



**THE CITY OF WINNIPEG**

# **BID OPPORTUNITY**

**BID OPPORTUNITY NO. 558-2017**

**2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS,  
CONTRACT 1**

## TABLE OF CONTENTS

### PART A - BID SUBMISSION

Form A: Bid	1
Form B: Prices	4
Form G1: Bid Bond and Agreement to Bond	6
Form G2: Irrevocable Standby Letter of Credit and Undertaking	8

### PART B - BIDDING PROCEDURES

B1. Contract Title	1
B2. Submission Deadline	1
B3. Site Investigation	1
B4. Enquiries	1
B5. Confidentiality	2
B6. Addenda	2
B7. Substitutes	2
B8. Bid Components	3
B9. Bid	4
B10. Prices	4
B11. Disclosure	5
B12. Qualification	5
B13. Bid Security	7
B14. Opening of Bids and Release of Information	8
B15. Irrevocable Bid	8
B16. Withdrawal of Bids	8
B17. Evaluation of Bids	9
B18. Award of Contract	9

### PART C - GENERAL CONDITIONS

C0. General Conditions	1
------------------------	---

### PART D - SUPPLEMENTAL CONDITIONS

#### General

D1. General Conditions	1
D2. Scope of Work	1
D3. Definitions	1
D4. Contract Administrator	2
D5. Contractor's Supervisor	2
D6. Ownership of Information, Confidentiality and Non Disclosure	2
D7. Notices	3
D8. Furnishing of Documents	3

#### Submissions

D9. Authority to Carry on Business	3
D10. Safe Work Plan	3
D11. Insurance	4
D12. Performance Security	4
D13. Detailed Prices	5
D14. Subcontractor List	5
D15. Detailed Work Schedule	5

#### Schedule of Work

D16. Commencement	5
D17. Working Days	6
D18. Critical Stages	7
D19. Substantial Performance	7
D20. Total Performance	7
D21. Liquidated Damages	7

### **Control of Work**

D22. Job Meetings	8
D23. Prime Contractor – The Workplace Safety and Health Act (Manitoba)	8
D24. The Workplace Safety and Health Act (Manitoba) – Qualifications	8

### **Measurement and Payment**

D25. Payment	8
--------------	---

### **Warranty**

D26. Warranty	8
Form H1: Performance Bond	9
Form H2: Irrevocable Standby Letter of Credit	11
Form J: Subcontractor List	13
Form L: Contractor Experience	14

## **PART E - SPECIFICATIONS**

### **General**

E1. Applicable Specifications and Drawings	1
--	---

### **General Requirements**

E2. Confined Space Entry	1
E3. Shop Drawings	4
E4. Mobilization and Demobilization	4
E5. Higgins Ave Site Access	5
E6. Traffic Management	5
E7. Excavations and Pipeline Access	6
E8. Flow Control	10
E9. Sewer Inspections	12
E10. Sewer and Manhole Repairs and Stabilization	18
E11. Cured-In-Place-Pipe (CIPP)	24
E12. Segmental Sliplining with GRP Composites	36
E13. Bonded FRP Liners	47
E14. Centrifugally Cast Concrete Pipe (CCCP)	61
E15. Spiral Wound PVC Strip Lining	69
E16. Cast-in-Place Concrete	80
E17. Reinforcing Steel	81
E18. Restoration	82

## **PART F - SECURITY CLEARANCE**

F1. Security Clearance	1
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## **APPENDICES**

Appendix A	AECOM - Confined Space Safe Work Procedure
Appendix B	Record Drawings
Appendix C	Site Photos
Appendix D	CPR Geotechnical Protocol for Pipeline and Utility Installations with Railway Right-of-Way

## **PART B - BIDDING PROCEDURES**

### **B1. CONTRACT TITLE**

- B1.1 2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS, CONTRACT 1

### **B2. SUBMISSION DEADLINE**

- B2.1 The Submission Deadline is 12:00 noon Winnipeg time, August 24, 2017.
- B2.2 Bids determined by the Manager of Materials to have been received later than the Submission Deadline will not be accepted and will be returned upon request.
- B2.3 The Contract Administrator or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

### **B3. SITE INVESTIGATION**

- B3.1 Further to C3.1, the Contract Administrator or an authorized representative will be available at Higgins Ave site (Emterra Environmental) at 9:00 am on August 15, 2017 to provide Bidders access to the Site. Bidders to meet at the front entrance of the Emterra Environmental office.
- B3.2 Proponents attending the investigation are required to register for the Site Investigation at least 48 hrs prior by contacting the Contract Administrator listed in D4.
- B3.3 The Bidder is advised that the Higgins Ave site requires access through Emterra Environmental's sorting facility. All attendees shall supply their own personal protective equipment, including high visibility vests, hard hats, steel toes boots, and safety glasses.
- B3.4 The Bidder shall not be entitled to rely on any information or interpretation received at the Site investigation unless that information or interpretation is the Bidder's direct observation, or is provided by the Contract Administrator in writing.
- B3.5 Although attendance at the Site investigation is not mandatory, the City strongly suggests that Proponents attend.
- B3.6 Further to C3.1, the Bidder may view the Dawson Road site without making an appointment.
- B3.7 The Bidder is advised that video inspections of all sewers (and manholes where available) included in this Contract are available from the Contract Administrator. The corresponding inspection condition coding reports are also available. Refer to E11.6.4(b).

### **B4. ENQUIRIES**

- B4.1 All enquiries shall be directed to the Contract Administrator identified in D4.1.
- B4.2 If the Bidder finds errors, discrepancies or omissions in the Bid Opportunity, or is unsure of the meaning or intent of any provision therein, the Bidder shall notify the Contract Administrator of the error, discrepancy or omission, or request a clarification as to the meaning or intent of the provision at least five (5) Business Days prior to the Submission Deadline.
- B4.3 Responses to enquiries which, in the sole judgment of the Contract Administrator, require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator to all Bidders by issuing an addendum.
- B4.4 Responses to enquiries which, in the sole judgment of the Contract Administrator, do not require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator only to the Bidder who made the enquiry.

B4.5 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B4 unless that response or interpretation is provided by the Contract Administrator in writing.

## **B5. CONFIDENTIALITY**

B5.1 Information provided to a Bidder by the City or acquired by a Bidder by way of further enquiries or through investigation is confidential. Such information shall not be used or disclosed in any way without the prior written authorization of the Contract Administrator. The use and disclosure of the confidential information shall not apply to information which:

- (a) was known to the Bidder before receipt hereof; or
- (b) becomes publicly known other than through the Bidder; or
- (c) is disclosed pursuant to the requirements of a governmental authority or judicial order.

B5.2 The Bidder shall not make any statement of fact or opinion regarding any aspect of the Bid Opportunity to the media or any member of the public without the prior written authorization of the Contract Administrator.

## **B6. ADDENDA**

B6.1 The Contract Administrator may, at any time prior to the Submission Deadline, issue addenda correcting errors, discrepancies or omissions in the Bid Opportunity, or clarifying the meaning or intent of any provision therein.

B6.2 The Contract Administrator will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B6.2.1 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Division website at <http://www.winnipeg.ca/matmgt/bidopp.asp>

B6.2.2 The Bidder is responsible for ensuring that he/she has received all addenda and is advised to check the Materials Management Division website for addenda regularly and shortly before the Submission Deadline, as may be amended by addendum.

B6.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 10 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

## **B7. SUBSTITUTES**

B7.1 The Work is based on the Plant, Materials and methods specified in the Bid Opportunity.

B7.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.

B7.3 Requests for approval of a substitute will not be considered unless received in writing by the Contract Administrator at least five (5) Business Days prior to the Submission Deadline.

B7.4 The Bidder shall ensure that any and all requests for approval of a substitute:

- (a) provide sufficient information and details to enable the Contract Administrator to determine the acceptability of the Plant, Material or method as either an approved equal or alternative;
- (b) identify any and all changes required in the applicable Work, and all changes to any other Work, which would become necessary to accommodate the substitute;
- (c) identify any anticipated cost or time savings that may be associated with the substitute;
- (d) certify that, in the case of a request for approval as an approved equal, the substitute will fully perform the functions called for by the general design, be of equal or superior

substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance;

- (e) certify that, in the case of a request for approval as an approved alternative, the substitute will adequately perform the functions called for by the general design, be similar in substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance.

- B7.5 The Contract Administrator, after assessing the request for approval of a substitute, may in his/her sole discretion grant approval for the use of a substitute as an "approved equal" or as an "approved alternative", or may refuse to grant approval of the substitute.
- B7.6 The Contract Administrator will provide a response in writing, at least two (2) Business Days prior to the Submission Deadline, to the Bidder who requested approval of the substitute.
- B7.6.1 The Contract Administrator will issue an Addendum, disclosing the approved materials, equipment, methods and products to all potential Bidders. The Bidder requesting and obtaining the approval of a substitute shall be responsible for disseminating information regarding the approval to any person or persons he/she wishes to inform.
- B7.7 If the Contract Administrator approves a substitute as an "approved equal", any Bidder may use the approved equal in place of the specified item.
- B7.8 If the Contract Administrator approves a substitute as an "approved alternative", any Bidder bidding that approved alternative may base his/her Total Bid Price upon the specified item but may also indicate an alternative price based upon the approved alternative. Such alternatives will be evaluated in accordance with B17.
- B7.9 No later claim by the Contractor for an addition to the Total Bid Price because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

## **B8. BID COMPONENTS**

- B8.1 The Bid shall consist of the following components:
  - (a) Form A: Bid;
  - (b) Form B: Prices;
  - (c) Bid Security
    - (i) Form G1: Bid Bond and Agreement to Bond, or  
Form G2: Irrevocable Standby Letter of Credit and Undertaking, or  
a certified cheque or draft;
- B8.2 Further to B8.1, the Bidder should include the written correspondence from the Contract Administrator approving a substitute in accordance with B7.
- B8.3 All components of the Bid shall be fully completed or provided, and submitted by the Bidder no later than the Submission Deadline, with all required entries made clearly and completely.
- B8.4 The Bid shall be submitted enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address.
  - B8.4.1 Samples or other components of the Bid which cannot reasonably be enclosed in the envelope may be packaged separately, but shall be clearly marked with the Bid Opportunity number, the Bidder's name and address, and an indication that the contents are part of the Bidder's Bid.

- B8.5 Bidders are advised not to include any information/literature except as requested in accordance with B8.1.
- B8.6 Bidders are advised that inclusion of terms and conditions inconsistent with the Bid Opportunity document, including the General Conditions, will be evaluated in accordance with B17.1(a).
- B8.7 Bids submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.
- B8.8 Bids shall be submitted to:  
The City of Winnipeg  
Corporate Finance Department  
Materials Management Division  
185 King Street, Main Floor  
Winnipeg MB R3B 1J1

**B9. BID**

- B9.1 The Bidder shall complete Form A: Bid, making all required entries.
- B9.2 Paragraph 2 of Form A: Bid shall be completed in accordance with the following requirements:
- (a) if the Bidder is a sole proprietor carrying on business in his/her own name, his/her name shall be inserted;
  - (b) if the Bidder is a partnership, the full name of the partnership shall be inserted;
  - (c) if the Bidder is a corporation, the full name of the corporation shall be inserted;
  - (d) if the Bidder is carrying on business under a name other than his/her own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.
- B9.2.1 If a Bid is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B9.2.
- B9.3 In Paragraph 3 of Form A: Bid, the Bidder shall identify a contact person who is authorized to represent the Bidder for purposes of the Bid.
- B9.4 Paragraph 12 of Form A: Bid shall be signed in accordance with the following requirements:
- (a) if the Bidder is a sole proprietor carrying on business in his/her own name, it shall be signed by the Bidder;
  - (b) if the Bidder is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;
  - (c) if the Bidder is a corporation, it shall be signed by its duly authorized officer or officers and the corporate seal, if the corporation has one, should be affixed;
  - (d) if the Bidder is carrying on business under a name other than his/her own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.
- B9.4.1 The name and official capacity of all individuals signing Form A: Bid should be printed below such signatures.
- B9.5 If a Bid is submitted jointly by two or more persons, the word "Bidder" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Bidders in the Bid and the Contract, when awarded, shall be both joint and several.

**B10. PRICES**

- B10.1 The Bidder shall state a price in Canadian funds for each item of the Work identified on Form B: Prices.

- B10.1.1 Notwithstanding C12.2.3(c), prices on Form B: Prices shall not include the Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable.
- B10.2 The quantities listed on Form B: Prices are to be considered approximate only. The City will use said quantities for the purpose of comparing Bids.
- B10.3 The quantities for which payment will be made to the Contractor are to be determined by the Work actually performed and completed by the Contractor, to be measured as specified in the applicable Specifications.
- B10.4 Payments to Non-Resident Contractors are subject to Non-Resident Withholding Tax pursuant to the Income Tax Act (Canada).

## **B11. DISCLOSURE**

- B11.1 Various Persons provided information or services with respect to this Work. In the City's opinion, this relationship or association does not create a conflict of interest because of this full disclosure. Where applicable, additional material available as a result of contact with these Persons is listed below.
- B11.2 The Persons are:
- (a) Andy Sherwin (Channeline International)

## **B12. QUALIFICATION**

- B12.1 The Bidder shall:
- (a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba; and
  - (b) be financially capable of carrying out the terms of the Contract; and
  - (c) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract.
- B12.2 The Bidder and any proposed Subcontractor (for the portion of the Work proposed to be subcontracted to them) shall:
- (a) be responsible and not be suspended, debarred or in default of any obligations to the City. A list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at <http://www.winnipeg.ca/matmgt/debar.stm>
- B12.3 The Bidder and/or any proposed Subcontractor (for the portion of the Work proposed to be subcontracted to them) shall:
- (a) have successfully carried out work similar in nature, scope and value to the Work; and
  - (b) be fully capable of performing the Work required to be in strict accordance with the terms and provisions of the Contract; and
  - (c) have a written workplace safety and health program if required pursuant to The Workplace Safety and Health Act (Manitoba);
- B12.4 Further to B12.3(a) the Bidder and/or any proposed Subcontractor completing Segmental Sliplining using GRP composites, CIPP, or Spiral Wound PVC Strip Lining must be able to demonstrate the following specific qualifications in accordance with B12.8 (Form L: Contractor Experience):
- (a) A minimum of three examples of successful non-circular installations with an internal height equal to or greater than 1200 mm.



