester resins most typically are qualified and specified for gravity and storm sewer pipe rehabilitation. For internal pressure, elevated temperatures and/or applications where concentrated chemicals are present, specialized resin systems may be required and additional data indicating chemical and thermal resistance, or mechanical integrity shall be provided to the project engineer for approval.

4.0 STRUCTURAL REQUIREMENTS

4.01 Design Criteria

The cured-in-place-pipe thickness shall be calculated and designed based upon the following physical condition of the existing pipe to be rehabilitated.

1. All pipes shall be classified as either Partially Deteriorated or Fully Deteriorated as defined in Section X1.1 of ASTM F1216.
2. All pipes shall have a minimum of 2% ovality in the circumference.
3. The water table is assumed to be present 5 feet below the top of the ground.
4. For pipes classified as Fully Deteriorated a soil density 120 lbs./c.ft.
5. For pipes classified as Fully Deteriorated any pipelines running under highways, city streets, or other roadways shall be assumed to carry highway live loads of (16,000lbs.).
4.02 Mechanical Properties

Installed cured-in-place-pipe shall meet the following minimum structural standards:

- Flexural Strength (ASTM D790)  4,500 psi
- Flexural Modulus (ASTM D790)  250,000 psi
- Heat Distortion Temperature  70° C
- Retention of Properties to Account for Long Term Effects (D2990)  50%

Installed cured-in-place-pipe using “enhanced resin systems” to produce high modulus shall meet the following minimum structural standards:

- Flexural Strength (ASTM D790)  4,500 psi
- Flexural Modulus (ASTM D790)  400,000 psi
- Heat Distortion Temperature  70° C
- Retention of Properties to Account for Long Term Effects (D2990)  50%

5.0 INSTALLATION PROCEDURES

5.01 Safety

The Contractor shall carry out this operation in strict accordance with all OSHA and manufacturer’s safety requirements. Particular attention is drawn to those safety requirements involving working with scaffolding entering confined spaces and operations with hot media.

5.02 Pre-Installation

Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles, and service connections. Before installing CIPP the existing pipe must be carefully inspected to determine the location of any conditions, which may prevent proper installation of the CIPP, and it shall be noted so that these conditions can be corrected. The Owner shall keep a videotape and suitable log for later reference.

(A) Bypass

**Bypass Pumping:** The contractor shall provide for the flow of sewage around the section of sewer lines designated for lining. The bypass shall be made by plugging the line at an existing upstream manhole and pumping or directing the flow to a downstream manhole or adjacent sanitary sewer system. The
pump(s) and bypass lines shall be of adequate capacity and size to handle the flow. Raw sewage shall be routed back to the sanitary sewer system.

(B) Cleaning

Pre-Installation Cleaning: It shall be the responsibility of the Contractor to remove all debris which is located within the sewer pipe and dispose of the debris in accordance with all applicable laws and regulations.

(C) Pre-Inspection

Pre-Installation Television Inspection: It shall be the responsibility of the Contractor to video (TV) inspect the sewer pipe immediately before the insertion of the impregnated tube to assure that the pipe is clean and existing pipe conditions are acceptable for lining.

5.03 Resin Impregnation

The Contractor will designate a location where the tube will be impregnated. The volume of resin used for tube impregnation should be sufficient to fill the volume of air voids in the tube with additional resin in the range of 5 to 10% for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process and a roller system shall be used to remove air from the tube and uniformly distribute the resin throughout the tube.

5.04 Inversion Using Hydrostatic Head

The resin-impregnated tube shall be inserted through an existing manhole by means of an inversion ring or standpipe, capable of applying the hydrostatic head required to fully extend the tube to the next designated manhole or termination point. The tube shall be inserted into the inversion standpipe: the tube shall be turned inside out and attached to the inversion standpipe so that a leak-proof seal is corrugated. The inversion head shall be adjusted to a sufficient height to invert the tube from manhole to manhole and to hold it tight against the existing pipe wall, producing dimples at side connections and flared ends at the manhole. Care shall be taken not to overstress the tube at the elevated curing temperatures, which may cause damage or failure prior to cure.

5.05 Inversion Using Pressurized Air
The resin-impregnated tube shall be installed through an existing manhole by means of a guide chute or specialized air chamber that allows for controlled air pressure to fully extend the tube to the next designated manhole or termination point. The tube shall be turned inside out at the front of the guide chute or air chamber and the inversion air pressure shall be adjusted to a sufficient level to invert the tube from one manhole to the other and hold it tight against the existing pipe. Care shall be taken not to overstress the tube at the elevated curing temperatures, which may cause damage or failure prior to cure.

