

**Specification for the
Cured-In-Place Rehabilitation of
Sanitary/Storm Sewer Services**

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TS 4.11.01 Scope

This specification is for the Cured-in-Place Pipe (CIPP) and Cured-in-Place Construction (CIPC) rehabilitation of sewer services including the sewer service lateral pipeline and the sewer service connection to the main sewer in the city of Toronto. The sewers with services may include sanitary sewers and combined sewers.

The Work shall include performing the following operations: notification of public, traffic control, cleanout installation, CCTV inspections, determining sewer dimensions (main and lateral), determining liner dimensions, cleanout installation, determining/confirming design parameters for liners, flow control and bypass pumping, cleaning and preparation for lining, service connection investigation and related work, installation and curing of the cured-in-place sewer service rehabilitations, reinstatement of sewer service connections, return of the rehabilitated sewer service to regular service plus any other work required for and incidental to the foregoing.

The work involved requires special equipment to be handled by persons experienced in all phases of the work.

Sewer Service Rehabilitation

The sewer service lateral pipeline is referred to in abbreviation as the lateral pipeline. The sewer service connection at the main sewer is referred to in abbreviation as the service connection.

This specification covers three types of sewer service rehabilitations.

- Type A – Lateral Pipe Liner Only—from just outside of main sewer to property line.
- Type B – Service Connection and Lateral Pipe Liner—from inside main sewer to property line.
- Type C – Service Connection Liner—from inside main line sewer to short distance up service lateral pipeline.

For Type A, B and C, the rehabilitation of the lateral pipeline shall always provide for a lateral pipeline in fully deteriorated condition. For Type B and Type C the rehabilitation of service connection within the main sewer shall be able to provide for a main sewer in either partially or fully deteriorated condition.

The requirement for Type A, B or C sewer service rehabilitation will be specified in the Tender Call or alternatively specified by the Contract Administrator after the sewer service assessment as specified in Contract Documents is completed by the Contractor. For Types B and C the Contract Administrator will specify the main sewer condition, either partially or fully deteriorated. A contract may require more than one type of sewer service rehabilitation.

For all types, the complete rehabilitation shall be installed and cured as a one-piece cured-in-place construction. For Type B and C there shall be shall no separate constructions for the service pipeline portion and the main sewer portion. Within the service pipeline itself, the rehabilitation shall be CIPP. Within the main line sewer, the rehabilitation shall be either a CIPP or CIPC.

The rehabilitations shall accommodate lateral pipeline sizes of 100, 125 and 150 mm nominal sizes. Type B and C rehabilitations shall accommodate main sewer sizes of 200, 225, 250, 300, 375 and 450 mm nominal sizes.

TS 4.11.02 Objectives for Sewer Service Rehabilitation

The sewer service rehabilitation installations shall accomplish the following objectives throughout their design life:

For Type A

- fit tightly to the inside surface of the existing lateral pipe;
- prevent infiltration of ground water;
- provide structural performance in accordance with the design requirements in TS 4.11 herein;
- provide a smooth flow path for the sewage;
- prevent root intrusion;
- provide a continuous one piece cured-in-place construction;
- be fixed tightly in place; and
- provide flow capacity equal or better than existing capacity before lining.

For Type B and C

Accomplish all objectives listed for Type A, plus for the portion in the main sewer:

- provide a continuous one piece cured-in-place construction;
- provide a smooth surface inside the main sewer;
- provide a smooth transition from the main sewer surface to the cured-in-place structure;
- provide, within the main sewer, the level of structural performance required;
- provide structural performance in accordance with the design requirements in TS 4.11 herein; and
- allow normal main sewer cleaning, reaming and maintenance without damage to the rehabilitation.

Where, in the Contract Administrator's opinion, the proposed Type A, B or C rehabilitations will not accomplish these objectives, the proposed product or its installation shall not be acceptable.

TS 4.11.03 Information to be Reviewed Prior to Bid Submission

For Tender Calls where the sewer service locations for rehabilitation have been identified in the Tender Call, all Bidders shall review the City CCTV inspection records of these locations prior to submission of their Bid. Arrangements for viewing these records shall be made according to the instructions in the Tender Call. Upon viewing, the prospective bidder shall fill out and sign the *CCTV Review Sign Up Sheet*.

If, for bidding purposes, the Contractor is of the opinion further inspection is required in order to properly assess the work to be undertaken, the Contractor will be responsible to perform such additional inspection. Permission to enter the City's sewer system for inspection purposes must be obtained from the Contract Administrator.

TS 4.11.04**Information to be Submitted with Bid**

The Tender Call requires the following information to be submitted with the Bid for the review and approval of the Contract Administrator. Further information could be required to be submitted elsewhere in the Tender Call other than in TS 4.10 herein.

Submit with Bid:

- 1) The name of a professional engineer licensed in the province of Ontario who will provide the CIPP liner engineering designs required according to the liner design requirements in TS 4.11 herein. The professional engineer shall be authorized to perform such work by Professional Engineers Ontario (PEO).
- 2) CIPP liner design for all sewer service sections identified in the Tender Call: The liner design shall be according to TS 4.11 herein. The designs shall bear the seal and signature of an Engineer.
- 3) A CIPP liner design example if no sewer service sections identified in the Tender Call: The liner design shall be according to TS 4.11 herein. For Type B and C designs shall include for both partially and fully deteriorated main sewer. The designs shall bear the seal and signature of an Engineer.

Where more than one type of sewer service rehabilitation is required in the Tender Call, an example design shall be submitted for each type required. The example designs shall be illustrative of future designs that shall be submitted during the Contract. As sewer sections are identified during the contract, the designs submitted shall bear the seal and signature of an Engineer.

- 4) Material specifications and structural details of the proposed sewer service rehabilitations in sufficient detail to enable confirmation by the Contract Administrator that the rehabilitation proposed will meet the design requirements of TS 4.11 herein. Include the proposed resin manufacturer, resin type and manufacturer's resin identification number. Include the proposed liner tube manufacturer and type of tube.
- 5) Details illustrating the dimensions of the main sewer portions for Type B and C rehabilitations including for partially and fully deteriorated main sewer.
- 6) A CCTV recording on Digit Video Disc (DVD) showing completed installations for all the types of sewer service rehabilitations required for this Tender Call. The CCTV recording shall show that the proposed rehabilitations comply with the contract requirements including the requirements of TS 4.11 herein where these requirements can be demonstrated visually.
- 7) A complete list of equipment including CCTV cameras, robotic service connection cutters, reamers and other necessary major items to be dedicated to the work. The list of equipment shall specify type, manufacture and quantity of equipment.
- 8) A summary of the Contractor's proposed sewer service rehabilitation installation procedure. Include one example of the liner wet-out process sheet and one example of the liner curing process summary sheet to be used, for each liner, for the work.
- 9) A certified original copy complete with supporting literature from the resin manufacturer of the Infrared Spectrograph of the catalyzed resin(s) mixture proposed for this Contract.

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- 10) A reference list of municipal locations where the proposed sewer service rehabilitation products have been installed including contact information necessary for follow up by the Contract Administrator.
 - 11) Substantiation by independent testing of the CIPP or CIPC rehabilitation properties such as flexural modulus and flexural strength used in design of the sewer service rehabilitations. Substantiation shall be included for both short-term and long-term properties.

TS 4.11.05 Notification to Public and Log Record

Prior to commencement of any work on the Contract the Contractor must deliver written notices to all affected parties a minimum of 7 Days to a maximum of 14 Days prior to any work commencing at each location. The Contractor must schedule the works accordingly. Such written notices shall consist of letters supplied by both the Contract Administrator and the Contractor and both must be delivered at the same time.

From time to time during the Contract other notices, such as the *Service Interruption Notice*, shall be distributed by the Contractor.

Contractor's notices shall be typed on the Contractor's letterhead and clearly indicate both daytime and after hours local contact telephone numbers. Telephone numbers shall be either local area code or toll free numbers. No work will be allowed to commence without such notices. Any Contractor's written notice shall be submitted to the Contract Administrator for approval prior to notice delivery.

Service Interruption Notice

At all times when a sewer service will be interrupted or limited by rehabilitation activities, the Contractor shall provide a 24-hour *Service Disruption Notice* to the affected property. The notice shall be typed on the Contractor's letterhead and clearly indicate both daytime and after hours local contact telephone numbers for the Contractor. The notice shall include notifying the property residents to limit their sewer use, including the use of any mechanical devices, for example sump or ejector pump from discharging to the sewer service, in a manner that may adversely affect the lining process. The Contractor must schedule the sewer service rehabilitation installation accordingly.

No service disruption will be allowed without such 24-hour notification. In the event that the Contractor is unable to install the sewer service rehabilitation on the date stated in the *Service Disruption Notice* the Contractor must immediately provide written notification of the change of date including the new date for the sewer service rehabilitation installation. After the service line and connection has been fully returned to service the Contractor shall notify the property that the sewer service is returned to service.

Log Record

The Contractor shall maintain a log record of notices delivered by the Contractor and follow-up activities by the Contractor at each property throughout the contract work.

Damage or Loss due to Failure to Notify

In the event that damage or loss or both to person or property occurs as a result of the Contractor not notifying the public as per the notification protocol, all such liabilities shall be fully borne by the Contractor.

TS 4.11.06 Contacting the Property Owner

Where contacting the property owner is necessary for notification or obtaining any permissions from the property owner that may be required for the work, the Contractor shall make reasonable efforts to contact the property owner to make such notification or obtain such permissions. Such efforts shall include a minimum of three attempts including directly at the property and by telephone. The Contractor shall keep a log record of all attempts. When, after reasonable attempts, the Contractor remains unable to contact the property owner for the required reason or when contact has been made and the property owner does not wish to cooperate, Contractor shall advise the Contract Administrator and wait for instructions from the Contract Administrator.

The Contractor shall maintain a log record of notices delivered by the Contractor and follow-up activities by the Contractor at each property throughout the contract work.