- (b) A minimum of one example of a successful installation requiring active mainline and sewer service flow control.
- B12.5** Further to B12.3(a) the Bidder and/or any proposed Subcontractor undertaking a Bonded FRP installation must be able to demonstrate the following specific qualifications in accordance with B12.8 (Form L: Contractor Experience):
- (a) A minimum of three examples of successful internal Bonded FRP liner installation in pipelines with an internal height equal to or greater than 1200 mm (circular or non-circular); and,
  - (b) A minimum of one example of a successful Bonded FRP liner installation requiring active mainline and sewer service flow control.
- B12.6** Further to B12.3(a) the Bidder and/or any proposed Subcontractor completing a CCCP installation must be able to demonstrate the following specific qualifications in accordance with B12.8 (Form L: Contractor Experience):
- (a) A minimum of three examples of successful CCCP installations in pipelines with an internal height equal to or greater than 2100 mm (circular or non-circular);
  - (b) A minimum of one example of a successful CCCP installations in a non-circular pipeline with an internal height equal to or greater than 1200 mm; and,
  - (c) A minimum of one example of a successful CCCP installation requiring active mainline and sewer service flow control.
- B12.7** Further to B12.3(c), the Bidder shall, within five (5) Business Days of a request by the Contract Administrator, provide proof satisfactory to the Contract Administrator that the Bidder/Subcontractor has a workplace safety and health program meeting the requirements of The Workplace Safety and Health Act (Manitoba), by providing:
- (a) Written confirmation of a safety and health certification meeting SAFE Work Manitoba's SAFE Work Certified Standard (e.g., COR™ and SECOR™) or
    - (i) a copy of their valid Manitoba COR certificate and Letter of Good Standing (or Manitoba equivalency) as issued under the Certificate of Recognition (COR) Program administered by the Construction Safety Association of Manitoba or by the Manitoba Heavy Construction Association's WORKSAFELY™ COR™ Program; or
    - (ii) a copy of their valid Manitoba SECOR™ certificate and Letter of Good Standing (or Manitoba equivalency) as issued under the Small Employer Certificate of Recognition Program (SECOR™) administered by the Construction Safety Association of Manitoba or by the Manitoba Heavy Construction Association's WORKSAFELY™ COR™ Program or
  - (b) a report or letter to that effect from an independent reviewer acceptable to the City. (A list of acceptable reviewers and the review template are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at <http://www.winnipeg.ca/matmgt/>).
- B12.8** The Bidder shall submit, within five (5) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the following for the rehabilitation method(s) proposed:
- (a) Historical material properties and testing results to be used in the design. This shall include both demonstration and type testing requirements outlined in E11, E12, E13, E14, and E15. Where historical testing data meeting the requirements noted herein are not available, provide acceptable equivalent data and a concise plan for obtaining all requested testing information prior to proceeding with the design and installation of the liners.
  - (b) Design Procedures:
    - (i) Provide design procedures meeting the requirements in outlined within E11, E12, E13, E14, and E15. Submitted design procedures shall include all necessary calculations, assumptions on host pipe conditions, and material properties/testing required for design.

- (ii) Provide a design example for each site slated for rehabilitation stamped by a Professional Engineer, registered to practice engineering in the Province of Manitoba. Temporary submissions completed by Engineers with registration pending in the Province of Manitoba will be considered with the proviso that all final submissions shall be sealed by a Professional Engineer, registered to practice engineering in the Province of Manitoba.
- (c) Provide quality assurance procedures meeting the requirements outlined in E11, E12, E13, E14, and E15 and the requirements of the proposed rehabilitation system.

B12.9 The Bidder shall submit, within three (3) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the qualifications of the Bidder and of any proposed Subcontractor.

B12.10 The Bidder shall provide, on the request of the Contract Administrator, full access to any of the Bidder's equipment and facilities to confirm, to the Contract Administrator's satisfaction, that the Bidder's equipment and facilities are adequate to perform the Work.

### **B13. BID SECURITY**

B13.1 The Bidder shall provide bid security in the form of:

- (a) a bid bond, in the amount of at least ten percent (10%) of the Total Bid Price, and agreement to bond of a company registered to conduct the business of a surety in Manitoba, in the form included in the Bid Submission (Form G1: Bid Bond and Agreement to Bond); or
- (b) an irrevocable standby letter of credit, in the amount of at least ten percent (10%) of the Total Bid Price, and undertaking issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form included in the Bid Submission (Form G2: Irrevocable Standby Letter of Credit and Undertaking); or
- (c) a certified cheque or draft payable to "The City of Winnipeg", in the amount of at least fifty percent (50%) of the Total Bid Price, drawn on a bank or other financial institution registered to conduct business in Manitoba.

B13.1.1 If the Bidder submits alternative bids, the bid security shall be in the amount of the specified percentage of the highest Total Bid Price submitted.

B13.1.2 All signatures on bid securities shall be original.

B13.1.3 The Bidder shall sign the Bid Bond.

B13.1.4 The Surety shall sign and affix its corporate seal on the Bid Bond and the Agreement to Bond.

B13.2 The bid security of the successful Bidder and the next two lowest evaluated responsive and responsible Bidders will be released by the City when a Contract for the Work has been duly executed by the successful Bidder and the performance security furnished as provided herein. The bid securities of all other Bidders will be released when a Contract is awarded.

B13.2.1 Where the bid security provided by the successful Bidder is in the form of a certified cheque or draft pursuant to B13.1(c), it will be deposited and retained by the City as the performance security and no further submission is required.

B13.2.2 The City will not pay any interest on certified cheques or drafts furnished as bid security or subsequently retained as performance security.

B13.3 The bid securities of all Bidders will be released by the City as soon as practicable following notification by the Contract Administrator to the Bidders that no award of Contract will be made pursuant to the Bid Opportunity.

#### **B14. OPENING OF BIDS AND RELEASE OF INFORMATION**

- B14.1 Bids will be opened publicly, after the Submission Deadline has elapsed, in the office of the Corporate Finance Department, Materials Management Division, or in such other office as may be designated by the Manager of Materials.
- B14.1.1 Bidders or their representatives may attend.
- B14.2 Following the Submission Deadline, the names of the Bidders and their Total Bid Prices (unevaluated, and pending review and verification of conformance with requirements) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Division website at <http://www.winnipeg.ca/matmgt/default.stm>
- B14.3 After award of Contract, the name(s) of the successful Bidder(s) and the Contract amount(s) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Division website at <http://www.winnipeg.ca/matmgt/default.stm>
- B14.4 The Bidder is advised that any information contained in any Bid may be released if required by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law or by City policy or procedures (which may include access by members of City Council).

#### **B15. IRREVOCABLE BID**

- B15.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid.
- B15.2 The acceptance by the City of any Bid shall not release the Bids of the next two lowest evaluated responsive Bidders and these Bidders shall be bound by their Bids on such Work until a Contract for the Work has been duly executed and the performance security furnished as herein provided, but any Bid shall be deemed to have lapsed unless accepted within the time period specified in Paragraph 11 of Form A: Bid.

#### **B16. WITHDRAWAL OF BIDS**

- B16.1 A Bidder may withdraw his/her Bid without penalty by giving written notice to the Manager of Materials at any time prior to the Submission Deadline.
- B16.1.1 Notwithstanding C23.3, the time and date of receipt of any notice withdrawing a Bid shall be the time and date of receipt as determined by the Manager of Materials.
- B16.1.2 The City will assume that any one of the contact persons named in Paragraph 3 of Form A: Bid or the Bidder's authorized representatives named in Paragraph 12 of Form A: Bid, and only such person, has authority to give notice of withdrawal.
- B16.1.3 If a Bidder gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials will:
- (a) retain the Bid until after the Submission Deadline has elapsed;
  - (b) open the Bid to identify the contact person named in Paragraph 3 of Form A: Bid and the Bidder's authorized representatives named in Paragraph 12 of Form A: Bid; and
  - (c) if the notice has been given by any one of the persons specified in B16.1.3(b), declare the Bid withdrawn.
- B16.2 A Bidder who withdraws his/her Bid after the Submission Deadline but before his/her Bid has been released or has lapsed as provided for in B15.2 shall be liable for such damages as are imposed upon the Bidder by law and subject to such sanctions as the Chief Administrative Officer considers appropriate in the circumstances. The City, in such event, shall be entitled to

all rights and remedies available to it at law, including the right to retain the Bidder's bid security.

## **B17. EVALUATION OF BIDS**

B17.1 Award of the Contract shall be based on the following bid evaluation criteria:

- (a) compliance by the Bidder with the requirements of the Bid Opportunity, or acceptable deviation there from (pass/fail);
- (b) qualifications of the Bidder and the Subcontractors, if any, pursuant to B12 (pass/fail);
- (c) Total Bid Price;
- (d) economic analysis of any approved alternative pursuant to B7.

B17.2 Further to B17.1(a), the Award Authority may reject a Bid as being non-responsive if the Bid is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Bid, or waive technical requirements or minor informalities or irregularities, if the interests of the City so require.

B17.3 Further to B17.1(b), the Award Authority shall reject any Bid submitted by a Bidder who does not demonstrate, in his/her Bid or in other information required to be submitted, that he/she is responsible and qualified.

B17.4 Further to B17.1(c), the Total Bid Price shall be the sum of the quantities multiplied by the unit prices for each item shown on Form B: Prices.

B17.4.1 Further to B17.1(a), in the event that a unit price is not provided on Form B: Prices, the City will determine the unit price by dividing the Amount (extended price) by the approximate quantity, for the purposes of evaluation and payment.

## **B18. AWARD OF CONTRACT**

B18.1 The City will give notice of the award of the Contract or will give notice that no award will be made.

B18.2 The City will have no obligation to award a Contract to a Bidder, even though one or all of the Bidders are determined to be responsible and qualified, and the Bids are determined to be responsive.

B18.2.1 Without limiting the generality of B18.2, the City will have no obligation to award a Contract where:

- (a) the prices exceed the available City funds for the Work;
- (b) the prices are materially in excess of the prices received for similar work in the past;
- (c) the prices are materially in excess of the City's cost to perform the Work, or a significant portion thereof, with its own forces;
- (d) only one Bid is received; or
- (e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B18.3 Where an award of Contract is made by the City, the award shall be made to the responsible and qualified Bidder submitting the lowest evaluated responsive Bid, in accordance with B17.

B18.3.1 Following the award of contract, a Bidder will be provided with information related to the evaluation of his/her Bid upon written request to the Contract Administrator.

## PART C - GENERAL CONDITIONS

### C0. GENERAL CONDITIONS

- C0.1 The *General Conditions for Construction* (Revision 2006 12 15) are applicable to the Work of the Contract.
- C0.1.1 The *General Conditions for Construction* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at [http://www.winnipeg.ca/matmgt/gen\\_cond.stm](http://www.winnipeg.ca/matmgt/gen_cond.stm)
- C0.2 A reference in the Bid Opportunity to a section, clause or subclause with the prefix “**C**” designates a section, clause or subclause in the *General Conditions for Construction*.

## PART D - SUPPLEMENTAL CONDITIONS

### GENERAL

#### D1. GENERAL CONDITIONS

D1.1 In addition to the *General Conditions for Construction*, these Supplemental Conditions are applicable to the Work of the Contract.

#### D2. SCOPE OF WORK

D2.1 The Work to be done under the Contract shall consist of the trenchless rehabilitation of the combined sewers on Higgins Ave and Dawson Road.

D2.2 The major components of the Work are as follows:

- (a) Traffic control;
- (b) Flow control;
- (c) Developing access to the trunk sewers at each location;
- (d) Sewer cleaning, preparation, and inspection;
- (e) Trenchless rehabilitation of the identified sewers; and,
- (f) Site restoration.

#### D3. DEFINITIONS

D3.1 When used in this Bid Opportunity:

- (a) "**ASTM**" means American Society for Testing and Materials;
- (b) "**ACI**" means American Concrete Institute;
- (c) "**AREMA**" means American Railway Engineering and Maintenance-of-Way Association;
- (d) "**AWWA**" means American Water Works Association;
- (e) "**CPR**" means Canadian Pacific Railway;
- (f) "**CSA**" means Canadian Standards Association;
- (g) "**IGN**" means Information and Guidance Notes;
- (h) "**WIS**" means Water Industry Standard;
- (i) "**GRP**" means glass reinforced plastic;
- (j) "**CIPP**" means cured-in-place pipe;
- (k) "**FRP**" means fibre reinforced polymer;
- (l) "**CFRP**" means carbon fibre reinforced polymer;
- (m) "**GFRP**" means glass fibre reinforced polymer;
- (n) "**CCCP**" means centrifugally cast concrete pipe;
- (o) "**Bonded FRP**" means the application and bonding of an FRP laminate sheet to the interior of a host pipe for the purpose of creating a composite structure with the host pipe;
- (p) "**Spiral Wound PVC**" means the installation of a spirally wound liner consisting of interlocking PVC strips forming a continuous liner within the host pipe. The liner is grouted in place after installation;
- (q) "**Segmental Sliplining**" means the installation of discrete pipe segments within the host pipe. Liner segments are grouted in place after installation;

- (r) **"Partially Deteriorated"** means the host pipe can support the soil and surcharge loads throughout the design life of the rehabilitated pipe. Liners for partially deteriorated pipes shall be designed to account for external hydrostatic pressure only;
- (s) **"Fully Deteriorated"** means the host pipe is not structurally sound and cannot support soil and live loads or is expected to reach this condition over the design life of the rehabilitated pipe. Liners for fully deteriorated pipes shall be design to support all overburden loads, including: soil, live, and external hydrostatic pressure;
- (t) **"Higgins Ave Trunk"** means the City of Winnipeg Trunk Sewers targeted for rehabilitation on the former City of Winnipeg right of way (Higgins Ave) currently occupied by Emterra Environmental shown on the Drawings (Asset ID's: S-MA20019733 and S-MA20019742); and,
- (u) **"Dawson Road Trunk"** means City of Winnipeg Trunk Sewer targeted for rehabilitation on Dawson Road and shown on the Drawings (Asset ID: S-MA50010470).

D3.2 Notwithstanding C1.1, when used in this Bid Opportunity:

- (a) **"Business Day"** means any Calendar Day, other than a Saturday, Sunday, or a statutory or civic holiday.

#### **D4. CONTRACT ADMINISTRATOR**

D4.1 The Contract Administrator is AECOM Canada Ltd., represented by:

Adam Braun, P.Eng.  
Municipal Engineer

Telephone No. 204-928-9216  
Email Address adam.braun@aecom.com

D4.2 At the pre-construction meeting, Mr. Braun will identify additional personnel representing the Contract Administrator and their respective roles and responsibilities for the Work.

D4.3 Bids Submissions must be submitted to the address in B8.8.

#### **D5. CONTRACTOR'S SUPERVISOR**

D5.1 At the pre-construction meeting, the Contractor shall identify his/her designated supervisor and any additional personnel representing the Contractor and their respective roles and responsibilities for the Work.

#### **D6. OWNERSHIP OF INFORMATION, CONFIDENTIALITY AND NON DISCLOSURE**

D6.1 The Contract, all deliverables produced or developed, and information provided to or acquired by the Contractor are the property of the City and shall not be appropriated for the Contractors own use, or for the use of any third party.

