

1.0 GENERAL

- 1.1 Description** .1 Section 33.05.24S refers to those portions of the work that are unique to the supply and installation of Cured-In-Place-Pipe liner for circular sewer main rehabilitation up to and including 1000mm diameter. This section must be referenced and interpreted simultaneously with all other sections pertinent to the works described herein. This supplemental specification supersedes section 33.05.24, Cured In Place Pipe Liners, of the Platinum Edition of the MMCD, Vol. II.
- 1.2 Related Work** .1 Traffic Regulation - Traffic and Highway Bylaw.
.2 CCTV Pipeline Inspection Section 33 01 30.1.
.3 Sewer Cleaning Section 33 01 30.2.
- 1.3 References** .1 Reference standards, specification or publications (current issues).
- .1 ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Material.
 - .2 ASTM D2990 Standard Test Method for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.
 - .3 ASTM D5813 Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems.
 - .4 ASTM E1252 Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis.
 - .5 ASTM F1216 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
 - .6 ASTM F1743 Standard Practice for the Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).
 - .7 ASTM F2019 Standard Practice for the Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).

- 1.4 Material Certification** .1 All materials to conform to this specification, to the latest edition of the appropriate specifications of the American Society for Testing and Materials (ASTM) or other standards expressly specified. All provisions in ASTM and other specified standards pertaining to materials, workmanship, finish, inspection and rejection form part of these specifications as far as they are applicable and providing that they are not inconsistent with this specification. This specification takes precedence over the ASTM specifications in case of a discrepancy or conflict. Materials incorporated into the Work but not specifically covered in the specifications are to be obtained from the Contract Administrator prior to installation.
- 1.5 Work Regulations** .1 Work to conform to all applicable regulations of Work Safe BC Confirm training compliance in the following:
- .1 Confined space entry procedures.
 - .2 Atmospheric monitoring and ventilation methods.
 - .3 Personal protective equipment.
 - .4 Interpretation of Material Safety Data Sheets (MSDS).
- 1.6 Submissions** .1 The Contractor shall submit the following information at the time of tender submission:
- .1 Description of proposed lining product including the name of the manufacturer of the tube and resin together with relevant references to applicable ASTM procedures for product manufacture and product installation.
 - .2 Independent third party test data supporting values for long-term modulus of elasticity of proposed CIPP composite material in accordance with ASTM D2990. These tests must include a description of the composite verifying the type of resin, carrier material and corresponding reference numbers.
 - .3 Infrared Spectroscopy report (graph) of proposed resin in accordance with ASTM E1252.
 - .4 Structural design calculations for liner thickness based on ASTM F1216-09 Appendix XI.

- .5 Statement of compliance confirming that the liner will be installed in strict adherence to the appropriate ASTM Standard Practice. Alternatively provide concise statement of items of deviation from the Standard Practice.
 - .6 Provide three (3) references for similar CIPP projects carried out in the past three years. References to include: The name of the municipality for which the liner installations were completed, contact name and telephone numbers of project manager.
 - .7 Statement as to whether the intended installation and curing method is for hydrostatic head, steam/pressure or Ultra-violet ray. Provide brief description of associated equipment.
 - .8 Resume of experience for the wet-out supervisor and on-site lining superintendent.
- .2 Contractor to submit the following information at least ten (10) days prior to initiation of rehabilitation work:
- .1 Calculated values for maximum inversion head and curing head and maximum allowable tensile strength for each section of CIPP liner.
 - .2 Resin curing schedule including anticipated temperature and cure times for the various stages of installation reflecting the proposed resin system, liner length, thickness and diameter.
 - .3 Resin volume calculations for each section of liner.
 - .4 Written confirmation of safety training for field crews.
 - .5 Site sketch indicating proposed layout of bypass pumping system.
 - .6 Project schedule detailing a work plan time-line.
 - .7 Traffic management plan.
 - .8 Certificate of Calibration for the time / temperature monitors conducted within the past 18 months of the beginning of the contract.
- .3 No CIPP liner installation shall take place prior to review and written acceptance of the aforementioned submissions by the Contract Administrator.