TS 4.11.07 Site Investigation

Before commencing any construction work at a site the Contractor shall investigate each site to determine the existing site conditions and identify any obstructions or any other problem that may affect the completion of the proposed works. No additional payment shall be made on account of difficulties to complete the works because the Contractor failed to investigate the site prior to commencement of the work.

TS 4.11.08 Existing Sewer Service Records and Drawings

The Contract Administrator shall provide the Contractor with a list of services for rehabilitation, available CCTV inspections for the services and any available City sewer map drawings for the sewer service locations. This information will be provided either in full at the start of the Contract or alternately on an incremental monthly basis during the contract. The method of provision either in full or incrementally will depend on the structure of the Contract.

The Contractor shall review the inspection information and drawings prior to undertaking any work in the sewer and sewer service laterals.

TS 4.11.09 Locating Sanitary Sewer Services

The contractor shall be responsible for locating the existing sanitary sewer service for rehabilitation and any existing cleanout on the service pipeline.

The Contractor shall make sure that the sewer service located for rehabilitation is the sanitary service, not a storm service. Some properties may have both sanitary and storm services. Both services may be located in close proximity to each other.

Dye Testing Required to Positively Identify Sanitary Service

When more than one service pipe from a property is found or known to exist, dye testing shall be used to positively identify the sanitary service for rehabilitation. The dye testing shall identify the sanitary service pipeline(s) and its corresponding service connection(s) at the main sewer. Where no clean out is available or to be installed, the Contractor shall be required to perform the dye testing from within the property as arranged by the Contractor with the property owner.

TS 4.11.10 Weather Conditions

The Contractor shall review the Environment Canada weather forecast prior to commencement of lining operations. Where the anticipated weather conditions are such that anticipated sewer or sewer service flows or both may exceed the Contractor's bypass pumping capacity or may cause potential basement flooding such as blocked laterals due to the liner, commencement of construction shall be delayed until favourable weather is forecast.

TS 4.11.11 Sewer Service Assessment

Before proceeding with any rehabilitation work at any service location, the Contractor shall assess the condition of the service lateral pipeline and the main sewer service connection. The assessment shall be used by Contract Administrator to determine the sewer service rehabilitation type required—Type A, B or C—and the main sewer condition—either partially or fully deteriorated.

Assessment Method

The assessment shall utilize CCTV inspection of the lateral pipeline and service connection. V1 assessment CCTV shall be performed as indicated in section TS 4.11.16. The Contractor may choose to perform the CCTV inspection either from an existing cleanout or from the main sewer. In either case the CCTV inspection shall be sufficient for the Contract Administrator to determine:

- 1) Suitability of the sewer service lateral pipeline for rehabilitation;
- 2) Suitability of the sewer service connection to the main sewer for rehabilitation;
- 3) Type of sewer service rehabilitation system to be installed, that is Type A, B or C; and
- 4) Structural requirement for the service connection part of the sewer service rehabilitation for Types B and C, that is the main sewer condition at the connection shall be assessed as partially or fully deteriorated.

When Existing Suitable Cleanout

Where a suitable cleanout exists, the Contractor shall make the assessment inspection from the cleanout. Alternatively, at the Contractor's cost, the Contractor may choose to perform the assessment inspection from the main sewer.

When No Existing Suitable Cleanout

Where no suitable cleanout exists, the Contractor shall install a new cleanout at the property line and make the assessment inspection from the new cleanout. Alternatively, at the Contractor's cost, the Contractor may choose to perform the assessment inspection from the main sewer.

Note About Other Requirements for Cleanout

Installation of a cleanout may be required even if the assessment inspection is performed from the main sewer. Refer to Contract Documents, such as Special Specifications for when a cleanout is always required and must be installed if no suitable cleanout exists, regardless of whether a cleanout is needed for assessment inspection or rehabilitation installation.

Assessment Results and Rehabilitation Requirements

The Contract Administrator, on the basis of the assessment, will specify the type of sewer service rehabilitation, such as Type A, B or C that is to be installed by the Contractor at the service location. For Types B and C rehabilitations, the Contract Administrator will specify the main sewer condition—either partially or fully deteriorated—that the rehabilitation shall accommodate.

Assessment to Identify Wye in Sewer Service

The assessment shall identify, by the CCTV, if there is a wye fitting in the sewer service whereby two service pipelines, typically from different properties come together into a common service pipeline leading to the main sewer. Where a wye is identified, its location shall be recorded. The Contractor shall advise the Contract Administrator when a wye is found and its location.

TS 4.11.12 New Cleanout Installation

The Contractor shall install a new cleanout as required for service assessment, as required for service rehabilitation or as required by the Contract. The Contractor shall determine the location for the new cleanout, which shall be located at the property line.

All excavation for cleanout installation shall be done using a vacuum excavation method and every attempt must be made to minimize the size of the excavation at property line, with the maximum allowable excavation diameter being 900 mm subject to soil conditions.

A City approved 150 mm PVC cleanout with a brass/metal cap, proper bedding and couplings shall be installed and brought up to grade at the property line.

If it is not feasible or not possible to install a clean out on the property line due to tree roots, close proximity to tree trunk or any other unforeseen reason, then a cleanout shall be installed as close as possible to the property line, on the public or private side that is feasible and approved by the Contract Administrator.

The Contractor shall provide GPS co-ordinates of the cleanout cover accurate to 0.30 m horizontally referenced to Zone 10 of the Ontario Coordinate System, NAD 1927, 1969 adjustment, 3° Modified Transverse Mercator projection used by the Survey and Utility Mapping section.

The excavation areas shall be restored to its original condition or better according to City standards.

TS 4.11.13 Flow Control and Bypass

When interruption of sewer line flows is necessary to properly conduct the work including such as CCTV inspection and sewer service rehabilitation installation operations, acceptable methods of flow control shall be provided. Where bypass pumping is used, flow control shall be according to TS 4.01 – *Construction Specification for Temporary Sewer Bypass System*.

The Contractor is to make all necessary arrangements with the owners of each building. The Contractor shall contact all property owners or tenants or both to co-ordinate the repair work to the sewer and minimize any impact on residents businesses or both.

During the inspection and rehabilitation, sewer and sewer service flows shall be shut off in order to enable proper inspection of the pipe, including the invert. After the work is completed, flows shall be restored to normal. Excess sewage flows shall be transported through a closed, leak tight pipeline or by tank trucks to the nearest or most economical disposal area.

On all sewer service rehabilitation installation dates, the Contractor must maintain on site both a primary and stand-by bypass pump and pump power supply. Sufficient power supply and hoses must be on site in order to allow the pump to discharge into the next downstream sewer section. The stand-by bypass pump and power supply shall be of an equal or better capability than the primary bypass pump and power supply. No bypass pumps or related equipment shall be disconnected or removed from the sewer or job site until after all service connections have been reinstated and the Contractor has recorded the post-installation video.

All bypass pumping shall be in place and operation prior to the final pre-installation inspection. All bypass pumping capacities and configurations must be approved by the Contract Administrator prior to the actual liner installation date.

All bypass pumps and related equipment must be silenced equipment or contained within an acceptable sound reduction structure.

Flow Control Included Limit Provision

The Contractor shall provide for all bypass capacity up to and including 150 mm pump configurations where a 150 mm pump shall have a minimum capacity of 4540 L/min (1200 USGPM). The Contractor shall be responsible for determining the bypass capacity. Where the Contractor has determined that the bypass requires capacities exceeding 4540 L/min, the Contractor shall advise the Contract Administrator of the requirement and any additional cost for the higher bypass capacity. The Contract Administrator shall provide further instruction to the Contractor as needed including, as required, negotiation of additional payment for the bypass capacities exceeding 4540 L/min.

Sufficient Capacity for Flow Control

No flow control or bypass pumping shall be employed that has insufficient capacity to maintain flow in the sewer system. It is the Contractor's responsibility to employ flow control of sufficient capacity. No work requiring flow control shall proceed until flow control arrangements are in place that provide sufficient flow control capacity including for situations that exceed the *Flow Control Included Limit Provision*.

TS 4.11.14**CCTV Inspections and Reports**

CCTV inspections for V1, V2 and V3 assessments shall follow the following:

CCTV Equipment

The cameras and transmission cables utilized under this contract shall produce colour recordings and the recording equipment utilized shall produce MPEG-1 or MPEG-2; one MPEG file per sewer section inspection.

The CCTV camera used in the main sewer inspections shall be colour, pan, tilt and zoom view type capable of radial rotation of 360°, lateral rotation of 270°, and of producing a continuous picture resolution of not less than 400 lines at the periphery of the picture. Picture resolutions shall, at the discretion of the Contract Administrator, be confirmed using a RS Resolution Chart—Retina Type.

The CCTV camera used in sewer service inspections shall be colour and suitable for providing the necessary level of detail for assessment of sewer service conditions pre and post lining.

The cameras shall be equipped with a self-contained, adjustable, directed light source compatible with the lens angle and dispersed to create even distribution of the light around the pipe perimeter without the loss of contrast, flare out of picture or shadowing.

The CCTV camera for main sewer inspections shall be self-propelled. The mounting of the camera shall be adjustable such that the central axis of the camera lies at a point equidistant between the invert and overt of the pipe during inspection of the sewer. In the case of egg shaped sewers, the camera lens must be positioned vertically above the invert at a height two thirds of the vertical dimension of the sewer. In all instances, when transporting the camera through the sewer the camera lens must be positioned on, and looking along the central axis of the sewer.

The CCTV camera for sewer service pipeline inspections shall be suitable to provide a clear view of the inside of the pipe, including the invert to allow proper judgment of the pipeline condition being inspected.

The equipment and cables utilized shall be capable of inspecting a minimum sewer length of 150 m, without reversal in main sewers and 20 m in sewer service pipelines without reversal.

Internal Conditions for CCTV Inspections

The sewer service under inspection shall be sufficiently dry so that any remaining water does not obscure any part of the interior of the main sewer or sewer service during the CCTV inspection. Where required, flow control shall be used to accomplish this clear viewing of the sewer.

The camera shall provide sufficient light and proper focus to enable clear viewing of the pipe surface at all locations.