D6.2 The Contractor shall not make any public announcements or press releases regarding the Contract, without the prior written authorization of the Contract Administrator.

D6.3 The following shall be confidential and shall not be disclosed by the Contractor to the media or any member of the public without the prior written authorization of the Contract Administrator;

- (a) information provided to the Contractor by the City or acquired by the Contractor during the course of the Work;
- (b) the Contract, all deliverables produced or developed; and
- (c) any statement of fact or opinion regarding any aspect of the Contract.

D6.4 A Contractor who violates any provision of D6 may be determined to be in breach of Contract.

## **D7. NOTICES**

- D7.1 Except as provided for in C23.2.2, all notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the Contractor shall be sent to the address or facsimile number identified by the Contractor in Paragraph 2 of Form A: Bid.
- D7.2 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D7.3, D7.4 or elsewhere in the Contract, shall be sent to the attention of the Contract Administrator at the facsimile number identified in D4.1.
- D7.3 Notwithstanding C21., all notices of appeal to the Chief Administrative Officer shall be sent to the attention of the Chief Financial Officer at the following facsimile number:
- The City of Winnipeg  
Chief Financial Officer  
Facsimile No.: 204 949-1174
- D7.4 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications required to be submitted or returned to the City Solicitor shall be sent to the following facsimile number:
- The City of Winnipeg  
Legal Services Department  
Attn: Director of Legal Services  
Facsimile No.: 204 947-9155
- D7.5 Bids Submissions must not be submitted to the above facsimile numbers. Bids must be submitted in accordance with B8.**

## **D8. FURNISHING OF DOCUMENTS**

- D8.1 Upon award of the Contract, the Contractor will be provided with five (5) complete sets of the Bid Opportunity. If the Contractor requires additional sets of the Bid Opportunity, they will be supplied to him/her at cost.

## **SUBMISSIONS**

### **D9. AUTHORITY TO CARRY ON BUSINESS**

- D9.1 The Contractor shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Contractor does not carry on business in Manitoba, in the jurisdiction where the Contractor does carry on business, throughout the term of the Contract, and shall provide the Contract Administrator with evidence thereof upon request.

### **D10. SAFE WORK PLAN**

- D10.1 The Contractor shall provide the Contract Administrator with a Safe Work Plan at least five (5) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.
- D10.2 The Safe Work Plan should be prepared and submitted in the format shown in the City's template which is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at <http://www.winnipeg.ca/matmgt/Safety/default.stm>



D10.3 Notwithstanding B12.7 at any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require an updated COR Certificate or Annual Letter of good Standing. A Contractor, who fails to provide a satisfactory COR Certificate or Annual Letter of good Standing, will not be permitted to continue to perform any Work.

## **D11. INSURANCE**

D11.1 The Contractor shall provide and maintain the following insurance coverage:

- (a) commercial general liability insurance, in the amount of at least two million dollars (\$2,000,000.00) inclusive, with The City of Winnipeg added as an additional insured, with a cross-liability clause, such liability policy to also contain contractual liability, unlicensed motor vehicle liability, non-owned automobile liability and products and completed operations, to remain in place at all times during the performance of the Work and throughout the warranty period;
- (b) if applicable, Automobile Liability Insurance covering all motor vehicles, owned and operated and used or to be used by the Contractor directly or indirectly in the performance of the Work. The Limit of Liability shall not be less than \$2,000,000 inclusive for loss or damage including personal injuries and death resulting from any one accident or occurrence.

D11.2 Deductibles shall be borne by the Contractor.

D11.3 The Contractor shall provide the City Solicitor with a certificate(s) of insurance, in a form satisfactory to the City Solicitor, at least two (2) Business Days prior to the commencement of any Work but in no event later than the date specified in C4.1 for the return of the executed Contract.

D11.4 The Contractor shall not cancel, materially alter, or cause each policy to lapse without providing at least thirty (30) Calendar Days prior written notice to the Contract Administrator.

## **D12. PERFORMANCE SECURITY**

D12.1 The Contractor shall provide and maintain performance security until the expiration of the warranty period in the form of:

- (a) a performance bond of a company registered to conduct the business of a surety in Manitoba, in the form attached to these Supplemental Conditions (Form H1: Performance Bond), in the amount of fifty percent (50%) of the Contract Price; or
- (b) an irrevocable standby letter of credit issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form attached to these Supplemental Conditions (Form H2: Irrevocable Standby Letter of Credit), in the amount of fifty percent (50%) of the Contract Price; or
- (c) a certified cheque or draft payable to "The City of Winnipeg", drawn on a bank or other financial institution registered to conduct business in Manitoba, in the amount of fifty percent (50%) of the Contract Price.

D12.1.1 Where the performance security is in the form of a certified cheque or draft, it will be deposited by the City. The City will not pay any interest on certified cheques or drafts furnished as performance security.

D12.2 The Contractor shall provide the City Solicitor with the required performance security within seven (7) Calendar Days of notification of the award of the Contract by way of letter of intent and prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.

### **D13. DETAILED PRICES**

- D13.1 The Contractor shall provide the Contract Administrator with a detailed price breakdown (Form I: Detailed Prices) at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.
- D13.2 The Contractor shall state a price for each item or sub-item of the Work identified on Form I: Detailed Prices. The detailed prices must be consistent with the price(s) provided in the Contractor's Bid.

### **D14. SUBCONTRACTOR LIST**

- D14.1 The Contractor shall provide the Contract Administrator with a complete list of the Subcontractors whom the Contractor proposes to engage (Form J: Subcontractor List) at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.

### **D15. DETAILED WORK SCHEDULE**

- D15.1 The Contractor shall provide the Contract Administrator with a detailed work schedule at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.
- D15.2 The detailed work schedule shall consist of the following:
- (a) a Gantt chart for the Work based on the C.P.M. schedule.
- D15.3 Further to D15.2(a), the C.P.M. schedule shall clearly identify the start and completion dates of all of the following activities/tasks making up the Work as well as showing those activities/tasks on the critical path:
- (a) Geotechnical bore hole;
  - (b) pre-design inspections;
  - (c) mobilization to site;
  - (d) shaft construction;
  - (e) sewer cleaning and prep work;
  - (f) installation of structural sewer liner; and
  - (g) planned breaks in the performed work pursuant to D17.7.
- D15.4 The Contractor shall provide an updated detailed work schedule at least once per month or within two (2) Business Days of a request by the Contract Administrator.

## **SCHEDULE OF WORK**

### **D16. COMMENCEMENT**

- D16.1 The Contractor shall not commence any Work until he/she is in receipt of a letter of intent from the Award Authority authorizing the commencement of the Work.
- D16.2 The Contractor shall not commence any Work on the Site until:
- (a) the Contract Administrator has confirmed receipt and approval of:
    - (i) evidence of authority to carry on business specified in D9;
    - (ii) evidence of the workers compensation coverage specified in C6.15;
    - (iii) the Safe Work Plan specified in D10;
    - (iv) evidence of the insurance specified in D11;

- (v) the performance security specified in D12;
  - (vi) the detailed prices specified in D13;
  - (vii) the Subcontractor list specified in D14; and,
  - (viii) the detailed work schedule specified in D15.
- (b) the Contractor has attended a pre-construction meeting with the Contract Administrator, or the Contract Administrator has waived the requirement for a pre-construction meeting.

## **D17. WORKING DAYS**

- D17.1 Further to C1.1(jj), the Contract Administrator's determination of whether or not atmospheric and Site conditions are such that a Working Day is deemed to have elapsed may be based at one time on one type of work while at another time a Working Day may be based on another type of work. When more than one type of major work is involved, the quantity of equipment that must be able to work in order to meet the requirements of a Working Day may vary considerably from that specified in the General Conditions.
- D17.2 In the event that incidental work is behind schedule which, in the opinion of the Contract Administrator, should have been or could have been carried out by the Contractor in conjunction with or immediately following work of a major type, the City hereby reserves the right to charge Working Days on the incidental work until such time as it is up to schedule.
- D17.3 When the major type of work involves restoration of the site to the condition it was prior to rainfall, Working Days shall not be charged.
- D17.4 The Contract Administrator will furnish the Contractor with a daily record for each major type of work showing various information concerning the equipment, the time it worked, could have worked and Working Days charged. This report is to be signed each day by an authorized representative of the Contractor.
- D17.5 Notwithstanding C1.1(gg) if the Contractor chooses to work on a Saturday, Sunday, or statutory or civic holiday and is able to complete at least seven (7) hours of work during the period between 7:00 a.m. Winnipeg time or the time the Contractor's operations normally commence, whichever is earlier, and 7:00 p.m. Winnipeg time the day shall be considered a Working Day.
- D17.6 Working Days shall be incurred by the Contractor for every Working Day as defined herein. Working days shall be incurred starting on the date the Contractor commences work on site, or the date of commencement identified on the Contractors submitted schedule (D15), whichever occurs first.
- D17.7 Planned Breaks in Construction
- (a) The Contractor will be permitted planned suspensions of on-site construction to facilitate crew breaks. Working Days will not be incurred during these periods.
  - (b) All planned breaks in on-site construction activity must be clearly identified in the Contractors detailed construction schedule (D15) and notice must be provided in writing a minimum of two (2) Business Days prior to the planned suspension of work. Failure of the Contractor to provide adequate notice, in the opinion of the Contract Administrator, may result in Working Days being incurred.
  - (c) During these periods, the Site must be made secure, roadways operational as permitted in E6, and all existing facilities and work in progress be protected from weather or other potentially harmful effects.
  - (d) Upon recommencement of site activities after long breaks (greater than 1 month), the Contractor shall provide an updated schedule and notification to the Contract Administrator a minimum of five (5) Business Days prior to recommencement of work.
  - (e) No changes to Contract completion dates resulting from suspension of contract time as described herein will be considered.

- (f) No additional costs associated with demobilization and remobilization resulting from suspension of contract time will be considered

**D18. CRITICAL STAGES**

D18.1 The Contractor shall achieve critical stages of the Work in accordance with the following requirements:

- (a) Submission of shoring designs for the access shaft on the Higgins Ave Trunk for submission to CPR for approval. Shoring designs shall be submitted complete with all required supporting documentation within thirty five (35) Business Days of Award.

**D19. SUBSTANTIAL PERFORMANCE**

D19.1 The Contractor shall achieve Substantial Performance within forty (40) consecutive Working Days of the commencement of the Work as specified in D16 or by March 2, 2018, whichever comes first.

D19.2 When the Contractor considers the Work to be substantially performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Substantial Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be reinspected.

D19.3 The date on which the Work has been certified by the Contract Administrator as being substantially performed to the requirements of the Contract through the issue of a certificate of Substantial Performance is the date on which Substantial Performance has been achieved.

**D20. TOTAL PERFORMANCE**

D20.1 The Contractor shall achieve Total Performance within seventy (70) consecutive Working Days of the commencement of the Work as specified in D16 or July 13, 2018, whichever comes first.

D20.2 When the Contractor or the Contract Administrator considers the Work to be totally performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Total Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be reinspected.

D20.3 The date on which the Work has been certified by the Contract Administrator as being totally performed to the requirements of the Contract through the issue of a certificate of Total Performance is the date on which Total Performance has been achieved.

**D21. LIQUIDATED DAMAGES**

D21.1 If the Contractor fails to achieve Critical Stages, Substantial Performance or Total Performance in accordance with the Contract by the days fixed herein for same, the Contractor shall pay the City the following amounts per Working Day for each and every Working Day following the days fixed herein for same during which such failure continues:

- (a) Critical Stage – two thousand dollars (\$2,000.00);
- (b) Substantial Performance - two thousand dollars (\$2,000.00);
- (c) Total Performance - five hundred dollars (\$500.00).

D21.2 The amounts specified for liquidated damages in D21.1 are based on a genuine pre-estimate of the City's losses in the event that the Contractor does not achieve critical stages, Substantial Performance or Total Performance by the days fixed herein for same.

D21.3 The City may reduce any payment to the Contractor by the amount of any liquidated damages assessed.

## **CONTROL OF WORK**

### **D22. JOB MEETINGS**

- D22.1 Regular weekly job meetings will be held at the Site. These meetings shall be attended by a minimum of one representative of the Contract Administrator, one representative of the City and one representative of the Contractor. Each representative shall be a responsible person capable of expressing the position of the Contract Administrator, the City and the Contractor respectively on any matter discussed at the meeting including the Work schedule and the need to make any revisions to the Work schedule. The progress of the Work will be reviewed at each of these meetings.
- D22.2 The Contract Administrator reserves the right to cancel any job meeting or call additional job meetings whenever he/she deems it necessary.

### **D23. PRIME CONTRACTOR – THE WORKPLACE SAFETY AND HEALTH ACT (MANITOBA)**

- D23.1 Further to C6.24, the Contractor shall be the Prime Contractor and shall serve as, and have the duties of the Prime Contractor in accordance with The Workplace Safety and Health Act (Manitoba).

### **D24. THE WORKPLACE SAFETY AND HEALTH ACT (MANITOBA) – QUALIFICATIONS**

- D24.1 Further to B12.7, the Contractor/Subcontractor must, throughout the term of the Contract, have a Workplace Safety and Health Program meeting the requirements of The Workplace Safety and Health Act (Manitoba). At any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require updated proof of compliance, as set out in B12.7.

## **MEASUREMENT AND PAYMENT**

### **D25. PAYMENT**

- D25.1 Further to C12, the City may at its option pay the Contractor by direct deposit to the Contractor's banking institution.

## **WARRANTY**

### **D26. WARRANTY**

- D26.1 Notwithstanding C13.2, the Contract Administrator may permit the warranty period for a portion or portions of the Work to begin prior to the date of Total Performance if:
- (a) a portion of the Work cannot be completed because of unseasonable weather or other conditions reasonably beyond the control of the Contractor but that portion does not prevent the balance of the Work from being put to its intended use.
- D26.1.1 In such case, the date specified by the Contract Administrator for the warranty period to begin shall be substituted for the date specified in C13.2 for the warranty period to begin.

**FORM H1: PERFORMANCE BOND**  
(See D12)

KNOW ALL MEN BY THESE PRESENTS THAT

\_\_\_\_\_ ,  
(hereinafter called the "Principal"), and

\_\_\_\_\_ ,  
(hereinafter called the "Surety"), are held and firmly bound unto **THE CITY OF WINNIPEG** (hereinafter called the "Obligee"), in the sum of

\_\_\_\_\_ dollars (\$\_\_\_\_\_)

of lawful money of Canada to be paid to the Obligee, or its successors or assigns, for the payment of which sum the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS the Principal has entered into a written contract with the Obligee for

BID OPPORTUNITY NO. 558-2017

2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS, CONTRACT 1

which is by reference made part hereof and is hereinafter referred to as the "Contract".