- 1.7 Material Samples**
- .1 Provide one (1) restrained sample for each liner installed for mains up to 400mm diameter. Sample to measure minimum of 450 mm in length and formed in suitable circular pipe mould. For sewer mains greater than 400mm diameter the contractor will extract a field sample from the lined main as directed by the engineer.
 - .2 Provide one (1) control sample of uncatalyzed resin direct from manufacturer to testing agency.
 - .3 Provide three (3) 200 ml samples of uncatalyzed resin direct from resin drum at time of wet-out as directed by the Contract Administrator.
- 1.8 Scheduling**
- .1 Schedule work to minimize interruptions to existing services.
 - .2 Hours of work to comply with noise restriction bylaw unless granted exemption from governing authority.
- 1.9 Measurement for Payment**
- .1 All units of measurement for payment will be as specified herein unless shown in the Form of Tender.
 - .2 Measurement for payment of by-pass pumping system will be on a lump sum basis for the completed project as described in the Form of Tender. This shall include the supply and installation of the temporary by-pass pumping system including pumps, piping, hoses, controls, power supply, standby power/pump supply, transfer switch, by-pass of all designated connections to the main, fuel and maintenance cost, security fencing and other appurtenances and services required to establish and maintain the system for the duration of the project.
 - .3 Measurement for payment for sewer cleaning will be on a per linear metre basis as described in the Form of Tender and in accordance with Supplementary Specifications – Sewer Cleaning Section 33 01 30.2.
 - .4 Measurement for payment of root cutting will be made on an hourly basis as described in the Form of Tender and in accordance with Supplementary Specifications – Sewer Cleaning Section 33 01 30.2.
 - .5 Measurement for payment of Pre-installation CCTV inspection will be on a linear metre basis as described in the Form of Tender and in accordance with Supplementary Specifications – Sewer Cleaning – Section 33 01 30.1.
 - .6 Measurement for payment of removal of intruding connections will be paid at the unit price as described in the Form of Tender. This shall include the supply of all equipment and labour to

remotely remove intruding connections comprised of PVC, vitrified clay, concrete, asbestos cement and cast iron.

- .7 Measurement for payment for sewer lining will be on a linear metre basis for respective pipe diameters described in the Form of Tender. The length will be based on linear metres indicated on the Contract Drawings and confirmed in the field by CCTV inspection measurement or above ground measurement unless otherwise agreed upon in writing by the Engineer.
- .8 Measurement for payment of service connection re-instatement will be paid at the unit price as described in the Form of Tender. This shall include the supply of all equipment and labour to remotely re-instate designated service connections.
- .9 Measurement of payment for Measurement for payment of Post-installation CCTV inspection will be on a linear metre basis as described in the Form of Tender and in accordance with Supplementary Specifications – Sewer Cleaning – Section 33 01 30.1.

1.10 Inspection and Testing

- .1 Contractor to provide Engineer free access to inspect the materials and wet-out procedures and render all assistance including installation of the Engineer's testing equipment (thermistor cables) and confined space entry equipment to facilitate physical inspection of finished liner.
- .2 Contractor to provide Engineer 48 hours advance notice of wet-out operation. The wet-out shall not commence without the owners designated inspector in attendance unless waived in writing by the Contract Administrator.
- .3 Physical property values used in submitted structural calculations must be met prior to release of progress and final payments. Failure to achieve these values will require the re-submission of calculations using the physical properties determined by independent laboratory test results as per ASTM D 790.
 - .1 The material testing laboratory will be selected by the Contract Administrator. No other material tests results conducted by other than the designated material testing facility will be considered

- .2 The minimal values for Flexural Strength and Flexural Modulus shall be in accordance with Table 1 of the corresponding ASTM Standard Practice for each liner technology. Failure to achieve these values may incur payment penalties.
- .3 Digital copy of the Time and Temperature (and where applicable pressure) curing logs to be presented within 72 hours of liner installation and prior to release of interim payments.