5.06 Pulling Resin-Impregnated Tube into Position

Resin-impregnated tubes that are designed to be installed by the pulled-in-place method may be designed with or without an inner plastic coating. The resin-impregnated tube shall be pulled into place using a power winch. The tube should be pulled through an existing manhole or approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during the pull-in process. If the tube has an inner plastic coating it is attached to a vertical standpipe of sufficient height for curing with water. For air or steam cure the tube is attached at both ends to an appropriate manifold for controlling the air and/or steam pressures. If the tube does not have an inner plastic coating then it will be inflated with the inversion of an inner calibration hose into the center of the resin-impregnated tube. The calibration hose may be inverted with the use of a vertical standpipe for water cure and with the use of a guide chute or pressure chamber for air/steam cure. Either method of installing the calibration hose and inflating the resin-impregnated tube tightly against the existing pipe shall be according to ASTM F1743. The acceptable longitudinal elongation shall not be more than 5% of the overall length measured after the tube has been inflated and/or the calibration hose has been installed.

5.07 Curing Using Circulated Heated Water

After the tube installation process is completed, the Contractor shall supply a suitable heat source and water recirculation throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin system. The manufacturer of the resin system shall recommend the temperature/time cure cycle for the installed liner that will include an initial heat up and post cure, as necessary.

The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge shall be placed between the layers of the impregnated tube in the upstream, downstream, and intermediate manholes to determine the
temperature during curing. Water temperature in the line during the curing period shall not be less than 130 degrees F or more than 200 degrees F as measured at the heat source return line. Initial cure may be considered complete when the exposed portions of the CIPP appear to be hard, and the remote sensing device indicates the temperatures to be adequate, as recommended by the manufacturer of the resin system.

5.08 Curing Using Steam

After the tube installation process is completed, the Contractor shall supply suitable steam generating equipment that is capable of distributing steam throughout the section to uniformly raise the temperature above the temperature required to effect a cure of the resin system. The manufacturer of the resin system shall recommend the temperature/time cure cycle for the installed liner that will include an initial heat up and post cure, as necessary.

The steam generating equipment shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing steam supply, as well as internal pressure of the steam in the liner. Another such gauge shall be placed between the layers of the impregnated tube in the upstream, downstream, and intermediate manholes to determine the temperature during curing. Initial cure may be considered complete when the exposed portions of the CIPP appear to be hard, and the remote sensing device indicates the temperatures to be adequate, as recommended by the manufacturer of the resin system. The curing of the CIPP must take into account the existing pipe material, the resin system, materials of construction of the liner, and ground conditions (temperature, moisture level, and thermal conductivity of the soil).

5.09 Cooling Down for Water and Steam

The Contractor shall cool the hardened cured-in-place-pipe to a temperature below 100 degrees F before relieving the water column or internal steam pressure. For water curing, cool water may be added to the water column while draining hot water from a small hole at the end of the CIPP so that a constant water column height is maintained until cool-down is completed. For steam cure, cool water may also be introduced into the section to replace a mixture of air/steam being relieved from a small hole at the end of the CIPP. For either curing method, pressure shall be maintained inside the CIPP during cool down and careful attention shall be taken not to cool too quickly to eliminate the possibility of thermal shock or otherwise damaging the newly installed CIPP.

5.07 Service Connection
After curing, the Contractor shall reinstate the existing live building laterals designated by the Construction Engineer. All lateral services shall be reinstated within hours of beginning the inversion process. This shall generally be done without excavation from the interior of the pipe by means of a television camera and a cutting device that reinstates the building laterals to not less than 90% of their original capacity. The Contractor shall certify that he has a minimum of two (2) complete working units plus spare key components on the site before each inversion.

5.08 Fit/Finish

The finished pipe shall be continuous over the entire length of the sewer section. The finished liner will tightly conform to the walls of the existing (host) pipe, therefore, it is the Contractor’s responsibility to verify the section lengths and pipe dimensions. No gap or annular space between the finished liner and the host pipe shall be allowed or be visible at the manhole, sewer service connection, or other exposed points within the finished liner section. The finished liner shall be homogenous throughout and free of any protrusions, holes, cracks, etc., which in the opinion of the Engineer will affect the liner’s structural integrity, hydraulic performance, future maintenance access, and overall line performance. After the work is completed, the Contractor shall provide the Engineer with a videotape showing both the before and after conditions of the liner including the reinstated building lateral connections.

5.09 Inspection Practices

For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one of the following methods:

The sample should be fabricated from material taken from the fabric tube and the resin system used, and cured in a clamped mold, placed in the downtube when heated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the appropriate orientation (axial or circumferential) of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with any other representative method.

Alternatively, samples may be cut from a section of the cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means.
The restraining pipe or tube must be held in place by a suitable heat sink, such as sandbags.

For either sample method, the CIPP samples must be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing in accordance with Section 8.3.1 of ASTM D5813. For internal pressure or other applications tensile testing (ASTM D638) may be required and should be carried out in accordance with Section 8.3.3 of ASTM D5813.

Installed CIPP wall thickness measurements shall be measured from the representative samples and measured in accordance Section 8.1.2 of ASTM D5813.

Any additional or alternative tests required by the specifying engineer shall be mutually agreed upon by the installer and owner prior to the installation of the CIPP.

### 5.10 Clean Up

After the installation work has been completed and all testing acceptable, the Contractor shall clean up the entire project area. The Contractor shall dispose of all excess material and debris not incorporated into the permanent installation.