NOW THEREFORE the condition of the above obligation is such that if the Principal shall:

- (a) carry out and perform the Contract and every part thereof in the manner and within the times set forth in the Contract and in accordance with the terms and conditions specified in the Contract;
- (b) perform the Work in a good, proper, workmanlike manner;
- (c) make all the payments whether to the Obligee or to others as therein provided;
- (d) in every other respect comply with the conditions and perform the covenants contained in the Contract; and
- (e) indemnify and save harmless the Obligee against and from all loss, costs, damages, claims, and demands of every description as set forth in the Contract, and from all penalties, assessments, claims, actions for loss, damages or compensation whether arising under "The Workers Compensation Act", or any other Act or otherwise arising out of or in any way connected with the performance or non-performance of the Contract or any part thereof during the term of the Contract and the warranty period provided for therein;

THEN THIS OBLIGATION SHALL BE VOID, but otherwise shall remain in full force and effect. The Surety shall not, however, be liable for a greater sum than the sum specified above.

AND IT IS HEREBY DECLARED AND AGREED that the Surety shall be liable as Principal, and that nothing of any kind or matter whatsoever that will not discharge the Principal shall operate as a discharge or release of liability of the Surety, any law or usage relating to the liability of Sureties to the contrary notwithstanding.

IN WITNESS WHEREOF the Principal and Surety have signed and sealed this bond the

\_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_ .

**SIGNED AND SEALED**  
in the presence of:

\_\_\_\_\_  
(Witness as to Principal if no seal)

\_\_\_\_\_  
(Name of Principal)

Per: \_\_\_\_\_ (Seal)

Per: \_\_\_\_\_

\_\_\_\_\_  
(Name of Surety)

By: \_\_\_\_\_ (Seal)  
(Attorney-in-Fact)

**FORM H2: IRREVOCABLE STANDBY LETTER OF CREDIT  
(PERFORMANCE SECURITY)**  
(See D12)

\_\_\_\_\_  
(Date)

The City of Winnipeg  
Legal Services Department  
185 King Street, 3rd Floor  
Winnipeg MB R3B 1J1

RE: PERFORMANCE SECURITY - BID OPPORTUNITY NO. 558-2017

2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS,  
CONTRACT 1

Pursuant to the request of and for the account of our customer,

\_\_\_\_\_  
(Name of Contractor)

\_\_\_\_\_  
(Address of Contractor)

WE HEREBY ESTABLISH in your favour our irrevocable Standby Letter of Credit for a sum not exceeding in the aggregate

\_\_\_\_\_ Canadian dollars.

This Standby Letter of Credit may be drawn on by you at any time and from time to time upon written demand for payment made upon us by you. It is understood that we are obligated under this Standby Letter of Credit for the payment of monies only and we hereby agree that we shall honour your demand for payment without inquiring whether you have a right as between yourself and our customer to make such demand and without recognizing any claim of our customer or objection by the customer to payment by us.

The amount of this Standby Letter of Credit may be reduced from time to time only by amounts drawn upon it by you or by formal notice in writing given to us by you if you desire such reduction or are willing that it be made.

Partial drawings are permitted.

We engage with you that all demands for payment made within the terms and currency of this Standby Letter of Credit will be duly honoured if presented to us at:

\_\_\_\_\_  
(Address)

and we confirm and hereby undertake to ensure that all demands for payment will be duly honoured by us.



All demands for payment shall specifically state that they are drawn under this Standby Letter of Credit.

Subject to the condition hereinafter set forth, this Standby Letter of Credit will expire on

\_\_\_\_\_  
(Date)

It is a condition of this Standby Letter of Credit that it shall be deemed to be automatically extended from year to year without amendment from the present or any future expiry date, unless at least 30 days prior to the present or any future expiry date, we notify you in writing that we elect not to consider this Standby Letter of Credit to be renewable for any additional period.

This Standby Letter of Credit may not be revoked or amended without your prior written approval.

This credit is subject to the Uniform Customs and Practice for Documentary Credit (2007 Revision), International Chamber of Commerce Publication Number 600.

\_\_\_\_\_  
(Name of bank or financial institution)

Per: \_\_\_\_\_  
(Authorized Signing Officer)

Per: \_\_\_\_\_  
(Authorized Signing Officer)



**FORM L: CONTRACTOR EXPERIENCE**  
(See B12)

**2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS, CONTRACT 1**

Attach additional resumes and documents as required. Indicate whether Projects/Project Personnel are for Contractor or Subcontractor, and if applicable include name of Subcontractor.

**1. Project References:**

Project Client/Contact: \_\_\_\_\_

(Name)

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(phone)

\_\_\_\_\_  
(email)

<u>Year</u>	<u>Description of Project, including type of pipe</u>	<u>Value</u>
-------------	---	--------------

_____	_____	_____
_____	_____	_____
_____	_____	_____

**2. Project References:**

Project Client/Contact: \_\_\_\_\_

(Name)

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(phone)

\_\_\_\_\_  
(email)

<u>Year</u>	<u>Description of Project, including type of pipe</u>	<u>Value</u>
-------------	---	--------------

_____	_____	_____
_____	_____	_____
_____	_____	_____

**FORM L: CONTRACTOR EXPERIENCE**

(See B12)

**2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS, CONTRACT 1**

**3. Project References:**

Project Client/Contact: \_\_\_\_\_

(Name)

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(phone)

\_\_\_\_\_  
(email)

<u>Year</u>	<u>Description of Project, including type of pipe</u>	<u>Value</u>
-------------	---	--------------

_____	_____	_____
_____	_____	_____
_____	_____	_____

**4. Project References:**

Project Client/Contact: \_\_\_\_\_

(Name)

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(phone)

\_\_\_\_\_  
(email)

<u>Year</u>	<u>Description of Project, including type of pipe</u>	<u>Value</u>
-------------	---	--------------

_____	_____	_____
_____	_____	_____
_____	_____	_____

**FORM L: CONTRACTOR EXPERIENCE**

(See B12)

**2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS, CONTRACT 1**

**5. Project References:**

Project Client/Contact: \_\_\_\_\_

(Name)

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(phone)

\_\_\_\_\_  
(email)

<u>Year</u>	<u>Description of Project, including type of pipe</u>	<u>Value</u>
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_____	_____	_____
_____	_____	_____
_____	_____	_____

**6. Project References:**

Project Client/Contact: \_\_\_\_\_

(Name)

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(phone)

\_\_\_\_\_  
(email)

<u>Year</u>	<u>Description of Project, including type of pipe</u>	<u>Value</u>
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_____	_____	_____
_____	_____	_____
_____	_____	_____

**FORM L: CONTRACTOR EXPERIENCE**

(See B12)

**2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS, CONTRACT 1**

**7. Project Personnel:**

Name and Title: \_\_\_\_\_  
(Name)

Qualifications: (attach resume and fill out information below)

<u>Year</u>	<u>Description of Past Project</u>	<u>For Whom Work Was Performed</u>	<u>Value</u>

**8. Project Personnel:**

Name and Title: \_\_\_\_\_  
(Name)

Qualifications: (attach resume and fill out information below)

<u>Year</u>	<u>Description of Past Project</u>	<u>For Whom Work Was Performed</u>	<u>Value</u>

**9. Project Personnel:**

Name and Title: \_\_\_\_\_  
(Name)

Qualifications: (attach resume and fill out information below)

<u>Year</u>	<u>Description of Past Project</u>	<u>For Whom Work Was Performed</u>	<u>Value</u>

**FORM L: CONTRACTOR EXPERIENCE**

(See B12)

2017 TRENCHLESS REHABILITATION OF NON-CIRCULAR COMBINED SEWERS, CONTRACT 1

**10. Project Personnel:**

Name and Title: \_\_\_\_\_  
(Name)

Qualifications: (attach resume and fill out information below)

<u>Year</u>	<u>Description of Past Project</u>	<u>For Whom Work Was Performed</u>	<u>Value</u>

## PART E - SPECIFICATIONS

### GENERAL

#### E1. APPLICABLE SPECIFICATIONS AND DRAWINGS

- E1.1 These Specifications shall apply to the Work.
- E1.2 *The City of Winnipeg Standard Construction Specifications* in its entirety, whether or not specifically listed on Form B: Prices, shall apply to the Work.
- E1.2.1 *The City of Winnipeg Standard Construction Specifications* is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at <http://www.winnipeg.ca/matmgt/Spec/Default.stm> .
- E1.2.2 The version in effect three (3) Business Days before the Submission Deadline shall apply.
- E1.2.3 Further to C2.4(d), Specifications included in the Bid Opportunity shall govern over *The City of Winnipeg Standard Construction Specifications*.
- E1.3 The following are applicable to the Work:

<u>Appendix No.</u>	<u>Title</u>
A	AECOM - Confined Space Safe Work Procedure
B	Record Drawings
C	Site Photos
D	CPR Geotechnical Protocol for Pipeline and Utility Installations with Railway Right of Way

<u>Drawing No.</u>	<u>Drawing Name/Title</u>
11631	Cover Sheet
11632	Higgins Avenue – Site Access Plan
11633	Higgins Avenue – Plan/Profile
11634	Dawson Road N – Plan/Profile
11635	Miscellaneous Sections & Details

### GENERAL REQUIREMENTS

#### E2. CONFINED SPACE ENTRY

- E2.1 Description
- (a) This Specification shall outline minimum requirements for confined space operations and provision of support for third party inspections through the course of the work.
- E2.2 General
- E2.2.1 The Contractor shall be aware that Hydrogen Sulphide Gas is present in all underground structures connected to the City's sewer systems and has been known to accumulate in concentrations sufficient to cause serious harm or death to personnel who are not using adequate Personal Protective Equipment.
- E2.2.2 The Contractor's attention is drawn to the Province of Manitoba Workplace Safety and Health Act ("the Act"), and the Regulations and Guidelines there-under pertaining to Confined Space Entry Work and in particular the requirements for conducting hazard/risk assessments and providing personal protective equipment (PPE).
- E2.2.3 The Contractor is responsible for all safety and confined space support for both the work and third party inspections by the City and Contract Administrator throughout the project.



## E2.3 Methods

### E2.3.1 Hazard Assessment

- (a) In conjunction with securing the site and obtaining underground clearances, the Contractor shall conduct a hazard assessment for each site requiring work within a sewer or manhole. The assessment shall identify and evaluate the hazards, including but not be limited to review of the following as it pertains to the work to be performed:
  - (i) nature of the defect;
  - (ii) location of the defect in the sewer/manhole;
  - (iii) structural condition and amount of debris in the remaining sewer/manhole;
  - (iv) condition of the manholes up and downstream of the required repair;
  - (v) atmospheric conditions in the manholes up and downstream of the required repair;
  - (vi) condition of adjacent downstream sewers; and,
  - (vii) flow in the sewer.
- (b) The hazard assessment shall be based on the Contractor's review of video for the sewer(s) and site inspection of the manholes, sewers and external conditions. Prior to the inspection, the Contractor shall conduct the necessary atmospheric monitoring of the affected manholes and sewers to establish acceptable entry conditions.
- (c) Based on the results of the hazard assessment the Contractor shall determine if they can perform the stabilization repairs in a safe manner. If the Contractor decides to proceed with the internal repairs they shall prepare a Safe Work Plan in accordance with E2.3.2 complete with the necessary controls and procedures required to maintain a safe working environment for the repair. Otherwise they shall notify the Contract Administrator and jointly the Contractor and the Contract Administrator shall review the nature of the work and determine alternative means of completing the work are required.

### E2.3.2 Safe Work Plan

- (a) Subsequent to performing a hazard assessment the Contractor shall develop a safe work plan to address the potential hazards associated with each site. In addition to addressing the potential hazards the safe work plan shall address but not be limited to the following:
  - (i) guidelines for confined space entry work established by The Manitoba Workplace Safety and Health Act;
  - (ii) provision for emergency response;
  - (iii) training and duties for entry personnel;
  - (iv) rescue and emergency services;
  - (v) requirement for purging, ingesting, flushing and/or continuous ventilation to eliminate or control atmospheric hazards;
  - (vi) requirement for and provision of supplied air;
  - (vii) communication between members of the repair crew in the pipe and on the ground's surface;
  - (viii) current and forecasted weather conditions;
  - (ix) isolating the workspace by plugging of upstream sewers and monitoring of upstream flow levels;
  - (x) provision of back-up equipment;
  - (xi) method of ingress into the sewer; and,
  - (xii) method of egress out of the sewer – forward and backwards.
- (b) The Contractor shall not enter the sewer or manholes to begin the work until they have completed a hazard assessment and safe work plan for the specific repair and reviewed the plans with their designated safety officer for acceptance. The safe work plan procedures and practices shall conform to all federal, provincial and municipal

codes, regulations and guidelines including Manitoba Workplace Safety and Health Regulations.

#### E2.3.3 Enter the Manhole and Sewer

- (a) The Contractor shall enter the manhole/sewer and complete the work in accordance with their safe work plan and requirements for the repair contained herein.
- (b) If at any time during the repair the attendant and/or Contractor believes he cannot safely perform the work they shall immediately stop the work and evacuate the sewer and manholes. The Contractor shall re-assess their safe work plan considering the reason for the work stoppage. The work shall only be resumed when the Contractor has deemed it safe to return by completing a re-assessment and safe work plan revision, where necessary.
- (c) If the Contractor deems the work cannot be safely completed by internal stabilization they shall notify the Contract Administrator and jointly the Contractor and the Contract Administrator shall review the nature of the defect and determine alternative means of completing the work are required.

#### E2.3.4 Third Party Inspections

- (a) The Contractor's safe work plan and confined space entry procedures for inspections involving AECOM personnel shall meet or exceed all requirements outlined in AECOM's Safe Work Procedure, attached in Appendix A.
- (b) The Contractor shall provide confined space support for third party inspections. AECOM and City personal will provide personal PPE. Support shall include but is not limited to:
  - (i) Furnishing all confined space entry documentation and permits. Copies of the signed and closed out permits shall be provided to the Contract Administrator within five (5) Business Days of the confined space entry;
  - (ii) Provision of an attendant and supervisor dedicated to the confined space entry;
  - (iii) Provision of a retrieval tripod, complete with retractable winch line;
  - (iv) Provision of confined space harnesses. Harnesses shall be certified in accordance with the manufacturer's recommendations;
  - (v) Provision of atmospheric monitors for each entrant. Atmospheric monitors shall be calibrated and tested in accordance with the manufacturer's recommendations; and,
  - (vi) The Contractor shall complete and document atmospheric monitoring prior to and during entry in accordance with submitted confined space procedures.
- (c) Unless otherwise authorised, the Contractor shall have flow control measures in place for all manned inspections of the pipeline;
- (d) The Contractor shall ensure the following minimum requirements are met for all third party inspections involving AECOM and City personnel:
  - (i) The upstream sewer shall be isolated from the work space to prevent hazardous atmospheric conditions from entering the work space; and,
  - (ii) The work space shall be ventilated to achieve a minimum of 7 air exchanges per hour. A full ventilation of the confined space is required prior to entry. The contractor shall provide evidence of ventilation calculations to achieve the required air exchanges.
- (e) If the Contractor is unable to adequately mitigate atmospheric hazards within the work space to the satisfaction of the confined space entrants, the provision of an on-site confined space rescue team may be required.
- (f) Inspections may be delayed or postponed where onsite confined space procedures, hazard mitigation measures, or confined space entry support do not meet the Contractors submitted and accepted safe work plan and procedures until such a time that discrepancies have been addressed to the satisfaction of the entrants. Claims for delays resulting from improper confined space operations will not be considered.