2.0 PRODUCTS

2.1 Liner Technology

- .1 The liner material shall be such that it will restore the structural integrity of the pipe and eliminate the potential for infiltrating ground water and exfiltration of contents. The completed liner shall contain only materials capable of withstanding the effects of conventional sanitary and storm sewage, the gases produced there from, grits and other materials normally transported in sanitary and storm sewage pipelines.
- .2 The following liner technologies only are acceptable under these specifications:
 - .1 Cured-in-place (Felt liners) Inversion Method –ASTM F1216- 09 *Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of Resin-Impregnated Tube*. This Standard Practice is deemed to be a specification. No deviation from this Standard Practice will be accepted without the express written permission of the Contract Administrator.
 - .2 Cured-in-place (Felt liners) Pull-in-place Method – ASTM F1743-08 *Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)*. The Title of Section 6 “Installation Recommendation” is replaced by the term “Specified Method of Installation”. No deviation from this Standard Practice will be accepted without the express written permission of the Contract Administrator.

- .3 Cured-in-place (Glass Reinforced Plastic) Pull-in-place Method – ASTM F2019 -11 *Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)* The Title of Section 6 “Installation Recommendation” is replaced by the term “Specified Method of Installation”. No deviation from this Standard Practice will be accepted without the express written permission of the Contract Administrator.
- 2.2 Liner Material**
- .1 Minimum material requirements for CIPP liners to conform to ASTM D5813.
- .2 All liner tube shall be made of virgin material. No rework except that obtained from the manufacturer’s own production of the same formulation shall be used.
- .3 Liner material to have a minimum tensile strength of 5 MPa (750 psi) in both longitudinal and transverse directions when tested in accordance with the requirements of ASTM D 1682 Test Methods for Breaking Load and Elongation of Textile Fabrics or ASTM D 5035.
- 2.3 Resin**
- .1 The following resins are permitted under the terms of this contract:
- .1 Premium polyester resins that do not contain a styrene monomer;
- .2 Vinyl Ester resins that do not contain a styrene monomer;
- .3 Epoxy resin.
- .4 Premium polyester resins containing styrene when cured only through the Ultra Violet (UV) process.
- .2 Resin used for impregnation to be consistent with the product identified in the ASTM D2990 testing performed by the resin manufacturer and submitted at the time of tender. If no long-term testing is available than the short-term Modulus of Elasticity to be discounted by 50%.
- .3 Volume of resin to be consistent with the volume calculations submissions in accordance with ASTM F1216-09, Section 7.2 *Resin Impregnation* including an allowance between 5% to 10% for change in resin volume due to polymerization and migration.
- 2.4 Workmanship and Finish**
- .1 The finished CIPP liner shall conform to Clause 6.2 *Workmanship* of ASTM D5813.