The main sewer or sewer service under inspection shall be free of any fog or vapour that obscures the view. Where required ventilation or other provision shall be used to eliminate such fog or vapour.

The inspection speed shall allow proper analysis of the sewer condition. The maximum camera travel speed shall be 5 m/minute.

When required for a specific inspection, the CCTV camera shall stop and view each service connection clearly and completely for at least five seconds.

Each individual CCTV inspection shall be continuous over the main sewer section or service pipeline being inspected.

Notice to City of Inspections

The Contractor shall advise the Contract Administrator or Inspector by 6:30 a.m. same day by phone or e-mail when a CCTV inspection is to be done in order so that the Contract Administrator or Inspector can arrange to be present for the CCTV inspection.

CCTV Screen Information

The main sewer CCTV inspection shall include the Title Screen in the format indicated below, clearly displayed for a minimum of 30 seconds at the start of all video inspection recordings. Inspection of the sewer section shall not proceed while the information screen is being displayed:

Line Number	TITLE SCREEN
1	CITY OF TORONTO
2	CONTRACT No. 12345
3	SL – 9 STREET: NIAGARA ST.
4	PRELIMINARY / POST-PREPARATION VIDEO
5	DATE: 21 MAR/99
6	TIME: 11:55 AM
7	SURFACE DISTANCE: 112.0 M
8	START MH No: 23 2ND S/O WELLINGTON
9	END MH No: 22 1ST S/O WELLINGTON
10	WEATHER: DRY / RAIN / MELTING SNOW / etc.
11	FLOW DIRECTION: N TO S
12	CAMERA DIRECTION: S TO N
13	START & S/C REFERENCE POINT: CAMERA PANNED 90°
	SIZE: 305 mm TYPE: CLAY DUTY: COMBINED
	CONTRACTOR: ACME LINERS INC.

Upon commencement of, and throughout the inspection, the following information shall be continuously displayed on-screen and captured on the recording: start and ending maintenance hole numbers, street name, continuous chainage, and feature/defect coding.

The sewer service CCTV inspection shall include the Title Screen in the format indicated below, clearly displayed for a minimum of 30 seconds at the start of all video inspection recordings. Inspection of the sewer service shall not proceed while the information screen is being displayed:

Line Number	TITLE SCREEN
1	CITY OF TORONTO CONTRACT # 02D3-123WP
2	HOUSE # 102
3	STREET: Dufferin St.
4	Preliminary Inspection / Post preparation Inspection /Final Inspection
5	DATE: 21 Mar/02
6	TIME: 11:35am
7	CLEANOUT LOCATION: Basement or Front Yard
8	WEATHER: Dry / Rain / Melting Slow / etc.
9	CAMERA DIRECTION: US or DS
	SIZE: 100mm
	TYPE: Clay
	CONTRACTOR: Acme Liners Inc.

Upon commencement of, and throughout the inspection, the following information shall be continuously displayed on-screen and captured on the recording: street name and property number, continuous chainage.

Sewer Condition and Defect Coding

Defect coding is not required for sewer service or main sewer inspections required for sewer service rehabilitation.

Inspection Information Recorded as Sewer.dat File

The CCTV inspection equipment and software shall make and record a WRc sewer.dat file of the inspection. The sewer.dat file shall capture all the information required to describe the main liner sewer or service pipeline. However defect coding in accordance with the required WRc sewer condition classifications is not required for either the main line sewer or the service pipeline. The sewer.dat file shall be according to the City's requirements for such files. Prior to the regular contract required submissions of CCTV inspections/reports, the Contractor shall submit a trial sewer.dat file of an inspection for approval by the Contract Administrator.

CCTV Video Recording File Format and Conventions

The required video recordings of CCTV inspections shall be provided to the Contract Administrator on Digital Video Disc (DVD) or approved alternate media.

The video file format shall be MPEG-1 or MPEG-2. The MPEG files shall be of a minimum video size resolution of 320 x 240 and encoded at a rate of no less than 750 kb/s

The MPEG file naming convention shall be:

startmaintenancehole_finishmaintenancehole_direction_MMDDYY.mpg

where direction is either "U" for upstream or "D" for downstream

The CCTV video recording must be indexed to the textual data. The field survey must record the time index on the video, which shows the image(s) corresponding to the text record. The indexing must include the start time of the entire survey and the exact time number for each pipe feature/defect recorded in the data. This indexing will permit the user to view a particular sewer pipe or a particular feature/defect in a pipe, after inserting the appropriate DVD, and then advance to the stored time index in the MPEG file, then display the image(s):

A DVD referencing ID shall be created using the following format.

YYYYMMDDCCCCTT (year, month, day, contractor, disk number) and clearly labeled.

CCTV Inspection Video Player Requirements

CCTV inspection video files shall play properly and completely on commonly used video file playing software applications. At a minimum, the video files must play properly and completely on correctly configured, up to date versions of Microsoft Windows Media Player, VideoLAN VLC Player and Apple QuickTime Player. Video files that do not play properly and completely on all these three players will be rejected. The Contractor is advised that playback problems often can be traced back to the software or equipment that was used to generate the MPEG files. Playback problems often also can be traced back to DVD burning software and equipment that may compress (or otherwise corrupt) files resulting in a file that will only play properly on a specific video player.

Inspection Reports

Each CCTV inspection submitted shall be accompanied by an electronic format sewer inspection report in PDF file format that is generated from the sewer.dat file. The reports shall be in the format required by the City. The PDF reports shall be included on the DVD along with the video file and sewer.dat file.

Prior to the regular contract required submissions of CCTV inspections/reports, the Contractor shall submit a trial inspection report in PDF format for approval by the Contract Administrator.

CCTV Inspection Submission

When a required CCTV inspection has been completed, it shall be submitted to the Contract Administrator on a properly identified DVD or other media approved by the Contract Administrator. The submission for a sewer service shall include the video file, the sewer.dat file and the PDF report file. These three files shall be grouped together on the DVD along with any other information relevant to the specific CCTV inspection such as images from the inspection. The grouping shall be identified by the street number corresponding to the sewer service inspected.

A single DVD may include CCTV inspections for more than one sewer service. In this case, the DVD shall be properly organized with each CCTV inspection submission in its own folder. Such folders shall be clearly and properly identified in regard to the sewer service to which it pertains by the street number corresponding to the sewer service inspected.

The reports shall be in a format that will enable direct down loading of the data into a data management system.

CCTV Inspections Submission Schedule

The Contractor shall submit the CCTV inspection DVD(s) to the Contract Administrator every 14 Days or as agreed with the Contract Administrator.

TS 4.11.15 CCTV Truck Units

Proper seating accommodation must be provided by the Contractor to enable two people, in addition to the operator, to clearly view the screen of the on-site monitor, which displays the inspection work in the main line sewer or sewer service as such work proceeds. No equipment utilized within the sewer shall be allowed to be stored in the viewing area.

The Contractor will equip the inspection units and crew supervisor with a cellular telephone utilizing province of Ontario telephone numbers and will provide the Contract Administrator with the cellular telephone numbers.

Each inspection unit shall be equipped with all fans or blowers or both necessary to remove any fog that may be present in the sewers during inspection.

TS 4.11.16 Assessment CCTV Inspection – V1

The Contractor shall make an assessment CCTV inspection—called the V1—of the sewer service, before undertaking any rehabilitation work. The V1 shall be performed from within the main sewer or alternatively from the cleanout to the main sewer. The V1 shall include the sewer service pipeline from the main line sewer to property line and its connection to the main line sewer. Sewer defect coding is not required for the V1.

The purpose of the V1 is to determine and record the initial condition of the sewer service and its connection to the main line sewer. The V1, as part of the sewer service assessment, shall provide the Contract Administrator with sufficient information concerning the lateral pipeline and service connection to allow the Contract Administrator to identify the required sewer service rehabilitation type for the location. The information shall also be sufficient to allow the Contract Administrator to determine, in the case of Type B and C rehabilitations, the structural performance requirement for the part of the rehabilitation within the main sewer—either partially deteriorated or fully deteriorated.

In making the V1, the Contractor shall employ only such minimal cleaning of the main sewer and the sewer service that is necessary to obtain a CCTV inspection sufficient to record the condition of the sewer service lateral pipeline and main sewer connection. De-watering of the main line sewer and sewer service shall be sufficient for V1 inspection purposes and bypassing of flows shall be done where the sewer is not sufficiently clear for V1 inspection purposes.

The V1 CCTV inspection shall be according to section *CCTV Inspections and Reports* of this specification. The V1 inspection shall be identified with the street house number address corresponding with the service inspected.

TS 4.11.17 Field Measurement for Rehabilitation Sizing

The Contractor shall field determine the internal diameters of the sewer service and where applicable the main sewer. The measurements taken shall be suitable for proper sizing of the Type A, B or C rehabilitations to be installed. The Contractor shall not rely on dimensions provided by the City. Determined sizing shall be provided to the Contract Administrator on request.

TS 4.11.18 Service Pipeline Cleaning and Preparation

The sewer service pipeline to be CIPP lined shall be cleaned to remove foreign materials prior to lining by means of a controlled hydro pressure sewer cleaner. Precautions shall be taken to ensure that no flooding of public or private property occurs during any phase of the cleaning or reaming operations or both. Precautions shall be taken to protect the sewer lines from damage that might be inflicted by the use of cleaning equipment.

All sludge, dirt, sand, rocks, grease and other solid or semi-solid material shall be cleaned from the sewer service. Resulting debris from the cleaning operations shall be removed at the downstream maintenance hole of the section containing the sewer service being cleaned or at the cleanout. Passing material from maintenance hole section to maintenance hole section shall not be permitted. The contractor shall also install a screen in the downstream maintenance hole in order to catch any material, which might migrate downstream. Such material from the maintenance hole shall be removed and properly disposed.

TS 4.11.19 Wye in Service Pipeline

Some sewer service locations may utilize a wye fitting whereby two sewer services from separate properties are joined to a single service pipeline leading to the main sewer. The wye is typically located at the property line.