## E2.4 Measurement and Payment

### E2.4.1 Confined Space Entry

- (a) Performing hazard assessments, preparing a Safe Work Plans, and confined space entry support for the Work and inspections will not be measured for payment and shall be considered incidental to the Work. No separate payment will be made.

## E3. SHOP DRAWINGS

### E3.1 Description

- (a) This Specification shall revise, amend, and supplement the requirements of CW 1110 of the City of Winnipeg's Standard Construction Specifications.
- (b) The term "Shop Drawings: means drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work.

E3.2 Submit all Shop Drawings in accordance with CW 1110 except as modified herein.

E3.3 The Contractor shall submit specified Shop Drawings to the Contract Administrator for review. All submissions must be in metric units. Where data is in imperial units, the correct metric equivalent shall also be shown on all submissions for Engineering review.

E3.4 Submit Shop Drawing submissions within five (5) Business Days of a request as indicated in E2 or receipt of Notice of Award in accordance with B18, whichever is earlier.

E3.5 Allow for a five (5) Business Days period for review by the Contract Administrator of each individual submission and re-submission, unless noted otherwise in the Contract Documents.

E3.6 Shop Drawings not meeting the requirements of CW 1100 or the requirements specified herein will be returned to the Contractor without review for resubmission.

E3.7 Shop drawing submissions will be limited to 2 reviews per shop drawing. This shall include a review of the initial submission and a review of the revised submission. Costs associated with subsequent reviews will be charged to the Contractor.

### E3.8 Measurement and Payment

- (a) The provision of Shop Drawings shall be considered incidental to the Work and will not be measured for payment. No additional payment will be made.

## E4. MOBILIZATION AND DEMOBILIZATION

### E4.1 Description

- (a) This Specification shall govern Mobilization and Demobilization from site.

### E4.2 Measurement and Payment

#### E4.2.1 Mobilization and Demobilization

- (a) Mobilization and demobilization will be measured on a lump sum basis and paid for at the Contract Lump Sum Price for "Mobilization and Demobilization". Payment for Mobilization and demobilization shall include all costs associated with mobilization and demobilization, site set up, and cleanup. Payment will be made on the following schedule:
- (b) 25% payment of the Mobilization and Demobilization lump sum price will be paid once lining crews arrive on site to commence cleaning and sewer preparation works.
- (c) 50% payment of the Mobilization and Demobilization lump sum price will be paid once lining crews arrive on site to commence lining installation.

- (d) 100% of the Mobilization and Demobilization lump sum price will be paid subsequent to the completion of the liner installation and site cleanup.

## **E5. HIGGINS AVE SITE ACCESS**

### **E5.1 Description**

- (a) This Specification shall govern the requirements accessing the Higgins Ave work site during the course of the Work.

### **E5.2 Methods**

- E5.2.1 The Contractor shall be aware that the Higgins Ave site requires access through Emterra Environmental's recycling facility at 1029 Henry Ave. The contact person for Emterra Environmental will be provided upon award.
- E5.2.2 The Contractor is to coordinate access to the site with Emterra Environmental and the Contractor. The Contractor is to cc the Contract Administrator on all correspondence.
- E5.2.3 The Contractor shall keep their work area within the areas identified on the Drawings. The work areas are the responsibility of the Contractor shall be suitable delineated and secured at all times.
- E5.2.4 All work outside of designated work areas (including site access) shall be completed in accordance with Emterra Environmental safety and site requirements.
- E5.2.5 The Contractor shall advise Emterra and the Contract Administrator a minimum of ten (10) Business Days prior to mobilizing to site, five (5) Business Days prior to grouting operations, and two (2) Business Days prior to significant material deliveries, including but not limited to: GRP panels and shoring materials.
- E5.2.6 The Contractor shall not encroach on CPR property (including overhead equipment) unless written authorization has been provided by CPR.

### **E5.3 Measurement and Payment**

- (a) Coordination of site access as outlined here will be considered incidental to the Work and will not be measured for payment. No separate payment will be made.

## **E6. TRAFFIC MANAGEMENT**

### **E6.1 Description**

- (a) This Specification shall govern the requirements traffic management during the course of the Work.

- E6.2 Further to Section 3.7 of CW 1130 of the General Requirements the Contractor shall be responsible to redirect and maintain traffic with appropriate signing in accordance with The City of Winnipeg, "Manual of Temporary Traffic Control in Work Areas on City Streets" at all times during construction.
- E6.3 Maintain access for approaches, driveways, public lanes and crossing streets for all locations.
- E6.4 The Contractor shall maintain access to all businesses during business hours, except where written authorization has been provided by the business.
- E6.5 The Contractor shall maintain access to all schools, community centres, and other public buildings at all times.
- E6.6 Further to Section 3.6 of CW 1130 of the General Requirements, the Contractor shall maintain safe pedestrian crossings at intersections at all times. If possible, only one pedestrian crossing at an intersection is to be blocked by construction at any one time. If more than one pedestrian crossing is blocked by construction at an intersection at the same time the Contractor shall provide flag persons to safely escort pedestrians across the intersection. The Contractor shall

leave pedestrian crossing locations safe and free of equipment that may hamper pedestrians when no construction activities are being performed at a particular crossing location.

- E6.7 Further to Clause 3.7 of CW 1130 of the General Requirements, should the Contractor be unable to maintain pedestrian or vehicular access to a residence or business, he/she shall review the planned disruption with the business or residence and the Contract Administrator, and take reasonable measures to minimize the impact. The Contractor shall provide a minimum of 24 hours notification to the affected residence or business and the Contract Administrator, prior to disruption of access.
- E6.8 The Contractor shall not park company or private vehicles inside the barricaded work zone in a manner that will block sightlines for vehicles and pedestrians approaching and crossing intersections.
- E6.9 The Contractor is responsible for maintaining safe vehicular and pedestrian traffic through their work site as identified herein. The Contractor shall rectify any unsafe conditions immediately upon notification. This could include but is not limited to, providing flag persons, clearing debris and snow from sites, moving equipment, and erecting additional signage.
- E6.10 Dawson Road
- E6.10.1 A directional closure of Dawson Road will be permitted during construction on Dawson Road. Southbound traffic shall be maintained at all times.
- E6.10.2 Traffic control relating to the directional closure on Dawson Road must be undertaken by City of Winnipeg Traffic Services. The Contractor shall provide notification to the Contract Administrator a minimum of twelve (12) Business Days prior to undertaking the work.
- E6.11 Measurement and Payment
- (a) Traffic management as outlined here will be considered incidental to the Work and will not be measured for payment. No separate payment will be made.

## **E7. EXCAVATIONS AND PIPELINE ACCESS**

- E7.1 Description
- (a) This Specification shall cover excavations, shoring, and modifications to the trunk sewers required for access for the purposes of completing the proposed rehabilitation work.
- E7.2 Submittals
- E7.2.1 Dawson Road
- (a) Shop Drawings for excavation shoring (where required) shall be prepared and submitted in accordance with E3 a minimum of five (5) Business Days prior to undertaking the excavation and shoring installation. Where required by Workplace Safety and Health Regulation, shoring Shop Drawings shall be sealed by a Professional Engineer, registered in the Province of Manitoba, experienced in the design of excavation shoring systems.
- E7.2.2 Higgins Ave
- (a) The Contractor shall submit a shoring plan for the Higgins Ave access shaft if an access shaft is required to complete the work. The shoring plan shall be sealed by a Professional Engineer, registered in the Province of Manitoba, experienced in the design of shoring systems for the excavation method proposed. The submitted shoring plan shall meet all requirements stipulated by CPR and AREMA relating to the submission of shoring plans for review.
- (b) The shoring plan shall conform to the CPR Geotechnical Protocol for Pipeline and Utility Installations with Railway Right of Way (see Appendix D) and shall include, but is not limited to the following information:

- (i) Cover letter depicting the proposed shoring system, shoring installation methods, means of protecting the tracks during construction, track settlement monitoring program, and any other relevant information required for approval of the shoring system by CPR;
  - (ii) Drawings:
    - ◆ Shoring installation and staging plan;
    - ◆ Drawings showing the proposed shoring in relation to existing tracks and structures; and,
    - ◆ Detailed structural shoring drawings.
  - (iii) Geotechnical report and bore hole log(s).
  - (iv) Design calculations in accordance with CPR Geotechnical Protocol for Pipeline and Utility Installations with Railway Right of Way (Appendix D), AREMA, and E7.3.4.
- (c) Submission to CPR
- (i) The submitted shoring plan will be submitted to CPR upon receipt by the Contract Administrator. Submissions not meeting the requirements of CPR, AREMA, or these specifications will be returned to the Contractor for resubmission.
  - (ii) The Contractor shall be aware that CPR and the Contract Administrator may request numerous meetings to discuss the submission.
  - (iii) The Contractor shall take all responsibility for completeness of the plans. Delays to the project as a result of not meeting CPR requirements in terms of completeness and quality of the design resulting in rejection by CPR will be considered the responsibility of the Contractor. Claims for delays as a result of redesign will not be considered. Costs associated with additional reviews by CPR will be the responsibility of the Contractor.

### E7.3 Shoring Design

- E7.3.1 Shoring shall be provided for excavations in accordance with CW 2030.
- E7.3.2 Excavation shoring shall be designed to accommodate the installation of the GRP liners and the existing trunk sewers.
- E7.3.3 All shoring systems shall comply with Manitoba Workplace Safety and Health requirements.
- E7.3.4 Shoring design for the Higgins Ave access shaft shall meet the following:
  - (a) Designs must confirm to CPR Geotechnical Protocol for Pipeline and Utility Installations with Railway Right of Way (see Appendix A) and the requirements of AREMA, Volume 2, Part 28;
  - (b) Design calculations must be stamped by a professional Engineer licensed to practice Engineering in the Province of Manitoba.

### E7.4 Geotechnical Bore Hole

- E7.4.1 If an access shaft is to be used on the Higgins Ave site, the Contractor shall complete a minimum of one geotechnical bore hole near the location of the proposed access shaft location for the purposes of assessing subsurface soil conditions. A geotechnical report complete with bore hole log(s) shall be included with the shoring plan for the Higgins Ave access shaft.

E7.5 Shoring and Track Settlement Monitoring Program on Higgins Ave

E7.5.1 The Contractor shall develop a shoring monitoring program and submit for review in conjunction with the shoring design.

E7.5.2 Horizontal and vertical movements of the shoring system shall be monitored by establishing survey points, installation of inclinometers, or a combination of both prior to excavation. The results shall be reviewed by a qualified geotechnical Engineer on a daily basis for a period of at least one week during excavation and following construction of the shoring system. Measurements shall be obtained on a weekly basis thereafter.

E7.5.3 The Contractor shall develop a track settlement monitoring program and submit for review in conjunction with the shoring design where an access shaft is required for the Higgins Ave liner installation.

E7.5.4 In addition to monitoring track settlement, visual inspection of the track shall be carried out prior to and during construction to prevent any track safety related incident. The Contractor shall coordinate with CPR for access to CPR property for the purposes of completing track inspection and monitoring.

E7.6 Construction Methods

E7.6.1 Access Shafts

- (a) If required to complete the work, the Contractor may install access shafts as shown on the Drawings to permit access to the top of the existing trunk sewers.
- (b) Access shafts shall be sized to permit removal of the top of the sewer, installation of the proposed liner product, and construction of the trunk sewer closures.
- (c) Shaft locations shown on the drawings are approximate only. The Contractor is responsible for confirming the location of the existing sewer, and locating the shafts to the proposed construction methodology. Confirm shaft locations with Contract Administrator prior to commencement of shaft construction.

E7.6.2 Excavation

- (a) The Contractor is responsible for locating the existing sewer and other buried utilities and shall take all steps to locate the existing sewer prior to excavation and installation of shoring.
- (b) Materials shall not be stockpiled over pipelines.
- (c) Carefully excavate to expose existing pipelines.
- (d) Only smooth edged buckets may be utilized for excavations within 1.5 m of the existing trunk sewer.
- (e) The existing trunk sewer shall be located prior to proceeding with excavations within 1.0 m of the pipe. Final excavation (within 300 mm of the pipe wall) shall be completed using soft dig or hand excavation methods to prevent damage to the pipe.
- (f) Excess excavation materials shall be disposed of off-site.
- (g) Open excavations shall not be left without visual inspection for long periods of time (greater than 48 hrs).

E7.6.3 Shoring Installation

- (a) Piles (if used) shall be installed with a minimum of 500 mm of clear separation between the pile and the outside of the existing sewer wall.
- (b) Piles (if used) shall be pre-bored to a depth below the invert of the sewer. Pre-bored holes shall be filled with a flowable low strength cementitious material after installation of piles to prevent movement of existing soils around the pipe, permit excavation/installation of shoring, and removal of piles.
- (c) Excavation and shoring installation shall not initiate movement or otherwise destabilize soils surrounding the existing trunk sewers.

- (d) Locate the extents of the existing sewer prior to pre boring and installing shoring using soft dig methods. Please note the wall thicknesses and outside diameter of the existing trunk sewers are unknown.
- (e) Construction Vibrations
  - (i) The Contractor shall use means and methods that will limit vibrations at the locations adjacent to utilities and structures. Where construction operations such as sheet pile driving or similar activities induce significant ground vibrations near the sewer line, vibration monitoring shall be performed using an accelerometer to measure the peak particle velocities.

#### E7.6.4 Demolition

- (a) Demolish existing concrete structures as shown on the Drawings and as follows.
  - (i) Carefully remove the tops of existing trunk sewers. The use of pneumatic breakers is prohibited. Tops of sewers may be saw cut or removed using small hand held jack hammers. Final openings in the existing trunk sewer shall be neatly cut square to the existing pipe prior to construction of the trunk sewer closure.

#### E7.6.5 Trunk Sewer Closures

- (a) Construct trunk sewer closures as shown on the drawings after completion of the liner installation.
- (b) Complete cast-in-place concrete and reinforcing steel work as shown on the Drawings and in accordance with E16 and E17.