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- .2 The Contractor shall field measure the internal circumference of the sewers to determine the exact size of liner so that the liner is tight to the wall of the existing pipe and the surface finish is free of pleats, folds or creases.
- .3 Physical dimensions of the liner shall conform to Clause 6.3 *Dimensions* of ASTM D5813.
- 2.5 Liner Design**
- .1 Liner thickness calculations shall assume that all sections of sewer main to be rehabilitated are considered to be “*Fully Deteriorated Gravity Pipe Condition*”. Designs will be based on the modified AWWA formula as detailed in Appendix XI of ASTM F1216-09 edition with the following minimum design assumptions:
- .1 The total external pressure on the pipe shall include an allowance for an AASHTO HS20 concentrated live load.
- .2 The minimum soil density utilized in computation of dead load shall be 1920 kg/m³.
- .3 The height of the water above the pipe shall be based on the assumption that the groundwater table is 1.0 metre below the ground surface elevation.
- .4 The ovality reduction factor shall be based on a minimum value of 3% unless a greater value is specified or warranted based on the Contractor’s observation of the CCTV inspection, remote measuring method or physical measurement.
- .5 The modulus of soil reaction (E’s) shall be assumed to be 6900 kPa unless a higher or lower value is specified in these documents.
- .6 The minimum factor of safety (N) to be utilized in the fully deteriorated design analysis shall be 2.
- .2 The long-term value for the flexural strength (E_L) shall satisfy the following:
- .1 The projected value at 50 years of continuous application of the load based on the specific resin and fabric composite proposed for use as established by ASTM D2990.
- .3 A design check using Manning’s formula shall be performed to confirm that the rehabilitated section will have a hydraulic capacity equal to or greater than the existing pipeline. The assumed value for Manning’s “n” for the CIPP section shall be 0.011.

- .4 Liner design calculations signed and sealed by a Professional Engineer or holder of an Engineering License under APEG BC.
- 2.6 Sealing Material** .1 Approved sealing material between host pipe and liner shall be an epoxy grout or alternative products approved by the Contract Administrator.
- 3.0 Execution**
- 3.1 Resin Impregnation (Wet-Out)** .1 Quality Control: Record and document all resin:catalyst ratios and weights of chemical components employed for each batch (barrel) of resin mixed.
- .2 Contractor to conduct gel tests (time to hardness) for each batch of resin mixed.
- .3 All documentation related to quality control of resin:catalyst ratios shall be made available for to the Contract Administrator upon request.
- 3.2 Bypass Pumping** .1 Contractor to provide notice of work to residents minimum 1 week prior to commencing (date on letter).
- .2 Contractor shall install temporary bypass pumping system around the designated sewer sections in accordance with pre-submitted arrangement.
- .3 Pumps and bypass lines shall be of adequate capacity to accommodate pre-determined flows as specified in the contract documents.
- .4 Contractor to take all necessary precautions to prevent spills to the environment or back-up of sewerage onto private property. In the event of a spill the Contractor shall be responsible for immediate clean-up operation and remediation of damaged property.
- .5 Contractor shall report any spills and back-ups to Engineer immediately.
- 3.3 Preparation** .1 Flush and clean sewer main of all debris, roots and ponding water before liner installation. Cleaning of sewers to be carried out in accordance with Standard Supplemental Specification for "Cleaning of Sewers" Section 33 01 30.2.
- .2 Remove intruding portions of service connections to within 5 mm of the mainline pipe wall. Finished surface of intruding connection to be left smooth to avoid damage to liner material.

- .3 Conduct pre-installation CCTV inspection in accordance with Standard Supplementary Specifications for CCTV inspection of Sewers - Section 33 01 30.1.
 - .4 Pre-measure and document the location of all service connections within the main. Record distance, clock position and diameter of connection.
 - .5 Notify Contract Administrator of any unforeseen obstructions or anomalies observed in the pre-installation CCTV inspection.
 - .6 Notify effected property owners 24 hours in advance of disruption of service. Information notice to be pre-approved by Contract Administrator.
- 3.4 Liner Installation**
- .1 Install liner in accordance with applicable ASTM standard as referenced in Section 1.2 *References* of this specification.
 - .2 Pull-in type liners shall have a calibrated dynamometer fitted to the winch. The pulling tension shall not exceed fifty (50%) of the tensile strength of the liner.
 - .3 Liners inverted by means of water column shall comply strictly with Items 7.4.1 of ASTM F 1216-09 have sufficient head to cause the impregnated tube to invert to point of termination and hold the tube tight to the pipe wall in a continuous operation. Monitor inversion head to ensure tensile stresses values are not exceeded.
 - .4 Liners inverted by means of air pressure to comply strictly with Items 7.4.2 and 7.4.3 of ASTM F 1216-09 and the following parameters;
 - .1 Liner to be installed within the minimum and maximum installation pressure (heads) as recommended by the tube manufacturer.
 - .2 The advancement of the liner will be controlled with the aid of a hold-back rope or tape to ensure a tight fit to the host pipe at all times in order to displace air pockets and residual water. The rate of advancement shall not exceed 1m per second.