Such wye's shall be identified and located during the sewer service assessment V1 CCTV inspection. When a wye is found, the Contractor shall notify the Contract Administrator.

Where a wye is found and the wye is in poor condition the wye shall be replaced with a new wye. Poor condition includes, broken, badly calcite encrusted and root intrusion.

When there is a wye in the service pipeline either left in place or replaced with a new wye, the CIPP rehabilitation shall terminate at the wye location so that incoming service pipelines are not blocked by the CIPP liner.

If there is no existing cleanout, a new cleanout shall be installed at the same time that any new wye installation is done.

TS 4.11.20 Service Connection Cleaning and Preparation

The service connection rehabilitation zone in the main sewer shall be cleaned and prepared for Type B and C rehabilitation types but not for Type A. The rehabilitation zone is defined as the surface area of the main sewer that will be covered by the rehabilitation installation and sufficient working area around the rehabilitation zone as may be required to assure good installation quality.

The cleaning and preparation shall include flushing, fixed debris removal and trimming back of protruding service as required to make the rehabilitation zone suitable for the rehabilitation installation. No grease, dirt, debris or protrusions shall remain that will be detrimental to the installation or long-term performance of the rehabilitation.

Where fixed debris removal or trim back or a protruding lateral is required the Contractor shall plan and execute the reaming/cutting/trimming operation to prevent damage to the main sewer, the sewer service connection or sewer service pipeline. Proper precautions shall be taken by the Contractor to ensure that the reaming operation does not cause damage and does not result in reamers or cutters becoming jammed within the sewer, service connection of sewer service pipeline. Any extraction of reaming tools or other equipment, including extraction by excavation, is the responsibility of the Contractor.

Protruding Service Connection

Where the service connection protrudes into the sewer, it shall be trimmed back to flush with the main sewer inside wall surface by means of robotic cutting or grinding. No service connection rehabilitation shall be installed over a protruding service connection or a protruding service that has not been properly trimmed back flush.

TS 4.11.21 Cleaning and Preparation of Main Sewer – Provisional

This is a provisional requirement for the situation where the condition of existing main sewer does not permit passage or operation of the sewer service rehabilitation equipment within the main sewer due to condition of the main sewer. It only applies when the Contract Administrator has determined from the sewer service assessment that the sewer service is to be rehabilitated with a Type B or C.

This provisional requirement does not apply to the sewer service assessment and associated V1 work.

The Contractor shall clean and otherwise prepare the main sewer to make it suitable for use by the sewer service rehabilitation equipment. This may include flushing, removal or protruding service connections and reaming/cutting/grinding of fixed debris.

Reaming, Cutting and Grinding of Fixed Debris

The main sewer shall be reamed to remove deposits and protrusions using an approved reaming method. Deposits and protrusions may include but not limited to, calcite build up, roots and protruding service connections. An acceptable CCTV camera must monitor reaming operations. Reaming shall mean reaming, cutting or grinding as required. Reaming shall be as sufficient to allow passage and operation of the sewer service rehabilitation equipment.

Protruding Service Connections

Any service connections that protrude into the sewer section and prevent passage or operation of the sewer service rehab equipment shall be sufficiently cut or ground back. Cut back protruding service connections shall be smooth and even with no jagged edges. If the service lateral piping or service connection is damaged or broken by the Contractor, then the Contractor shall repair the damage, by using excavation, if necessary, at no extra cost to the City. The Contractor shall submit for approval, the proposed method of repair and reinstatement for damaged sewer service connections.

Precaution to Prevent Damage to the Main Sewer, Service Connection or Service Pipeline

The Contractor shall plan and execute the reaming operation to prevent damage to the main sewer, the sewer service connection or sewer service pipeline. Proper precautions shall be taken by the Contractor to ensure that the reaming operation does not cause damage and does not result in reamers or cutters becoming jammed within the sewer, service connection or sewer service pipeline. Any extraction of reaming tools or other equipment, including extraction by excavation, is the responsibility of the Contractor.

Pre and Post CCTV Inspection Required for Provisional Cleaning and Preparation

When provisional cleaning and preparation is necessary, the Contractor shall make and record a CCTV inspection of the main sewer section before undertaking the provisional work and after completion of the provisional work. The CCTV inspection recordings shall be provided to the Contract Administrator.

TS 4.11.22 Disposal of Materials

In accordance with the requirements of the *Environmental Protection Act*, R.S.O 1990, Section 27 and subject to all terms and conditions related to Waste Management, the Contractor will be responsible for the complete removal and disposal off site, of all foreign materials flushed, scraped, or cut out of the sewer service pipeline or main line sewer. Flushing and abandoning of debris in main sewers or sewer laterals is not permitted.

The Contractor shall submit its MOE license with the Bid.

Prior to commencement of the Contract, the Contractor shall notify the Contract Administrator of the disposal site(s). The Contractor shall also provide the Contract Administrator with documentation, such as weigh scale tickets, attached to all relevant invoices, indicating discharge quantities, pertinent dates and discharge location(s).

TS 4.11.23 Post Cleaning and Preparation CCTV Inspection – V2

After completion of the cleaning and preparation of the sewer service pipeline and, when required, service connection rehabilitation zone in the main sewer, a CCTV inspection—called the V2—shall be done.

The V2 shall inspect the full length of the service pipeline—public and private— and its connection to main sewer. The private side inspection shall note any deficiencies in the private side and shall be made as far as possible subject to internal conditions that may prevent further CCTV camera travel. If there is a wye connection, the contractor shall inspect the private service pipelines servicing both properties. The V2 CCTV inspection shall be according to section *CCTV Inspections and Reports* of this specification.

The V2 complete with all reports shall be provided to the Contract Administrator at least 2 Days prior to service rehabilitation for the Contract Administrator’s approval of the cleaning and preparation. The V2 inspection shall be identified with the street house number address corresponding with the service inspected.

On its discretion, the Contract Administrator may waive the requirement for the V2 to be submitted for approval 2 Days prior to lining, such as when approval for lining was provided at a live viewing of the V2 by a City representative. However, in such cases the V2 submission shall always be submitted at a later time.

In the event that, after the V2, a deficiency in the cleaning and preparation is identified that requires correction, the V2 shall be redone after the correction has been done and the redone V2 submitted to the Contract Administrator.

No service rehabilitation installation shall commence until approval of the cleaning and preparation has been provided by the Contract Administrator to the Contractor.

TS 4.11.24 Sewer Service Rehabilitation – Type A

Type A is a lateral pipe liner and shall extend from the property line to within 150 mm from the main line sewer. It does not incorporate the service connection at the main sewer into the rehabilitation.

Type A shall be installed either through the cleanout at the property line or from within the main line sewer. If the main sewer condition is unsuitable for passage and operation of liner installation equipment, the liner shall be installed from the cleanout. Where no suitable cleanout exists, the Contractor shall install a new cleanout.

If the Contractor wishes to install from the main sewer, regardless of the condition of the main sewer, the Contractor may install from the main sewer, with any work to make the main sewer suitable for the Contractor's installation equipment being the responsibility of the Contractor. Where this requires any cleaning, reaming or any other preparation of the main sewer, the Contractor shall provide to the Contract Administrator pre and post CCTV inspection of the main sewer and the provision of this CCTV inspection shall be the responsibility of the Contractor without cost to the City.

Type A shall be capable of:

- lining lateral pipelines from 100 mm to 150 mm diameter;
- continuous liner installations up to 35 m in length;
- lining through bend fittings in the lateral pipeline up to 45 degrees; and
- lining through one lateral pipeline size transition (e.g. 150/125, 150/100).

Type A shall:

- be an all one-piece CIPP construction;
- accomplish the objectives for sewer service rehabilitation in TS 4.11 herein;
- be designed in accordance with the design requirements in TS 4.11 herein; and
- shall always be designed for the fully deteriorated existing pipe condition.

TS 4.11.25 Sewer Service Rehabilitation – Type B

Type B is a service connection and lateral pipe liner. It shall incorporate rehabilitation of the service connection within the main sewer and the lateral pipe in an all one-piece cured-in-place installation. Separate installation or curing of parts or both to make up the installation are not permitted. The Type B extends from within the main sewer to the property line. Within the lateral pipeline the Type B shall be CIPP; within the main sewer it shall be either CIPP or CIPC.

Type B shall be installed from within the main line sewer. Type B shall be capable of:

- lining lateral pipelines from 100 mm to 150 mm diameter;
- continuous lateral pipeline liner installations up to 35 m in length;
- lining through bend fittings in the lateral pipeline up to 45 degrees in the lateral pipe;
- lining through one lateral pipeline size transition (e.g. 150/125, 150/100); and

-
- providing service connection rehabilitation in main sewer from 200 to 450 mm diameter.

Type B shall:

- be an all one piece cured-in-place construction;
- be a CIPP construction within the lateral service pipe;
- be either a CIPP or CIPC construction within the main sewer;
- accomplish the objectives for sewer service rehabilitation in TS 4.11 herein;
- be designed in accordance with the design requirements in TS 4.11 herein;
- shall be designed for either partially deteriorated or fully deteriorated main sewer condition as required;
- provide a surface within the main sewer that is smooth, free of fins, excessive wrinkle or other irregularities unless reflecting the post cleaning and preparation condition of the main sewer;
- be resistant to lifting or separation by normal municipally used sewer cleaning equipment; and
- provide a smooth transition to the main sewer surface without step or shoulders that will impede flow in the main sewer or service pipeline.

Main Sewer Partially or Fully Deteriorated

The Contract Administrator will specify the condition of the main sewer either partially or fully deteriorated that must be accommodated by the sewer service rehabilitation.

For Partially Deteriorated Main Sewer

Type B rehabilitation shall be sufficiently structural to prevent infiltration within the Infiltration Prevention Zone (IPZ) as shown in Figure 1. Within the infiltration prevention zone including at its boundary, no groundwater shall be able to find a passage into the main sewer.

Products that rely on a bond to the sewer surface to accomplish the infiltration prevention requirement within the IPZ are not acceptable. Sealing elements against infiltration, such as hydrophilic seals rings or gaskets, are required.