#### E7.6.6 Shoring Removal

- (a) Shoring systems shall be completely removed upon completion of the works.
- (b) Care shall be taken to remove the shoring system and backfill the trench in such a way as to not create voids. If the shoring system requires removal after backfill is in place, resulting voids shall be filled with flowable cement slurry.

#### E7.6.7 Backfill

- (a) Backfill within 1 m of existing and proposed pavements shall be completed to CW 2030, Class 1 standards. Granular Class 2 backfill shall extend to the underside of the stabilized fill, as shown on the Drawings.
- (b) Backfill within 1 m of existing gravel driveways shall be completed to CW 2030, Class 2 standards.
- (c) All other areas shall be backfilled with a Class 4 backfill unless otherwise noted on the Drawings.
- (d) Backfilling with frozen materials will not be permitted.

#### E7.7 Measurement and Payment

- (a) "Pipeline Access Modifications" shall be measured and paid on a Lump Sum basis as listed in the Form B: Prices.
- (b) Payment for "Pipeline Access Modifications" shall include the supply of all materials and equipment required to complete the Work, including: excavation, shoring, demolition, cast-in-place concrete, reinforcing steel, and backfilling as specified herein.
- (c) Payment for Pipeline Access Modifications for Higgins Ave will be as follows:
  - (i) 20% payment of the Pipeline Access Modifications lump sum price will be paid upon submission of the shoring design and acceptance by CPR.
  - (ii) 50% payment of the Pipeline Access Modifications lump sum price upon completion of the access shafts or commencement of the liner installation where no access shafts are required.



- (iii) 100% payment of the Pipeline Access Modifications lump sum price subsequent to the completion of the concrete closures, and backfill of the shafts (including placement of stabilized fill).
- (d) Payment for Pipeline Access Modifications for Dawson Road will be as follows:
  - (i) 50% payment of the Pipeline Access Modifications lump sum price upon completion of the access shafts or commencement of the liner installation where no access shafts are required.
  - (ii) 100% payment of the Pipeline Access Modifications lump sum price subsequent to the completion of the lining works, concrete closures, and backfill of the shafts (including placement of stabilized fill).

## **E8. FLOW CONTROL**

### **E8.1 Description**

- (a) This Specification shall cover flow control measures required for main line sewer and sewer services required to perform the work.

### **E8.2 Submittals**

- (a) Submit a written flow control plan for sewers to be lined for review by the Contract Administrator in accordance with E2, a minimum of five (5) Business Days prior to undertaking the work. Flow control plans shall be prepared and stamped by a professional Engineer, registered in the Province of Manitoba and experienced in the design and implementation of temporary flow bypass works. Flow control plan shall include the following:
  - (i) A description and sketch detailing the arrangement of the proposed flow control measures.
  - (ii) A list of the key components required for the flow control measures, including but not limited to the following:
    - (i) Cofferdams
    - (ii) Piping or hoses (where required)
    - (iii) Pumps (where required)
  - (iii) A detailed procedure for installation and removal of the flow control measures.
  - (iv) Monitoring plan and 24 hr contact person.
  - (v) Means and methods for dealing with excessive flows or wet weather events.
  - (vi) Means and methods for bypassing flows from apartment complexes and commercial buildings.
  - (vii) Supply of temporary washroom facilities where required.

### **E8.3 Methods**

- (a) Provide necessary flow control measures for the main line sewer and sewer services required to perform the work. Diversion of wastewater flow directly or indirectly to the environment, land drainage sewers, or storm relief sewers will not be allowed.
- (b) Maintain existing sewer flows from upstream sewers during construction around the sewers being lined.
- (c) Where bypass pumping combined sewer flows, the Contractor shall provide a minimum pumping capacity of 2.75 times the estimated average day flows as provided herein or estimated by the Contractor.
- (d) Erection of scaffolding overtop of active roadways will not be permitted for the purposes of routing bypass hoses.
- (e) Provide adequate temporary bypass pumping for live sewer services connected to the sewer being lined from when the service is blocked off until it is reinstated.

- (f) Provide security personnel for locations where by-pass pumping requires normally secure or locked doors and access areas to be left open or unlocked.
- (g) Ensure all flow control components and materials are removed from the sewer system upon completion of the work.

#### E8.3.1 Mainline Sewer Flows

- (a) The Contractor is responsible for bypassing or the temporary storage of all dry weather flows, including peak flows.
- (b) For sewers greater than 450 mm in diameter the contractor shall provide flow bypass capacity for the following sewers. The following average day flows/conditions have been provided for the purpose of developing flow bypass plans:
  - (i) Higgins Ave (S-MA20019733 and S-MA20019742): 1.9 L/s
  - (ii) Dawson Road (S-MA50010470): 162.8 L/s

#### E8.3.2 Sewer Services

- (a) Intermittent/short term flow blockages (i.e. up to 1 day, intermittently) of live sewer services will be permitted on the proviso that building occupants are informed of the blockage and adequate steps are undertaken to ensure sewer service backups do not occur. The Contractor shall be responsible for any damages occurring from sewer service blockages in instances where inadequate or improper notice has been provided.
- (b) Provide temporary indoor portable toilets for residential homes and for each apartment in small apartment buildings (10 or less apartments) instead of temporary sewer service bypass pumping where feasible and approved by the building owner and the Contract Administrator.
- (c) Provide temporary indoor or outdoor toilet facilities for smaller commercial properties such as strip malls instead of temporary sewer service bypass pumping where feasible and approved by the building owner and the Contract Administrator. One toilet facility to be provided for each business in a strip mall.
- (d) Provide necessary supplies for portable toilets and clean as often as required while in use. Remove portable toilets and outdoor toilets promptly once sewer service is reinstated.
- (e) Expose sewer services for facilities with a high volume of effluent discharge that have no feasible means of intercepting the flow within the building or at a location outside the building agreed upon by the Contract Administrator and drain or pump the sewer service from that location until the sewer service is reinstated.
- (f) Excavate for sewer service exposure in accordance with CW 2030. Repair and backfill exposed sewer services in accordance with CW 2130.

#### E8.3.3 Weather

- (a) Review the Environment Canada weather forecast with the Contract Administrator before each day of liner installation.
- (b) Delay installation of liners and/or secure Works when the anticipated weather conditions are such that anticipated sewer flow will exceed the flow control measures provided.
- (c) The Contractor shall advise immediately of any weather-related delays.
- (d) The Contractor to schedule Work according to the weather; the City is not responsible for delays due to weather.

#### E8.4 Measurement and Payment

- (a) Flow control measures necessary for mainline sewers will be measured on a unit basis and paid for at the Contract Unit Price for "Flow Control". Number of units to be paid for will be the total number of units supplied in accordance with this specification, accepted and measured by the Contract Administrator.

- (b) Payment for "Flow Control" shall include, but is not limited to the following:
  - (i) Supply of flow control plans, drawings, and submissions;
  - (ii) Investigative work to confirm flows, manhole, and pipe configurations;
  - (iii) Supply, installation, and removal of cofferdams and flow diversions;
  - (iv) Supply, mobilization, monitoring, operation, and demobilization of pumps and hoses;
  - (v) Hydrovac, hauling, and disposal of sewage where required for flow control purposes;
  - (vi) Traffic signage;
  - (vii) Supply, installation, and removal of all traffic ramps and associated materials; and,
  - (viii) Any and all other plant and materials required to complete the work as specified herein and identified on reviewed flow control plans.
- (c) Only one unit of flow control will be paid for each sewer segment and will include all occurrences of mainline and sewer service flow control requirements for the sewer segment. Payment for flow control will be as follows:
  - (i) 25% payment of the Flow Control unit price will be paid when flow control measures have been mobilized to site and are in operation.
  - (ii) 100% of the Flow Control unit price will be paid subsequent to the completion of the liner installation and demobilization of flow control measures.
- (d) Where no flow control measures are undertaken, no payment will be made for this item of work.
- (e) The supply of temporary washroom facilities and flow control measures for sewer services shall be considered incidental to installation of the liner and will not be measured for payment. No additional payment will be made.

## **E9. SEWER INSPECTIONS**

### **E9.1 Description:**

- (a) This Specification describes the requirements for obtaining sewer measurements and CCTV inspections required to facilitate the specified rehabilitation work.

### **E9.2 Methods**

#### **E9.2.1 Verification of Existing Sewer Dimensions**

- (a) Verify sewer dimensions and depths prior to design as follows:
  - (i) Length of sewer from manhole to manhole using a steel tape.
  - (ii) Manhole invert depths (from the manhole rim) at the upstream, downstream, and any intermediate manhole.
  - (iii) Measure the diameter and cross-section of the sewer at the upstream and downstream manholes and at a minimum distance of 500 millimetres inside the sewer from each manhole.
  - (iv) Use calibrated callipers or other suitable measuring device capable of measuring accurately to +/- 1 mm to confirm cross section geometry at the following clock positions:
    - ◆ 12:00 to 6:00
    - ◆ 2:00 to 8:00
    - ◆ 3:00 to 9:00
    - ◆ 4:00 to 10:00
  - (v) Obtain additional measurements for large diameter (larger than 600 millimetres) and for non-circular sewers sufficient to define the cross section to meet the design objectives for the rehabilitation system being utilized, including but not limited to:
    - ◆ The length of the inside perimeter (circumference) of the sewer at the upstream and downstream ends.

- ◆ Perform a pre-design inspection in accordance with E9.2.2(b) where specified in order to confirm the dimensions of the existing host pipe.
- (b) Estimate the remainder of the sewer dimensional requirements based on dimensional checks and the CCTV sewer inspection videos.
- (c) Submit host pipe lengths, depths, and dimensions to the Contract Administrator in conjunction with the design submission and pre-design inspection where required.

E9.2.2 Perform the following sewer inspections in accordance with CW 2145 and as outlined herein:

- (a) Pre-Repair Inspection:
  - (i) Perform prior to undertaking repairs or prep-work.
  - (ii) Pre-repair inspection is not a pay item and shall be considered incidental to the cleaning and prep work operations.
  - (iii) Submission of the Pre-Repair Inspection is only required where sewer conditions differ from those identified during tendering and additional prep work was undertaken to complete the rehabilitation work.
  - (iv) No coding of the submission will be required.
- (b) Pre-Design Inspection (where specified):
  - (i) Perform prior to preparing the liner design.
  - (ii) Intent is to confirm the continuous or discontinuous (every 5 metres minimum) measurement of the height and width of large diameter and non-circular sewers along the entire length of the sewer.
  - (iii) The following methods may be employed:
    - ◆ Hand measurements
    - ◆ Laser profiling
    - ◆ Templating (Segmental Sliplining only)
  - (iv) CCTV inspections involving hand measurements shall clearly show the dimensional measurements and distance of the measurement from the upstream manhole on the video. Distances based on CCTV cable measurement will be permitted.
  - (v) Any change in sewer cross section shall be sufficiently dimensioned to permit design and post-lining assessment of liner dimensions. Where hand measurements are utilized, any changes in the sewers cross sectional shape shall be documented in accordance with E9.2.1.
  - (vi) CCTV inspections involving templating shall clearly show the passage of the template through the sewer. For templated sewers the dimensions of the template shall be measured visibly on the CCTV inspection and dimensions submitted for review with the pre-design inspection.
  - (vii) Laser profiling technology must have sufficient accuracy and replicability as per E9.6.2.
  - (viii) No coding of the submission will be required.
- (c) Pre-Lining Inspection:
  - (i) Perform after sewer cleaning and preparation.
  - (ii) The Pre-Lining Inspection shall confirm:
    - ◆ Necessary cleaning and pipe preparation work, including internal and external sewer repairs, have been satisfactorily completed.
    - ◆ Condition of the sewer pipe is consistent with the design conditions and the Specifications. The Contractor shall advise the Contract Administrator of any condition that is contrary to the design conditions or assumptions made that may affect either long or short term performance of the liner prior to commencing lining.

- (iii) Provide the Pre-Lining CCTV inspection a minimum of five (5) Business Days prior to lining for approval to proceed with the liner installation.
- (iv) No coding of the submission will be required.
- (d) Post-Lining Inspection:
  - (i) Perform immediately following installation of the liner, after completion of sewer service reinstatement, and while flow control measures are in place.
  - (ii) Perform Post-Lining Inspection where Regional Street lane closures are required within 24 hours of completing the installation of the liner.
  - (iii) Intent is to confirm the adequacy of sewer service reinstatements and the fit and finish of the liner.
  - (iv) Post-Lining inspection shall be submitted within fifteen (15) Business Days of completion of the liner installation. Substantial Performance and Total Performance for the project will not be granted prior to submission and acceptance of the Post-Lining inspection CCTV and associated reports.
  - (v) Full coding required.
- (e) Post-Design Inspection (where specified):
  - (i) Perform subsequent to installing the liner.
  - (ii) Post-Design inspection is required for:
    - ◆ CIPP; and,
    - ◆ Spiral Wound PVC; and,
    - ◆ CCCP.
  - (iii) Post-Design inspection is not required for:
    - ◆ Segmental Sliplining; and,
    - ◆ Bonded FRP.
  - (iv) Intent is to confirm the continuous or discontinuous (every 5 metres minimum) measurement of the height and width of large diameter and non-circular liners along the entire length of the sewer to confirm that the liner is consistent with the expected post-lining diameter or dimensions.
  - (v) The following methods may be employed:
    - ◆ Hand measurements
    - ◆ Templating
    - ◆ Laser profiling
  - (vi) Perform while flow control measures are in place.
  - (vii) CCTV inspections involving hand measurements shall clearly show the dimensional measurements and distance of the measurement from the upstream manhole on the video. Distances based on CCTV cable measurement will be permitted.
  - (viii) CCTV inspections involving templating shall clearly show the passage of the template through the sewer. For templated sewers the dimensions of the template shall be measured visibly on the CCTV inspection and dimensions submitted for review with the post-design inspection.
  - (ix) Laser profiling technology must have sufficient accuracy and replicability as per E9.6.2.
  - (x) Post-Design inspection shall be submitted within fifteen (15) Business Days of completion of the liner installation. Substantial Performance and Total Performance for the project will not be granted prior to submission and acceptance of the Post-Design inspection CCTV and associated reports.
  - (xi) No coding of the submission will be required.
- (f) Warranty Inspection:
  - (i) Perform before expiration of the warranty period and final acceptance but not prior to 10 months after installation of the liner.

- (ii) Intention is to confirm the fit and finish of the liner, the need for any remedial work, and acceptance of any repair work performed during the warranty period.
- (iii) Undertake sewer cleaning in accordance with CW 2140 as required to obtain a satisfactory inspection.
- (iv) Full coding required.

E9.2.3 Submit all inspection videos to the Contractor Administrator for review in accordance with CW 2145 and as specified herein.