- .3 Continuous pressure shall be maintained within the tube throughout the complete inversion, curing and cool-down cycle without falling below the minimum allowable pressure at anytime during the process. ***Should the pressure deviate from within the range of the minimum and maximum pressures, the installed tube shall be removed from the existing conduit.***
 - .5 Install temperature and pressure gauges to monitor both upstream and downstream ends of liner.
 - .6 Thermistors cables to be located between host pipe wall and inserted liner. Thermistors shall be connected to data logger and time/temperature (where applicable pressure) data gathered at a sampling rate designated by the Contract Administrator.
 - .7 The curing and cool-down process to follow the ASTM Standard Practice under which the liner is installed. Specifically the curing process will follow the resin manufactures recommendation to achieve; initial cure, followed by a period ***of not less than two (2) full hours*** of post-cure at the manufacturer's recommended temperature. Cool-down will take place at no greater rate of one (1) degree °F per thirty (30) seconds until such time as the designated cool-down target temperature is achieved.
 - .8 No deviation of the criteria set-out under Item .7 of this Section (curing and cool-down) will be acceptable without the express written consent of the Contract Administrator. Such requests by the contractor will be submitted in writing seven (7) days prior to the intended lining date.
 - .9 Present curing data to the Contract Administrator following each liner installation.
- 3.5 Field Cured Samples**
- .1 Install pipe mould or equivalent to form representative restrained sample at either upstream or downstream manhole. For pipe sizes of 450mm or less, the sample should be held in place by a suitable heat sink such as sandbags. For larger pipe sizes, plate samples will be provided or a sample of the in-situ CIPP liner shall be extracted from the new liner subject to approval by the Contract Administrator. The Contractor shall use an approved resin material to repair the location where the sample was extracted.
 - .2 Remove CIPP pipe samples and present to Contract Administrator immediately following each liner installation.

- 3.6 Service Reconnection**
- .1 Reconnect all designated service connection as specified in the contract documents and in accordance with Contract Drawings.
 - .2 Service connection re-opening to be carried out by remotely operated cutting equipment in tandem with articulating CCTV inspection camera.
 - .3 Brush finish each re-opened connection with wire brush attachment to eliminate uneven edges and leave smooth finish.
- 3.7 Termination at Manholes**
- .1 Liner terminal points at manholes to be tight fitting and tapered to eliminate impediments to flow.
 - .2 Seal annular space between host pipe and liner with approved sealant to eliminate water tracking.
- 3.8 Post Installation CCTV Inspection**
- .1 Conduct the following two CCTV inspection surveys:
 - (i) a preliminary post installation CCTV inspection immediately after the removal of the surplus head and tail sections of liner and prior to returning the sewer to service;
 - (ii) a full CCTV post-installation within 48 hours in accordance with Sections 33 01 30.1. Submit copy of inspection report to Engineer.
- 3.9 Acceptance**
- .1 Acceptance of each CIPP liner will be determined based on the following:
 - .1 Material tests of field cured samples shall have the minimum values as stated in ASTM F1216-09 – Section 7 – Table 1 (CIPP Structural Properties) and meet the claimed physical material properties used in the submitted structural calculations.
 - .2 Review of resin volume impregnation records.
 - .3 Installation and curing logs including:
 - .1 Installation, curing and cool-down heads.
 - .2 Curing temperatures and pressures for compliance with applicable ASTM standards.
 - .4 Review of post installation CCTV inspections reports.
 - .2 Penalties may be assigned to each liner which fail to meet acceptable standards.

END OF SECTION