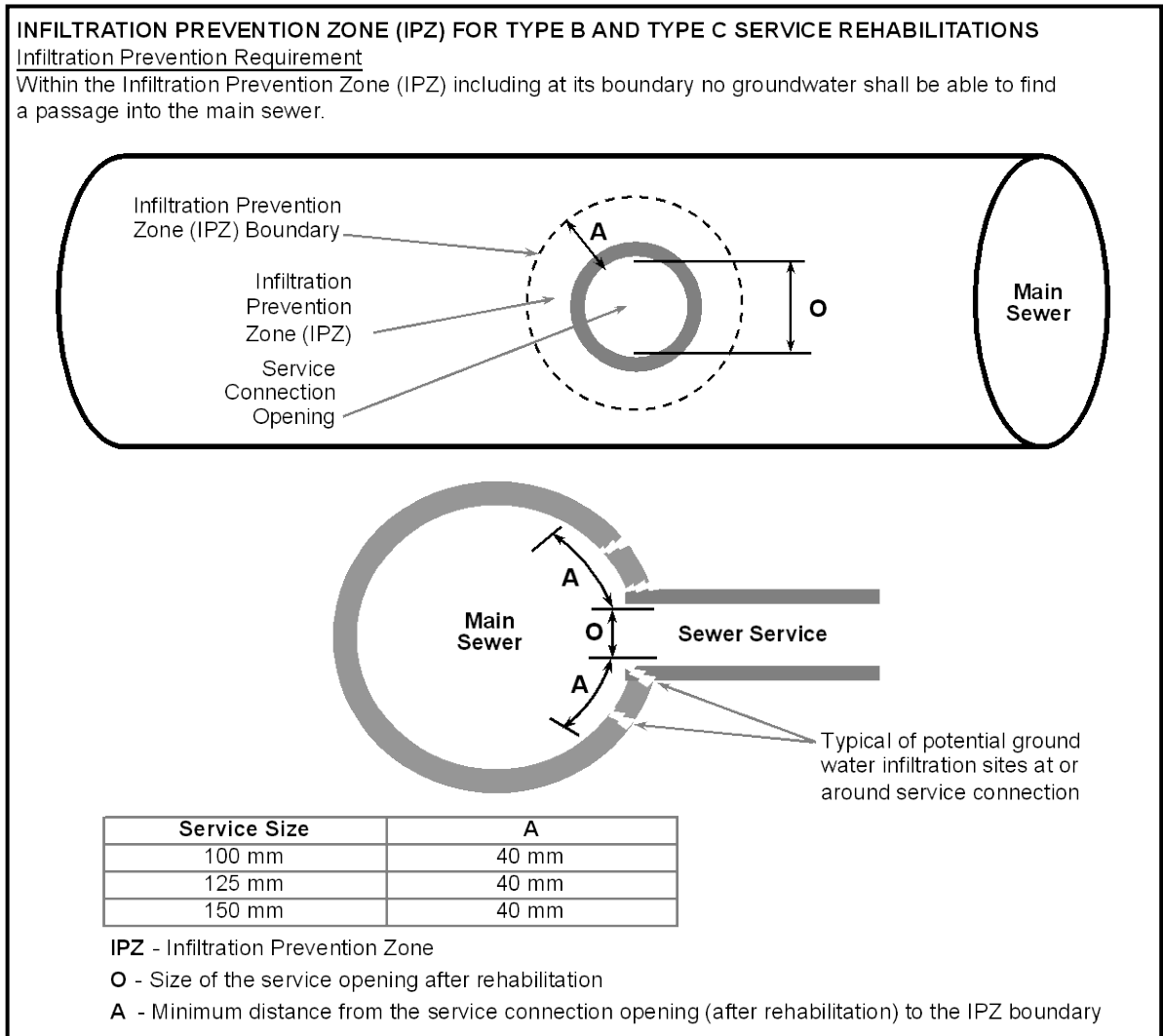


Figure 1: Infiltration prevention zone (IPZ) for Type B and Type C service rehabilitations

For Fully Deteriorated Main Sewer

Type B shall fulfill the requirements for Partially Deteriorated Main Sewer (above) plus within the Structural Restoration Zone (SRZ) provide structural restoration of the main sewer according to ASTM F1216 Appendix X1 design for Fully Deteriorated pipe condition. The SRZ is shown in Figure 2.

STRUCTURAL RESTORATION ZONE (SRZ) FOR TYPE B AND TYPE C SERVICE REHABILITATIONS

Structural Restoration Requirement

Within the structural restoration zone (SRZ) Type B and Type C rehabilitaitons shall provide full structural restoration in accordance with ASTM F1216 Fully Deteriorated design.

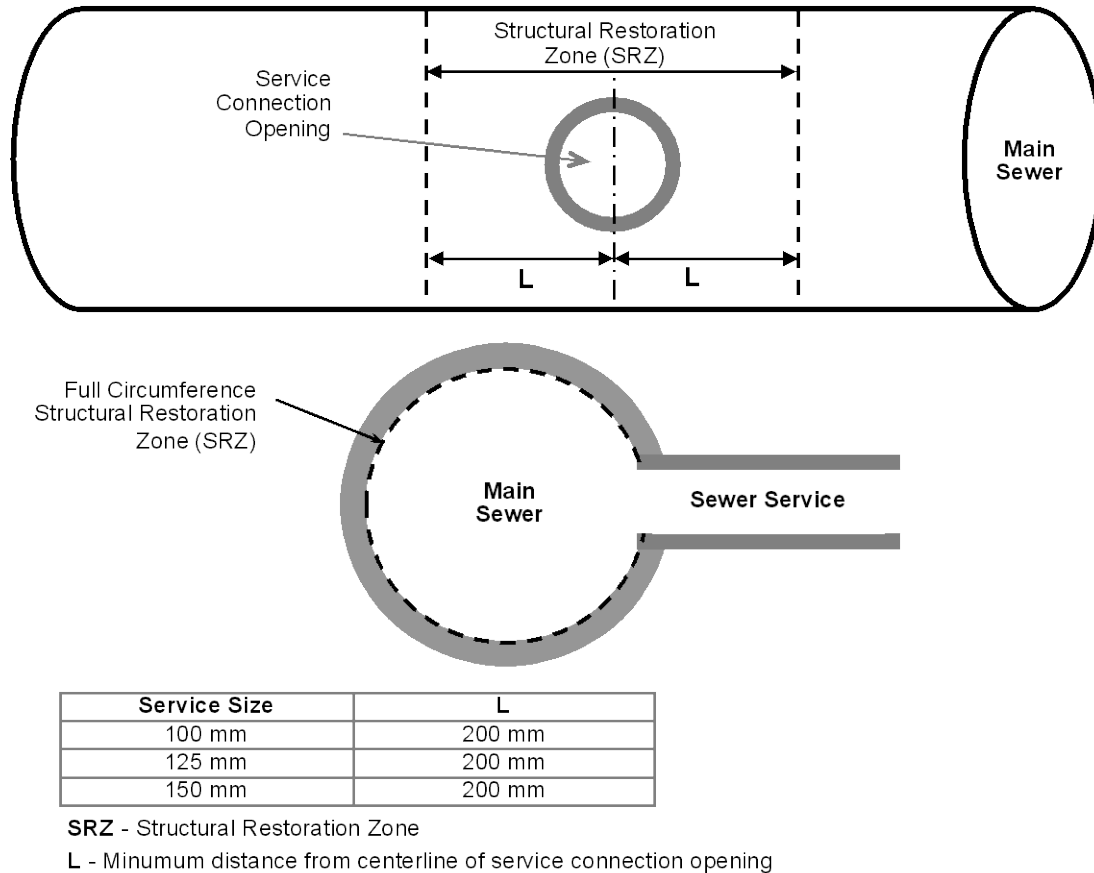


Figure 2: Structural restoration zone (SRZ) for Type B and Type C service rehabilitations

Products with Full 360° Cylindrical Element in Main Sewer

The full 360° cylindrical element in the main sewer shall encompass the SRZ and shall be designed for the ASTM F1216-07a X1 Fully Deteriorated existing pipe condition.

Products without Full 360° Cylindrical Element in Main Sewer

A full 360° cylindrical CIPP spot repair shall be installed to encompass the SRZ. Spot repair installation shall be either before or after the installation for the Type B sewer service rehabilitation. The CIPP Spot Repair shall be designed for the ASTM F1216-07a X1 Fully Deteriorated existing pipe condition. The Contractor shall submit a design for the CIPP Spot Repair to the Contract Administrator according to the design requirements for sewer service rehabilitations in section TS 4.11.28.

TS 4.11.26 Sewer Service Rehabilitation – Type C

Type C is a service connection liner than incorporates a short lateral pipe liner. It incorporates the rehabilitation of the service connection within the main sewer and a short lateral pipe liner in an all one-piece cured-in-place installation. Separate installation or curing of parts or both to make up the installation are not permitted.

With the exception of the length of liner in the lateral pipeline, the Type C shall be identical with the Type B and meet all the requirements for the Type B including requirements for partially or fully deteriorated main sewer including the provision of a spot repair for main sewer assessed as fully deteriorated by the Contract Administrator.

Length of Type C Within Service Lateral Pipeline

The required length in the service lateral pipeline shall depend on the Type C method of construction within the main sewer as follows.

Method of construction	Length up lateral from main sewer
Products with a full 360° cylindrical CIPP element in the main sewer	500 mm
Products without a full 360° cylindrical CIPP element in the main sewer	1500 mm

TS 4.11.27 Materials and Standards

The sewer service rehabilitation shall be installed and processed in place as a one-piece cured-in-place construction for all types. Materials shall be according to ASTM D5813-04 (2008).

The pipelining parts of the sewer service lateral rehabilitation shall be CIPP according to ASTM F1216-09 for inverted liners or ASTM F1743-08 for pulled in place liners or ASTM F2019-03(2009) for reinforced pulled in place liners.

Type B and C that incorporate a full 360° cylindrical wrap in the main line sewer shall be according to ASTM F2561-06 as well as applicable sections of ASTM F1216-09.