#### E9.3 Sewer Inspection Reports

- (a) Provide the Contract Administrator with the following sewer inspection reports prepared in accordance with CW 2145.
  - (i) Pre and post-lining inspection and reports before acceptance of the Work for Total Performance.
  - (ii) Warranty inspection report before Final Acceptance of the Work.

#### E9.4 Sewer Service Reports

- (a) The Contractor is responsible to determine the usage and status of all service connections connected to the sewer to be rehabilitated. Confirm exact location of all sewer services connected to the sewer being lined by dye testing, tracing, or other methods. Any additional investigative and/or remedial work resulting from improper identification of connected services shall be borne by the Contractor.
- (b) Submit a written Sewer Service Report for each liner location to the Contract Administrator a minimum of five (5) Business Days prior to installation of liners. Provide the following information for each sewer service including CB leads and utility manhole drains.
  - (i) Location of connection (chainage from upstream manhole and clock reference).
  - (ii) Diameter of sewer connection lateral.
  - (iii) Material type of sewer connection.
  - (iv) Observed condition of connection.
  - (v) Status of connection (active, inactive or unable to determine).
  - (vi) Property serviced including the address.
- (c) Sewer Service Reports shall be submitted in conjunction with the Pre-Lining CCTV Inspection submission.

#### E9.5 Amendments and Supplements to CW 2145:

##### E9.5.1 Replace Section 3.4 with:

- (a) Ensure each operator is fully trained in all aspects of sewer inspection and capable of making accurate observations and recording all conditions that may be encountered in the sewers.
- (b) Perform condition coding using operators who can demonstrate proficiency coding in accordance with the requirements of the WRc "Manual of Sewer Condition Classification 3<sup>RD</sup> Edition".

##### E9.5.2 Replace Section 3.5 with:

- (a) Perform sewer condition coding in accordance with the requirements of the WRc Manual of Sewer Condition Classification 3<sup>RD</sup> Edition.
- (b) Record place names in accordance with Clause 3.9.4 of the CW 2145.

E9.5.3 Further to Section 3.13, a paper or "hard copy" of the sewer inspection reports is not required and the digital format should be submitted on a CD-R.

- (a) The Contractor shall maintain backup copies of all digital video and inspection data submissions for the duration of the Warranty Period as stated in C13.

- (b) The Contractor shall supply inspection data for review by the Contract Administrator on a DVD.

E9.5.4 Replace Clause 3.8.1 with:

- (a) Provide a minimum of 400 lines of resolution around the periphery of the picture for digital MPEG video playback.

E9.5.5 Replace Clause 3.11.1 with:

- (a) Capture the inspections in digital format in colour from the live video source on archival grade digital versatile discs, DVD-R format to the following minimum requirements. Adjust requirements as required to achieve 400 lines of resolution specified in Clause E8.1.6 of this Specification.
  - (i) XDVD MPEG-2 or MPEG-4 format (MPEG-4 preferred).
  - (ii) Picture Size: NTSC 720 x 480 @ 29.97 frames per second.
  - (iii) Data/Bit Rate: 6.0 M-bits/sec.
- (b) Replace Clause 3.17.7.6, with:
  - (i) Record the distance from the centre of the manhole to the cable calibration location at the start of the inspection and adjust the distance reading so that zero is at the centre of the start manhole. This distance is known as the cable calibration distance. The cable calibration location is the intersection point between the camera's widest horizontal viewing angle and the pipe's side periphery (03 or 09 o'clock) when the camera is level and looking forward.

E9.6 Sewer Inspection Equipment

E9.6.1 Notwithstanding CW 2145, CCTV equipment meet the following requirements:

- (a) Minimum requirements of the in-line inspection platform include:
  - (i) Independently controlled drive tracks that enable the platform to manoeuvre around bends and climb over debris up to 300mm in height.
  - (ii) Operable under partially or fully submerged flow conditions, for distances up to 500m upstream or downstream from a single access point.
  - (iii) Operable in sewers of various cross-sections and constructed of standard pipe materials including brick, concrete, PVC, HDPE, and steel.
  - (iv) Tethered to facilitate extraction of the platform from the sewer, without causing damage to the sewer infrastructure, in the event the equipment fails or otherwise becomes uncontrollable within the sewer.
  - (v) Equipped with sufficient high intensity lighting to illuminate the sewer for visual inspection.
  - (vi) Equipment shall be capable of continuously capturing digital video from first generation recordings with no frame loss, regardless of the progression of the inspection.
  - (vii) Equipment shall be used to acquire continuous digital video images of the sewer for the entire length being inspected.

E9.6.2 Laser profiling equipment shall meet the following minimum requirements:

- (a) Three Dimensional (3D) LASER Scanning Inspection
  - (i) "Three Dimensional (3D) Laser Scanning" is a technique to determine the surface profile of mainline pipes using a three dimensional (3D) laser on the entire circumference above fluid level of the pipe.
  - (ii) Three Dimensional (3D) LASER scanning equipment shall provide an accurate determination of pipe geometry (features and defects) above the fluid level.
  - (iii) Minimum equipment requirements are:
    - ◆ The laser shall be Class 1; eye-safe for operator safety.

- ◆ Surface measurements accurate to 5mm at 3 metres in 1200mm pipes and larger.
- ◆ Precision ovality / deflection detailed range laser measurement scans accurate to  $\pm 1\%$ .
- ◆ Laser scans shall produce a point cloud with a maximum distance between points of 10 mm in the transverse direction and 40 mm in the longitudinal direction.

(iv) The rate of scan shall not exceed 9 m / minute.

#### E9.7 Video Coding

- (a) Perform sewer condition coding in accordance with the requirements of the WRc Manual of Sewer Condition Classification 3<sup>RD</sup> Edition.
- (b) Perform condition coding using operators who can demonstrate proficiency coding in accordance with the requirements of the WRc "Manual of Sewer Condition Classification 3<sup>RD</sup> Edition".
- (c) Ensure each operator is fully trained in all aspects of sewer inspection and capable of making accurate observations and recording all conditions that may be encountered in the sewers.
- (d) Operators failing to meet the accuracy requirements on two occasions will not be permitted to code on the remainder of the contract until they can demonstrate to the Contract Administrator that they can code in accordance with the requirements of the WRc Manual of Sewer Condition Classification 3<sup>RD</sup> Edition.
- (e) Incorporate a suitable distance-reading device to measure the location of the equipment in the pipe, to an accuracy of  $\pm 0.5\%$  of the length of the inspection.

#### E9.8 Measurement and Payment

##### E9.8.1 Verification of Sewer Dimensions:

- (a) Verification of existing sewer lengths, depths, and dimensions shall be considered incidental to the Work and will not be measured for payment. No separate payment will be made.

##### E9.8.2 Sewer inspections will be measured and paid for in accordance with CW 2145 except as modified herein:

- (a) The total length of inspection to be paid shall be the total length of sewer inspected to the satisfaction of the Contract Administrator. The length to be paid will be the manhole to manhole sewer length provided by the Contractor. Where partial or incomplete inspections are submitted, the length of sewer inspected will be the length recorded by the Contractors calibrated inspection equipment or as determined by the Contract Administrator.
- (b) No payment will be made for Post-Design inspections where rehabilitation technologies are deployed that do not require a post-design inspection as indicated in E9.2.2(e).

##### E9.8.3 Sewer Service Reports

- (a) Sewer service reports shall be considered incidental to the CIPP installation and will not be measured for payment. No separate payment will be made.
- (b) The Contractor is responsible for rectifying any damages caused or additional inspection work resulting from incomplete or erroneous Sewer Service Reports.

##### E9.8.4 Sewer Inspection Reports

- (a) Sewer inspection reports measured and paid for in accordance with CW 2145.



## **E10. SEWER AND MANHOLE REPAIRS AND STABILIZATION**

### **E10.1 Description**

- (a) Sewer and manhole stabilization shall mean the internal repair of sewers and manholes by man entry techniques. Repairs are varied and may consist of holes in sewers with voids, missing bricks in sewers, obstructions and manhole base or riser repairs. Sewer stabilization repairs shall be carried out as identified herein.
- (b) The scope of work involved in sewer stabilization is as follows:
  - (i) Secure the site and provide temporary traffic control.
  - (ii) Obtain all necessary underground clearances.
  - (iii) Conduct a hazard assessment, including identification and evaluation.
  - (iv) Develop a safe work plan.
  - (v) Implement the necessary procedures and controls to control hazards and maintain a safe working environment.
  - (vi) Enter the manhole/sewer and perform the required repairs.
  - (vii) Clean-up the site.

### **E10.2 Materials**

#### **E10.2.1 Concrete**

- (a) Concrete for large internal repairs to concrete and brick sewers and manholes and internal void filling shall be in conformance with Table CW 2160.1, Type B.
- (b) Patching and grouting of repairs to concrete and brick sewers and manholes shall be with a fast hardening high strength concrete repairing compound designed for underwater use
  - (i) Approved products: Duro-Crete by C C Chemicals or approved equal in accordance with B7.
- (c) Flowable cement-stabilized fill for external void filling from the ground surface shall be in conformance with Table CW 2160.1, Type D.

#### **E10.2.2 Manhole components shall conform to CW2130.**

### **E10.3 Sewer Repairs and Preparation Work**

#### **E10.3.1 Existing Sewer Design Conditions**

- (a) The assessment of the liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed as part of the City of Winnipeg's Sewer Inspection Program. Copies of these video inspections are available to the Contractor upon request by providing a portable hard disk drive (HDD) to the Contract Administrator. The Contract Administrator will copy the inspections onto the HDD and make available to the Contractor for review purposes.
- (b) The Contractor shall be aware the video inspections provided were completed immediately after sewer cleaning and the amount of sediment and debris present at the time of this Bid Opportunity may not be the same. The Contractor shall be responsible to determine the actual amount of sediment and debris in the sewers included in this Work.
- (c) For the purposes of this project, including design of the rehabilitation system, the host pipes shall be designated as follows:
  - (i) **S-MA20019733 (Higgins Ave) – Fully Deteriorated**
  - (ii) **S-MA20019742 (Higgins Ave) – Fully Deteriorated**
  - (iii) **S-MA20019733 (Dawson Road) – Partially Deteriorated**

E10.3.2 **S-MA20019733 (Higgins Ave)** - The following sewer stabilization, repairs, and preparation work can be reasonably assumed to be required and shall be completed prior to undertaking the identified rehabilitation work.

- (a) General Preparation
  - (i) Remove loose debris, solid debris, roots, and grease in accordance with CW 2140.
  - (ii) Remove any remaining organic or biological materials.
  - (iii) Remove any loose or spalling concrete to a depth sufficient to provide a competent host pipe surface.
  - (iv) Remove wall encrustations throughout.
  - (v) Remove encrustations at service connections.
  - (vi) Grout sewer services as required following encrustation removal.
  - (vii) Remove intruding sewer connection at 59.4m DS of MH20017732 in accordance with CW 2140.
  - (viii) Reshape host sewer pipe invert to the original dimension and cross section at locations where the invert has completely deteriorated.
- (b) In addition to E10.3.2(a), the following work shall be completed prior to the installation of CIPP liners.
  - (i) Prepare and fill all voiding, holes, and discontinuities in the concrete host pipe wall greater than 50 mm in depth or diameter to provide a reasonably smooth surface against which to install the liner.
  - (ii) Repair any sources of infiltration to a level required to successfully complete the liner installation.
- (c) In addition to E10.3.2(a), the following work shall be completed prior to the installation of grouted liners (GRP).
  - (i) The host pipe shall be thoroughly cleaned using water jetting or other acceptable methods prior to lining in accordance with WRC, Sewerage Rehabilitation Manual, Section 9.2.3 to remove any and all remaining organic materials, biological slim, roots, soft encrustation, and grease.
  - (ii) Repair any sources of infiltration to a level required to successfully complete the liner and grouting installation.
  - (iii) Any repairs to the host pipe shall be completed with a competent cementitious material compatible with the host pipe, grout, and liner. Repairs shall not compromise the intended structural behaviour or performance of the rehabilitated structure.
- (d) In addition to E10.3.2(a), the following work shall be completed prior to the installation of FRP liners.
  - (i) Prepare the surface of the host pipe for FRP liner installation in accordance with E13.6.3.

E10.3.3 **S-MA20019742 (Higgins Ave)** - The following sewer stabilization, repairs, and preparation work can be reasonably assumed to be required and shall be completed prior to undertaking the identified rehabilitation work.

- (a) General Preparation
  - (i) Remove loose debris, solid debris, roots, and grease in accordance with CW 2140.
  - (ii) Remove any remaining organic or biological materials.
  - (iii) Remove any loose or spalling concrete to a depth sufficient to provide a competent host pipe surface.
  - (iv) Remove wall encrustations as needed.
  - (v) Remove encrustations at service connections.
  - (vi) Grout sewer services as required following encrustation removal.

- (vii) Reshape host sewer pipe invert to the original dimension and cross section at locations where the invert has completely deteriorated.
- (b) In addition to E10.3.3(a), the following work shall be completed prior to the installation of CIPP liners.
  - (i) Prepare and fill all voiding, holes, and discontinuities in the concrete host pipe wall greater than 50 mm in depth or diameter to provide a reasonably smooth surface against which to install the liner.
  - (ii) Repair any sources of infiltration to a level required to successfully complete the liner installation.
- (c) In addition to E10.3.3(a), the following work shall be completed prior to the installation of grouted liners (GRP).
  - (i) The host pipe shall be thoroughly cleaned using water jetting or other acceptable methods prior to lining in accordance with WRC, Sewerage Rehabilitation Manual, Section 9.2.3 to remove any and all remaining organic materials, biological slim, roots, soft encrustation, and grease.
  - (ii) Repair any sources of infiltration to a level required to successfully complete the liner and grout installation.
  - (iii) Any repairs to the host pipe shall be completed with a competent cementitious material compatible with the host pipe, grout, and liner. Repairs shall not compromise the intended structural behaviour or performance of the rehabilitated structure.
- (d) In addition to E10.3.3(a), the following work shall be completed prior to the installation of FRP liners.
  - (i) Prepare the surface of the host pipe for FRP liner installation in accordance with E13.6.3.

#### E10.3.4

**S-MA20019733 (Dawson Road)** - The following sewer stabilization, repairs, and preparation work can be reasonably assumed to be required and shall be completed prior to undertaking the identified rehabilitation work.