Type B and C that do not incorporate a full 360° cylindrical wrap in the main line sewer shall meet the objectives for sewer service rehabilitation in TS 4.11 herein and shall meet the resin and resin impregnation requirements in ASTM F1216-09 section 7.2.

Design of all service rehabilitation types shall be according to the requirements in TS 4.11 herein. Note that design by ASTM F1216 shall be according to Appendix X1 in ASTM F1216-07a and not later versions of ASTM F1216.

The lining system shall be capable of receiving Ontario Ministry of Environment approval and of carrying effluent within the limits of the current Toronto Municipal Code, Chapter 681 Sewers, without adverse effect on the lining or the effluent.

All sewer service rehabilitation materials shall have a substantial history of successful use as CIPP materials in municipal sewer application in the province of Ontario. Material properties shall meet the requirements of referenced standards or the properties used in the liner designs, whichever are greater.

The quantity of resin used in the CIPP zones of the sewer service rehabilitations and its impregnation shall meet with the requirements of the applicable ASTM standard such as ASTM F1216-09, Section 7.2.

Where, in the course of work, the Contractor has reason to use materials that differ from the original proposed materials, either in general or for a specific installation, proposed alternate materials shall meet the above standards and require the approval of the Contract Administrator prior to use.

TS 4.11.28 Design Requirements for Sewer Service Rehabilitations

Type A Rehabilitations and Lateral Pipeline Portion of Type B and Type C Rehabilitations

Type A rehabilitations and lateral pipeline portion of Type B and Type C rehabilitations shall be designed according to ASTM F1216-07a X1 for fully deteriorated condition. Design by later versions of ASTM F1216 is not permitted.

Design parameters are provided in Table 1.

Type B and Type C Rehabilitations – Portion in Partially Deteriorated Main Sewer

The partially deteriorated main sewer requirement requires infiltration prevention within the IPZ (Figure 1). For partially deteriorated main sewer, Type B and C rehabilitation portions within the main sewer shall be designed in accordance with the product's method of construction as follows.

Method of construction	Design method
Products with a full 360° cylindrical CIPP element in the main sewer	By ASTM F1216-07a X1 for partially deteriorated. Design by later versions of ASTM F1216 is not permitted.
Products without a full 360° cylindrical CIPP element in the main sewer	The design shall address all the objectives for sewer service lateral rehabilitation in TS 4.11. The Contract Administrator reserves the right to reject the design method used, if in the Contract Administrator's opinion, is not consistent with the requirements of TS 4.11 and/or does not demonstrate that the design accomplishes the objectives for sewer service rehabilitation in TS 4.11. The design shall determine the CIPC material thickness or thicknesses required. Note: ASTM F1216 X1 design method is not applicable to products that do not incorporate a full 360° cylindrical CIPP construction in the main sewer.

Design parameters are provided in Table 1.

Type B and Type C Rehabilitations – Portion in Fully Deteriorated Main Sewer

The fully deteriorated main requirement requires structural restoration of the main sewer within the SRZ is shown in Figure 2.

For products that incorporate a full 360° cylindrical zone in the main sewer, this shall be achieved by designing the full 360° cylindrical zone for the ASTM F1216 Fully Deteriorated condition.

For products that do not incorporate a full 360° cylindrical zone in the main sewer, this shall be achieved by installing a full 360° cylindrical spot repair designed for the ASTM F1216 Fully Deteriorated condition. In this case an exception is made to the requirement for an all one-piece CIPC and the spot repair and sewer service rehabilitation may be installed separately. Installation of the spot repair shall be done either before or after the installation of the sewer service rehabilitation. In this case an exception is made to the requirement for an all one-piece CIPC.

For fully deteriorated main sewer, Type B and C rehabilitation portions within the main sewer shall be designed in accordance with the product's method of construction as follows.

Method of construction	Design method
Products with a full 360° cylindrical CIPP element in the main sewer	By ASTM F1216-07a X1 for fully deteriorated. Design by later versions of ASTM F1216 is not permitted.
Products without a full 360° cylindrical CIPP element in the main sewer	The CIPP spot repair design shall be in accordance ASTM F1216-07a X1 for fully deteriorated. The design of the Type B or C rehabilitation shall be at a minimum in accordance with the design for partially deteriorated main sewer. The design shall address all the objectives for sewer service lateral rehabilitation in TS 4.11. The Contract Administrator reserves the right to reject the design method used, if in the Contract Administrator's opinion, is not consistent with the requirements of TS 4.11 and/or does not demonstrate that the design accomplishes the objectives for sewer service rehabilitation in TS 4.11. The design shall determine the CIPC material thickness or thicknesses required.

Design parameters are provided in Table 1.

Designs Certified by Professional Engineer

Engineered designs covering all sewer service rehabilitations required in the Contract shall be provided by the Contractor and each design shall be approved by an Engineer bearing the seal and signature of an Engineer authorized to perform such work by Professional Engineers Ontario (PEO).

Designs shall be submitted to the Contract Administrator for approval. No sewer service rehabilitations shall be installed without an approved design.

Designs Correct for Field Conditions

The Contractor shall check and determine that actual field conditions for any sewer service rehabilitation installation correspond with the design for that installation. The field conditions to be checked shall include deepest depth to invert, ovality of the existing sewer lateral pipeline and main sewer and live load situation. Where the existing design is not adequate for the field conditions, the Contractor shall adjust the design accordingly and the sewer service rehabilitation installed shall meet the requirements of the adjusted design. The adjusted design shall be submitted to the Contract Administrator for approval.

Where a design previously approved by the Contract Administrator is found needing adjustment due to determined actual field conditions, the Contractor shall advise the Contract Administrator within 48 hours and wait for the Contract Administrator's instructions. Where the adjusted design results in a thicker cured-in-place construction to be installed, any additional cost involved shall be determined in accordance with the Contract Price where applicable and if Contract Price are not applicable, then shall be negotiated with the Contract Administrator.

No sewer service rehabilitation shall be installed that does not meet the requirements for actual field conditions, including CIPP and CIPC thickness required for actual field conditions.

Installed Thickness For Comparison with Design Thickness

The wall thicknesses of the installed sewer service rehabilitation shall meet or exceed the design thicknesses. Wall thickness measurements and determination of the actual effective thickness shall be according to ASTM D5813-04 (2008). Measurements of the actual installed wall thickness shall not include the thickness of any non-structural components.

When actual installed thickness or material properties appear to be deficient, design reconciliation based on test result values shall be permitted. Such reconciliation may or may not resolve the deficiency. For more information on the design reconciliation procedure, see section TS 4.11.34.

Table 1: Design parameters for sewer service rehabilitations

Parameter	Requirement
Design Method	In accordance with requirements detailed above
Design Condition	In accordance with the requirements detailed above
Design Life	50 years minimum
Ovality	For lateral pipeline: 3% or the actual ovality, whichever is greater. For main sewer: 3% or the actual ovality, whichever is greater.
External Hydrostatic Pressure	Corresponding to a ground water table at 2.0m below ground surface
External Earth Load ¹	Based on 4.0 m cover over top of pipe or the actual height of cover, whichever is greater
Live Load ¹	AASHTO HS-20 or the actual live load, whichever is greater
Soil Density ¹	18.85 KN/m ³ (1922 Kg/m ³)
Soil Modulus ¹	6.89 MPa

Parameter	Requirement
CIPP or CIPC Flexural Modulus used for design	The flexural modulus used for design shall be the long-term flexural modulus for the design life. The long-term flexural modulus shall be the amount of short-term flexural modulus (according to ASTM D790) retained for the design life. The short-term flexural modulus used shall be the value that will be reliably and repeatedly achieved in installations. The retention factor shall be derived from long-term testing and be appropriate for stress and stress duration in the installed liner. Independent third party test data is required (submit with tender) to substantiate the short-term and long-term values used in design. The design must identify the short-term and long-term values. Minimum short-term value shall be in accordance with the minimum requirement in ASTM F1216-07a (1724 MPa). All substantiation must meet with the approval of the Contract Administrator.
CIPP or CIPC Flexural Strength used for design	The flexural strength used for design shall be the long-term flexural strength for the design life. The long-term flexural strength shall be the amount of short-term flexural strength (according to ASTM D790) retained for the design life. The short-term flexural strength used shall be the value that will be reliably and repeatedly achieved in installations. The retention factor shall be derived from long-term testing and be appropriate for stress and stress duration in the installed liner. Independent third party test data is required (submit with Bid) to substantiate the short-term and long-term values used in design. The design must identify the short-term and long-term values. Minimum short-term value shall be in accordance with the minimum requirement in ASTM F1216-07a (31 MPa). All substantiation must meet with the approval of the Contract Administrator.

¹ Not applicable for design of the main sewer portion of rehabilitation Type B and C for partially deteriorated main sewer.

Material Properties for Non-F1216 X1 Design

The Contractor shall identify further or different properties than those identified in Table 1 that are required for the Contractor’s proposed design method. This identification shall include the short-term and long-term values. The values used for design shall be the long-term values for the design life. The long-term values shall be the amount of short-term values retained for the design life. The short-term values used shall be the values that will be reliably and repeatedly achieved in field installations. The retention factor shall be derived from long-term testing and be appropriate for stress and stress duration in the installed construction. Independent third party test data is required (submit with Bid) to substantiate the short-term and long-term values used in design. All substantiation must meet with the approval of the Contract Administrator. The design must identify the short-term and long-term values.

TS 4.11.29 Fit, Finish and Properties Requirements

The completed installed cured-in-place sewer service rehabilitation shall conform to the requirements for fit, finish and properties in Tables 2 and 3.

Table 2 applies to any CIPP element in the rehabilitation. Table 3 applies to any CIPC element in the rehabilitation.

Note: CIPP and CIPC are not the same. CIPP is Cured-in-Place Pipe while CIPC is Cured-in-Place Construction. CIPP construction produces a cylindrical liner. CIPC construction does not necessarily produce a cylindrical liner.

Table 2 applies to the service pipeline rehabilitation (CIPP).

Table 2 applies to service connection rehabilitation with full 360 ° cylindrical wrap (CIPP).

Table 3 applies to service connection rehabilitation without full 360 ° cylindrical wrap (CIPC).

Table 2: Fit, finish and property requirements for CIPP rehabilitation elements

Item	Requirement for CIPP (Cured-in-Place Pipe)
CIPP Continuity	The finished CIPP shall be continuous over the entire length of the required installation without any breaks, separations or joints.
CIPP Fit to Existing Sewer Lateral	The outside surface of the CIPP shall be in contact with the inside surface of the existing sewer service pipe subject to the contact tolerance. The inside surface of the existing sewer service is the surface after the service pipe has been cleaned and prepared for lining in accordance with the cleaning and preparation requirements. The contact tolerance is 1.0 mm. Where any space of gap between the outside surface of the CIPP and the inside surface of the service pipe exceeds 1.0 mm, the CIPP fit will be deficient, subject to exceptions noted below.
Exception to CIPP Fit for Service Pipe Irregularities	Existing sewer service pipe irregularities include off set joints, protrusions, bumps or other similar situations in the existing service pipe that remain after the service pipe has been prepared in accordance with the cleaning and preparation requirements. Neither ovalisation of the existing service pipe nor curves made by joint deflection are irregularities in this context. Where an irregularity exists, exception to the CIPP contact tolerance requirements will be allowed in the irregularity zone. The irregularity zone is defined as a zone extending a distance of up to ¼ of the CIPP inside diameter in any direction from the irregularity as measured along the inside surface of the CIPP. A CIPP fit exception at an existing sewer service irregularity shall not present an obstruction to sewage flow whether or not it complies with the allowed exceptions.
CIPP Fit at Bends	The CIPP shall fit and conform through horizontal and vertical bends up to 90 degrees without bunching, wrinkling or fining that will result in an impediment to flow.
CIPP Surface Finish	The CIPP surface shall be sufficiently smooth to create a Manning number ≤ 0.011 and shall be free of ribs, fins and other irregularities that will impede flow or interfere with sewer cleaning operations.
CIPP Shape	The CIPP shape will be as defined by CIPP fit to existing sewer lateral. In general the CIPP shape shall conform to the shape of the existing service pipe inside surface after its cleaning and preparation in accordance with requirements. However, where the existing service pipe shape is not defined (missing pieces of pipe) the CIPP may either bridge the missing wall section or indent into the missing wall section. Where the CIPP bridges, the shape of the CIPP shall match the shape of adjacent service pipe and the inside diameter of the CIPP shall be as required for Contact tolerance for the adjacent service pipe. Where the CIPP indents, the depth of the indent shall not reduce the CIPP wall thickness below the wall thickness tolerance.
CIPP Wall	The CIPP wall shall be free of any interior bulges, ribs, ripples, folds or other irregularities except where these irregularities comply with the CIPP wall thickness tolerance, fit, shape and wall thickness given above. The wall of the CIPP shall be free of any voids, cavities or bubbles.

Item	Requirement for CIPP (Cured-in-Place Pipe)
CIPP Terminations	The ends of the finished CIPP shall be neat and smooth. There shall be no lifts or separations away from the surface of the service pipe. There shall be not excessive lips or shoulders at the transitions to the service pipe.
CIPP Leak Resistance	The CIPP shall be leak tight to infiltration. There shall be no leakage of ground water through the CIPP wall or at CIPP end terminations.
CIPP Wall Thickness and Tolerance	<p>The CIPP's finished wall thickness shall be as specified in the sewer service rehabilitation design submitted by the Contractor meeting the requirements of the Contract and as approved by the Contract Administrator.</p> <p>The CIPP wall thickness shall be determined in accordance with ASTM D5813-04(2008) which specifies a minimum of 8 equally spaced thickness measurements around the circumference of the CIPP (including maximum and minimum thicknesses) with the effective CIPP thickness being the average of the measurements. Regardless of the average thickness result, the D5813 also requires that the minimum thickness at any point shall not be less than 87.5% of the specified thickness. Measurements of CIPP wall thickness shall not include the thickness of any non-structural components.</p> <p>The wall thickness tolerance is: Minus 0%, Plus 25%.</p>
CIPP Installed Physical Properties Requirements	<p>The final installed CIPP shall have the following required physical properties:</p> <p>Flexural Modulus: Shall meet or exceed the short-term value used in the sewer service rehabilitation design or the minimum value in the ASTM F1216, whichever is greater.</p> <p>Flexural Strength: Shall meet or exceed the short-term value used in the sewer service rehabilitation design or the minimum value in the ASTM F1216, whichever is greater.</p> <p>In the case of long-term values of flexural modulus and flexural strength used in design, the CIPP shall possess the required long-term retention characteristics such that the long-term values used in design will be met by the CIPP over its design life.</p>

Table 3: Fit, finish and property requirements for CIPC rehabilitation elements

Item	Requirement for CIPC (Cured-in-Place Construction)
CIPC Continuity	The CIPC in the main line sewer shall be continuous in all directions without breaks, cracks or separations.
CIPC Fit to Sewer Surface	The CIPC in the main sewer shall fit tightly to the inside surface of the main sewer at all locations subject to localized clearance that may be required for any sealing rings or gaskets. Any gap between the CIPC and the main sewer surface shall not exceed 1 mm except for localized clearance that may be required for any sealing rings or gaskets. The outer perimeter edges of the CIPC shall not be separated or deflected away from the main sewer surface at any location by more than 1 mm.
CIPC Extension beyond Lateral Opening	The CIPC shall provide not less than the minimum extension required in all directions outwards from the service connection opening periphery.
CIPC Edges	All outer perimeter edges of the CIPC shall be smooth and neat. No edge shall provide an impediment to flow. All edges shall be impervious to damage, lifting or dislodging by normal sewer cleaning and flushing procedures.
CIPC Leak Resistance	The CIPC shall be leak tight to infiltration. There shall be no leakage of ground water through the CIPC wall or around its outer edges.
CIPC Wall	The CIPC wall shall be free of any bulges, ribs, ripples, folds or other irregularities except where these irregularities reflect the post cleaning and preparation surface of the sewer. The wall shall be free of any voids, cavities or bubbles.
CIPC Surface Finish	The CIPC surface shall be sufficiently smooth to create a Manning number ≤ 0.011 and shall be free of ribs, fins and other irregularities that will impede flow or interfere with sewer cleaning operations.
CIPC Wall Thickness and Tolerance	<p>The CIPC's finished wall thickness shall be as specified in the sewer service rehabilitation design submitted by the Contractor meeting the requirements of the Contract and as approved by the Contract Administrator.</p> <p>The thickness shall be determined by taking a minimum of 8 equally spaced thickness measurements around the effective perimeter of the CIPC (including maximum and minimum thicknesses) with the effective liner thickness being the average of the measurements. Regardless of the average thickness result, the minimum thickness at any point shall not be less than 87.5% of the specified thickness. Measurements of the CIPC wall thickness shall not include the thickness of any non-structural components.</p> <p>The CIPC thickness tolerance is: Minus 0%, Plus 25%.</p>
CIPC Installed Physical Properties Requirements	<p>The complete installed CIPC shall have the following required physical properties:</p> <p>All properties used in the design shall meet or exceed the short-term value used in the design.</p> <p>In the case of long-term values used in design, the CIPC shall possess the required long-term retention characteristics such that the long-term values used in design will be met by the CIPC over its design life.</p>

Installation Procedure

The actual installation procedure shall be according to the submission with the Bid. Any proposed deviation from the submitted procedure shall be submitted, with explanation, to the Contract Administrator for approval and the submission shall include the approval of the lining manufacturer or senior licensor.

All CIPP and CIPC elements shall be protected during the installation into the main line sewer and sewer lateral. No significant amount of resin shall be lost by contact with cleanout walls or the sewer pipe during the installation. The CIPP or CIPC elements shall not be contaminated or diluted by exposure to dirt, debris, or water during the pull.

The Contractor shall ensure that all required equipment including as required by the Contract is on site and in satisfactory working order prior to commencing the installation of any sewer lateral rehabilitation.

Sewer service to a property shall not be interrupted by more than 4-hours during the installation of the sewer lateral rehabilitation.

Odour Control

The Contractor shall provide notice to the affected residents indicating possible odour resulting from sewer lateral rehabilitation and curing process. The notice shall indicate to the residents what to expect and typical procedures to alleviate odour and include advising residents to ensure all plumbing drain traps are full of water.

The Contractor is responsible to respond, investigate and act immediately on any odour complaint that may occur. Actions to be taken by the Contractor to alleviate an odour problem within a property shall include:

- seeking permission to enter the property;
- filling of any dry traps;
- preventing air flow from any traps which do not function properly: will not water seal;
- ventilating the property via open window and doors;
- ventilating the property with fans/blowers; and
- other actions that are useful in alleviating the odour problem.

The Contractor shall provide adequate sewer ventilation and odour mitigation during the sewer service rehabilitation process. At the minimum the following steps shall be taken:

Ventilation at Cleanout: Where the rehabilitation installation uses a cleanout, an exhaust fan shall be used at the cleanout. The exhaust fan shall have sufficient air flow capacity so that an airflow direction is established from the property to the cleanout, thereby preventing any odours from the rehabilitation installation from traveling upstream in the service pipe towards the property. The exhaust fan shall be maintained in operation at the cleanout as long as there is any chance that odours from the rehabilitation can travel upstream in the service to the property.

Exhaust Fans for Main Sewer: When a cleanout is not available for ventilation or when cleanout ventilation is not adequate to prevent odours to properties connected to the main sewer, then ventilation of the main sewer shall be done. Two maintenance hole (MH) exhaust fans with a minimum capacity of 2100 cfm each shall be used to exhaust air from the sewer via MHs. One fan shall be located at an adjacent MH immediately downstream of the sewer section being lined. The second fan shall be employed at the tail end MH as soon as access for the fan is available following removal of the liner tail. If the second fan cannot be readily employed at the tail end MH, it shall be employed at the closest possible adjacent MH that will permit air to be exhausted from the sewer being lined. In the event that odour control becomes a problem, the Contractor shall provide additional exhaust ventilation of the sewer to alleviate odour.

TS 4.11.31 CCTV Inspection of Completed Rehabilitation – V3

After each sewer service rehabilitation is complete a CCTV inspection—called the V3—of the full length of the rehabilitation shall be done, including when applicable, the main sewer connection rehabilitation. CCTV inspection of the main sewer connection rehabilitation shall be performed from within the main sewer with a suitable main sewer CCTV camera. The CCTV inspection and associate reports shall be submitted to the Contract Administrator on DVD within 5 Days of making the inspection. The V3 CCTV inspection shall be according to section *CCTV Inspections and Reports* of this specification. The CCTV inspection video file shall be identified by lateral street name and house number. The Contract Administrator will review the V3 as part of its approval process for the sewer lateral rehabilitation.

If the Contractor is aware of any major deficiencies identified during the V3 CCTV inspection, the Contractor shall immediately notify the Contract Administrator of such major deficiencies.

In the event that, after the V3, a deficiency in the sewer lateral rehabilitation is identified that requires repair or remediation, the V3 shall be redone after the repairs or remedial action have taken place and the redone V3 submitted to the Contract Administrator.

TS 4.11.32 Samples of Resin and Cured Rehabilitations

Resin Samples – Field

When required, the Contract Administrator will take a sample of resin from an on site a wet-out liner tube or CIPP. The Contractor shall provide necessary assistance in the taking of this sample. The Contract Administrator may have this resin sample tested by infrared (IR) analysis and compare the resulting spectrograph to the reference spectrograph provided in the tender submission for the resin identified for use by the Contractor for the CIPP lining work.

All field resin samples supplied for this Contract shall produce IR spectrographs that correspond to the reference IR spectrograph.

Field Samples from Cured Lateral Pipeline Liner

The Contractor may be required to furnish to the Contract Administrator a cylindrical sample of the lining at least 400 mm in length. The sampling shall be done through a separate excavation performed after the liner is installed and cured. The lateral pipeline where the sample was removed shall be repaired with PVC pipe and fittings suitable for the depth of the installation. The restoration of excavated areas shall be carried out according to the Special Specifications.

The Contractor shall identify on the sample by permanent marker the contract number, street name and property number for the lateral, lateral size and date of removal.

Samples shall be taken into custody by the Contract Administrator immediately and delivered to the testing agency by the Contract Administrator.

Field Samples from Cured Service Connection Rehabilitation Part

The Contractor may be required to furnish to the Contract Administrator a complete sample of the main sewer part of a sewer service rehabilitation. This shall require excavation at the service connection and removal of a portion of the mainline sewer and service pipe encompassing the complete service connection rehabilitation. The portion of the main sewer removed shall be at least one metre long along with at least 0.5 m of the service pipe.

On removal, the complete sample shall be given over to the custody of the Contract Administrator.

The main sewer and sewer service pipe shall be repaired with PVC sewer pipe and fittings suitable for the depth of the installation. The restoration of excavated areas shall be carried out according to the Special Specifications.

Failed Samples

Should the sample fail to meet the Contract Specification, the contractor shall cover the cost of sampling. In addition to the above, the Contractor will be responsible to excavate and relay the entire sewer service line and connection from property line to main sewer at no extra cost to the City. No payment will be made for the failed liner.

The City will also reserve the right to ask for further sampling at no extra cost to the City for any other liners that were installed on or near the day the failed liner was installed.

TS 4.11.33 Testing of Samples of Cured Sewer Service Rehabilitations

The Contractor shall pay for the cost for testing of samples of cured sewer service rehabilitations at an independent testing agency. The testing agency shall be subject to the approval of the Contract Administrator. The Contractor shall authorize the testing agency to forward the test reports to the Contract Administrator and communicate with the Contract Administrator concerning the testing and results. The Contract Administrator will arrange for delivery of the samples in custody to the testing agency. Samples shall be tested for flexural modulus and flexural strength according to ASTM D790 and thickness according to ASTM D5813-04 (2008). The provision of testing service shall allow for the obtaining of test reports within 7 Days of delivery of the sample to the testing agency.

The Contractor shall provide for the testing agency to forward test reports by e-mail to the Contract Administrator.

The Contractor shall provide the test agency with the design parameters for the liner corresponding with the sample as follows:

- flexural strength short-term
- flexural modulus short-term
- other applicable parameters short-term for CIPC

-
- wall thickness

These values shall have been identified in the Contactor's sewer service rehabilitation designs. The testing agency's report shall reference these values as the specified values.

TS 4.11.34 CIPP Liner Sample Test Results – Reconciliation and Deficiency

Where CIPP liner samples are tested, the tests shall include determination of sample flexural modulus, flexural strength and thickness according to ASTM D790, and ASTM D5813, respectively. Testing shall be done by an accredited third party testing agency knowledgeable in the testing of CIPP and approved by the Contract Administrator.

The test results shall meet or exceed the values used in the Contractor's designs that have been approved by the Contract Administrator. Where the test results do not meet or exceed the required physical properties, the liner shall be deemed deficient subject to reconciliation of the test results.

A liner deemed deficient based on sample test results shall be reconciled for true deficiency by repeating the design for the liner using the test results for flexural modulus and flexural strength while keeping all other design parameters the same. Where the repeated design (the reconciliation) shows that the combination of test results (flexural modulus, flexural strength and thickness) provides a liner that meets the design method requirements, the liner shall not be deemed deficient.

Such design reconciliation shall not be permitted when test results do not meet the minimum requirements for flexural modulus and flexural strength in the ASTM F1216 in which case the liner will be deficient.

The Contract Administrator shall make or otherwise approve any design reconciliation. Two examples of design reconciliations are shown below.

Reconciliation Example No. 1

For a 150 mm service pipeline CIPP liner, the required liner thickness, as per design is 3.3 mm. Test results show thickness is 3 mm. There is an apparent deficiency in liner thickness. However test properties are higher than design properties. The reconciliation of apparent deficiency is shown below.

Design parameter	As designed	Reconciliation
Design Condition	Fully Deteriorated	Fully Deteriorated
Sewer Size	150 mm	150 mm
Invert Depth	4.5 m	4.5 m
Water table below ground surface	2.0 m	2.0 m
Ovality	3 %	3 %
Soil Density	18.85 KN/m ³	18.85 KN/m ³
Soil Modulus	6.89 MPa	6.89 MPa
Live Load	HS-20	HS-20
Other Load	0	0
Flexural Modulus Short-term	2000 MPa	3000 MPa (Test result)
Long-term Retention for Flexural Modulus	50 %	50 %
Flexural Modulus Long-term for design	1000 MPa	1500 MPa
Flexural Strength Short-term	31 MPa	38.0 MPa (Test result)
Long-term Retention for Flexural Strength	50 %	50 %
Flexural Strength Long-term for design	15.5 MPa	19.0 MPa
Enhancement Factor	7	7
Poisson's Ratio	0.3	0.3
Safety Factor	2	2
Required Liner Thickness	3.3 mm	2.9 mm
Tested Thickness	3.0 mm	3.0 mm
Conclusion on Liner Thickness Deficiency	Thickness is deficient based on design properties	Thickness is not deficient based on test result properties

In this example the reconciliation shows that the as tested thickness of 3.0 mm is sufficient when the tested properties are taken into account. Therefore the liner would not be deficient based on test thickness.

Reconciliation Example No. 2

For a 100 mm service pipeline CIPP liner, the required liner thickness, as per design is 2.4 mm. Test results show thickness 2 mm. There is an apparent deficiency in liner thickness. However, test properties are higher than design properties. The reconciliation of apparent deficiency is shown below.

Design parameter	As designed	Reconciliation
Design Condition	Fully Deteriorated	Fully Deteriorated
Sewer Size	100 mm	150 mm
Invert Depth	4.5 m	4.5 m
Water table below ground surface	2.0 m	2.0 m
Ovality	3 %	3 %
Soil Density	18.85 KN/m ³	18.85 KN/m ³
Soil Modulus	6.89 MPa	6.89 MPa
Live Load	HS-20	HS-20
Other Load	0	0
Flexural Modulus Short-term	1724 MPa	200 MPa (Test result)
Long-term Retention for Flexural Modulus	50 %	50 %
Flexural Modulus Long-term for design	862 MPa	1000 MPa
Flexural Strength Short-term	31 MPa	35MPa (Test result)
Long-term Retention for Flexural Strength	50 %	50 %
Flexural Strength Long-term for design	15.5 MPa	17.5 MPa
Enhancement Factor	7	7
Poisson's Ratio	0.3	0.3
Safety Factor	2	2
Required Liner Thickness	2.4 mm	2.3 mm
Tested Thickness	2.0 mm	2.0 mm
Conclusion on Liner Thickness Deficiency	Thickness is deficient based on design properties	Thickness remains deficient based on test result properties

In this example the reconciliation shows that the as tested thickness of 2 mm is not sufficient when the tested properties are taken into account. Therefore, the liner is deficient based on test thickness.

TS 4.11.35 Deficiencies

When the Contractor is aware of any deficiencies in the work or in the results of the work, the Contractor shall advise the Contract Administrator of these deficiencies within 48-hours including situations where the deficiency has already been rectified.

Where deficiencies have been identified, either by the Contract Administrator or the Contractor, the Contractor shall resolve, correct or rectify the deficiencies to the satisfaction of the Contract Administrator. Depending on the nature of the deficiency, the Contract Administrator may request that the Contractor provide the Contract Administrator with a method statement, subject to the Contract Administrator's approval, for the repair of the deficiency.

Where in the Contract Administrator's opinion, there is no repair or correction that is satisfactory, the Contract Administrator may require removal and replacement of the sewer lateral rehabilitation or require an alternate resolution at the discretion of the Contract Administrator.

A deficiency will exist when the work or the results of the work is/are not in accordance with the Contract requirements.

TS 4.11.36 Payment

Payment at the Contract Price shall be full compensation for all labour, Equipment and Material to do the Work.