- (a) General Preparation
  - (i) Remove loose debris, solid debris, roots, and grease in accordance with CW 2140.
  - (ii) Remove any remaining organic or biological materials.
  - (iii) Remove any loose or damaged bricks in the existing brick invert liner.
  - (iv) Remove any loose or spalling concrete to a depth sufficient to provide a competent host pipe surface.
  - (v) Remove wall encrustations as needed.
  - (vi) Remove encrustations at service connections.
  - (vii) Remove intruding PVC service connection at DS MH50008491.
  - (viii) Grout sewer services as required following encrustation removal.
  - (ix) Reshape host sewer pipe invert to the original dimension and cross section at locations where the invert has completely deteriorated.
- (b) In addition to E10.3.4(a), the following work shall be completed prior to the installation of CIPP liners.
  - (i) Fill voiding from missing bricks with a cementitious repair product and prepare a smooth grouted transition between any edge of the existing brick invert liner and the wall of the host pipe.
  - (ii) Prepare and fill all voiding, holes, and discontinuities in the concrete host pipe wall greater than 50 mm in depth or diameter to provide a reasonably smooth surface against which to install the liner.
  - (iii) Repair any sources of infiltration to a level required to successfully complete the liner installation.

- (c) In addition to E10.3.4(a), the following work shall be completed prior to the installation of grouted liners (GRP, PVC).
  - (i) The host pipe shall be thoroughly cleaned using water jetting or other acceptable methods prior to lining in accordance with WRC, Sewerage Rehabilitation Manual, Section 9.2.3 to remove any and all remaining organic materials, biological slim, roots, soft encrustation, and grease.
  - (ii) Repair any sources of infiltration to a level required to successfully complete the liner and grout installation.
  - (iii) Any repairs to the host pipe shall be completed with a competent cementitious material compatible with the host pipe, grout, and liner. Repairs shall not compromise the intended structural behaviour or performance of the rehabilitated structure.
- (d) In addition to E10.3.4(a), the following work shall be completed prior to the installation of FRP liners.
  - (i) Prepare the surface of the host pipe for FRP liner installation, including the existing brick invert liner, in accordance with E13.6.3.
  - (ii) Prepare a smooth grouted transition between any edge of the existing brick invert liner and the wall of the host pipe.
- (e) In addition to E10.3.4(a), the following work shall be completed prior to the installation of CCCP liners.
  - (i) Prepare the surface of the host pipe for CCCP liner installation in accordance with E14.7.2.
  - (ii) Prepare and fill all voiding, holes, and discontinuities in the host pipe wall greater than 25 mm in depth or diameter to form a competent interior surface consistent with the design assumptions, including missing or damaged bricks or grout in the existing brick invert liner.
  - (iii) Prepare a smooth grouted transition between any edge of the existing brick invert liner and the wall of the host pipe.
  - (iv) Repair any sources of infiltration to a level required to successfully complete the liner installation.
  - (v) Any repairs to the host pipe shall be completed with a competent cementitious material compatible with the host pipe and liner materials. Repairs shall not compromise the intended structural behaviour or performance of the rehabilitated structure.

E10.3.5 The above is the minimum work program required, specific installation requirements for the chosen rehabilitation technology may require additional work beyond what has been specified herein. The Contractor is encouraged to familiarize themselves with the available CCTV data during tendering. Claims for additional costs related to prep work required to complete the installation where conditions are found to be consistent with the tendered condition of the pipeline will not be considered.

#### E10.4 Manhole Stabilization

E10.4.1 The following sewer stabilization, repairs shall be completed.

- (a) S-MA50008490 (Dawson Road)
  - (i) Remove loose and unsound material from inside surface of any cracked or spalling riser sections. Clean and prepare repair area as required and apply concrete patching compound in accordance with the manufacturer's recommendations. Fill all cracks ensuring all gaps are filled. Finish surface smooth and form to shape of wall.
  - (ii) Cut existing rungs and steps to be replaced flush with inside wall surface. Install approved rungs on alignment indicated on contract drawings and as directed by the Contract Administrator at 300 millimetres vertically on centre.

- (b) S-MA50008491 (Dawson Road)
  - (i) Cut existing rungs and steps to be replaced flush with inside wall surface. Install approved rungs on alignment indicated on contract drawings and as directed by the Contract Administrator at 300 millimetres vertically on centre.
- (c) S-MH20017732 (Higgins Ave)
  - (i) Cut existing rungs and steps to be replaced flush with inside wall surface. Install approved rungs on alignment indicated on contract drawings and as directed by the Contract Administrator at 300 millimetres vertically on centre.
  - (ii) Remove any loose and flaking mortar from brickwork at transition to sewer and clean repair area as required. Remove and replace cracked and broken bricks as necessary. Apply mortar to replacement brick before fitting into place. Work mortar completely into joints ensuring all gaps are filled. Remove excess mortar and shape joint to match existing.
- (d) S-MH20017745 (Higgins Ave)
  - (i) Cut existing rungs and steps to be replaced flush with inside wall surface. Install approved rungs on alignment indicated on contract drawings and as directed by the Contract Administrator at 300 millimetres vertically on centre.
- (e) S-MH20017744 (Higgins Ave)
  - (i) Remove loose and unsound material from inside surface of any cracked or spalling riser sections. Clean and prepare repair area as required and apply concrete patching compound in accordance with the manufacturer's instructions. Fill all cracks ensuring all gaps are filled. Finish surface smooth and form to shape of wall.
  - (ii) Cut existing rungs and steps to be replaced flush with inside wall surface. Install approved rungs on alignment indicated on contract drawings and as directed by the Contract Administrator at 300 millimetres vertically on centre.

#### E10.5 Construction Methods

##### E10.5.1 Equipment Set Up

- (a) In accordance with the safe work plan for the repair, the Contractor shall set up the required safety equipment and controls to safely perform the work.
- (b) Specialized equipment to perform the repair work, such as lights, pressure washers, drills and chipping hammers shall in no way adversely affect the operation of the safety equipment required to perform the work.
- (c) Subsequent to completion of the repairs the Contractor shall remove all equipment from the sewers and manholes.

##### E10.5.2 Internal Sewer Repairs

- (a) The Contractor shall repair the sewer fabric to restore the structural integrity of the sewer and provide a smooth flow surface conforming to the adjacent sewer/manhole cross-section and materials.
- (b) Large concrete repairs shall include a reasonable and limited level of surface preparation, including removal of unsound material and cleaning of the edges of the repair area, and setting of the required formwork and bracing. Concrete placement and finishing shall be done in accordance with CW 2160. All formwork and bracing shall be removed from the sewer/manhole at the completion of the work.
- (c) Concrete patching shall include a reasonable and limited level of surface preparation, including removal of unsound material and cleaning of the edges of the repair area. The Contractor shall apply the patching material in accordance with the manufacturer's printed instructions.
- (d) Small voids in the backfill shall be filled with concrete or other approved material from the inside of the sewer prior to repairing the sewer fabric or by pressure grouting after

completion of the repairs. The void shall be completely filled to prevent settlement of the backfill and provide a solid backing for the liner.

- (e) Pressure grouting shall be done in accordance with the manufacturer's printed instructions.
- (f) Large voids shall be filled from the ground surface after completion of the repairs. Holes shall be cored in the pavement or the pavement shall be saw cut and removed to permit vacuum excavation from the underside of the pavement to the void. The void shall then be completely filled with flowable cement-stabilized fill.

#### E10.5.3 Sewer Service Grouting

- (a) Sewer service grouting prior to lining shall be completed using a non-shrink, watertight cement grout, an appropriate polyurethane grout compound, or other approved grouting product, compatible with the existing host pipe. Grouting shall create a watertight and smooth inner surface for the host pipe and sewer service.
- (b) Sewer service grouting post lining shall fill voids between the CIPP and the host pipe at sewer service openings with an appropriate polyurethane or other grouting system that is compatible with the liner system to form a smooth watertight connection.

#### E10.5.4 Annulus Grouting for CIPP

- (a) Complete annulus grouting where directed by the Contract Administrator.
- (b) Annulus grouting post lining shall be completed using an appropriate cementitious or polyurethane grouting system that is compatible with the liner system.
- (c) A cementitious grout shall be used where grouting is required to achieve long term structural performance of the liner and host pipe. In all other applications, a polyurethane grout may be used to fill voids between the liner and host pipe.
- (d) Cementitious grout shall conform to the requirements of CW 2130 and CW 2160.
- (e) The Contractor shall ensure short term buckling pressures of the installed liner are not exceeded during the grouting process.
- (f) A detailed grouting plan shall be submitted for all grouting operations, including the following:
  - (i) Proposed grouting material complete with physical characteristics.
  - (ii) Grouting procedure complete with estimated grouting pressures.
  - (iii) Allowable grouting pressure based on the buckling capacity of the installed liner.

#### E10.5.5 Manhole Repairs, Modifications, and Installations

- (a) Complete manhole repairs, modifications, and new installations identified in the Specifications or on the Drawings in accordance with CW 2130.
- (b) Manhole rungs removed to facilitate liner installation must be replaced with new manhole rungs meeting the requirements of CW 2130.

#### E10.6 Quality Control

##### E10.6.1 Repair Acceptance

- (a) Upon completion of the designated repair the Contractor shall clean and perform the pre-lining inspection.
- (b) The Contractor shall not be responsible for defects in existing un-repaired sewer lines unless those defects are a direct result of the Contractor's operation.

##### E10.6.2 Correction of Deficiencies

- (a) The Contractor shall correct deficiencies found in the sewer repair at their own cost including the cost of re-cleaning and re-inspection to confirm that the deficiencies are rectified in accordance with these specifications.

## E10.7 Measurement and Payment

### E10.7.1 Sewer Cleaning

- (a) Sewer cleaning will be measured and paid for in accordance with CW 2140.
- (b) Only one item of payment will be made for pre-lining cleaning.

### E10.7.2 Sewer Preparation and Repairs Prior to Lining

- (a) Sewer repairs and preparation for lining, including removal of intruding services, grease, solid debris cutting, and any other preparation work required to complete the work will be considered incidental to "Supply and Installation of Structural Sewer Liner". No separate payment will be made.

### E10.7.3 Sewer Service Grouting

- (a) Sewer service grouting will be considered incidental to "Sewer Service Reinstatement". No separate payment will be made.

### E10.7.4 Annulus Grouting

- (a) Annulus voids due to the Contractor's method of lining, deficiencies in the CIPP installation, or any other reason related to the Contractor's workmanship or method of operations, they shall be filled at the Contractor's expense.
- (b) Repair of defective or incomplete annulus grouting shall be at the Contractors own expense.

### E10.7.5 Manhole Stabilization

- (a) Manhole stabilization will be measured on a lump sum basis and paid for at the Contract Unit Price for "Manhole Stabilization". Payment shall include all necessary traffic control, flow control, materials, labour, and any other work required to complete the required stabilization efforts.

E10.8 Replacement of existing manhole rungs will be measured and paid for in accordance with CW2130. Payment for replacement of existing manhole rungs shall include removal of existing rungs where required.

## E11. CURED-IN-PLACE-PIPE (CIPP)

### E11.1 Description

- (a) This specification covers the supply and installation of full segment rehabilitation using cured-in-place pipe (CIPP).
- (b) CIPP rehabilitation may be used for both Partially Deteriorated and Fully Deteriorated host pipe conditions.

### E11.2 References:

- (a) ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials;
- (b) ASTM D2990 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics;
- (c) ASTM D5813 – Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems;
- (d) ASTM F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-impregnated Tube;
- (e) ASTM F2019 – 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)

**E11.3 Definitions**

- (a) Cured-in-place-pipe (CIPP) means trenchless sewer rehabilitation by installing a resin-felt composite structure which when cured will form a continuous-close fit liner within an existing sewer.
- (b) Approved CIPP Suppliers and Installers means suppliers and installers pre-approved under City of Winnipeg “Request for Qualifications for the Supply and Installation of Cured in Pipe (CIPP)”. A list of pre-approved CIPP suppliers and installers for 2010 is included in the Specifications.
- (c) Full segment CIPP means CIPP extending from manhole to manhole or manhole to node (wye or tee connection to another sewer).
- (d) Partial full segment CIPP means CIPP extending from a manhole to an intermediate point within the sewer and shall generally be longer than ten metres in length.
- (e) Non-Reinforced CIPP liners shall be considered any CIPP liner constructed from a non-reinforced felt.
- (f) Reinforced CIPP liners shall be considered any CIPP liner constructed from either a carbon fibre or glass fibre reinforced felt.

**E11.4 Pre-Approved CIPP Suppliers, Installers, and Materials**

- (a) The following is a list of sewer lining systems – suppliers, installers and materials that have been pre-approved under the City of Winnipeg “Request for Qualifications for the Supply and Installation of Cured in Pipe (CIPP)” Bid Opportunity No. 253-2006 and Bid Opportunity 403-2007 for City of Winnipeg sewer rehabilitation projects.

**Table E2.3.1a): Pre-Approved CIPP Suppliers and Installers**

<b><i>Applicant</i></b>	<b><i>Insituform Technologies Limited</i></b>	<b><i>Capital Commercial Pipe Services</i></b>	<b><i>Nelson River Construction Inc.</i></b>	<b><i>Clean Water Works Inc.</i></b>
Contact	Andrew Foster 780-413-0200	Brian Ratchford 905-522-0522	Brad Morton 204-949-8700	Jeff Pappin 613-745-2444
Supplier	Insituform Technologies Inc.	Capital Commercial Pipe Services	C.I.P.P. Corporation	Clean Water Works Inc.
Installer	Insituform Technologies Limited	Capital Commercial Pipe Services	Nelson River Construction Inc.	Clean Water Works Inc.
Liner Name	Standard ITL CIPP & Standard ITL CIPP AISC	Capital Lining System (CIPP)	C.I.P.P. Corp Liner	CWW CIPP Design

**E11.5 Submittals**

- E11.5.1 Installation of CIPP liners shall not commence prior to submission and review of the submissions identified herein by the Contract Administrator.
- E11.5.2 Provide CIPP designs for review by the Contract Administrator in accordance with E2 a minimum of fifteen (15) Business Days prior to starting lining operations and a minimum of five (5) Business Days prior to wet out of the liners. CIPP shop drawings shall including the following information and shall be sealed and signed by a Professional Engineer, registered in the Province of Manitoba and experienced in the design of trenchless rehabilitation systems.
  - (a) CIPP thickness computations including all specified design checks identified in E11.6. Identify design assumptions based on a review of the Sewer Maintenance Inspection



that differ from the information provided in the Specifications for the existing sewer design conditions. Design calculations for each sewer shall be submitted on separate calculation sheets.

- (b) Name and manufacturer of the resin and felt tube proposed for each CIPP.
- (c) Means of liner installation and curing method (e.g. air/steam, water, air/UV).
- (d) CIPP material properties used for design.
- (e) Calculations showing the hydraulic capacity of the CIPP lined sewer versus the existing sewer.
- (f) Host pipe measurements identified in E9.2.1, including the following:
  - (i) Sewer length
  - (ii) Host pipe dimensions
  - (iii) Sewer invert depths
- (g) Other information that may reasonably be required by the Contract Administrator to confirm the CIPP design proposed conforms to the specified requirements and design intent.

E11.5.3 Provide resin samples within five (5) Business Days of a request by the Contract Administrator. Samples shall be provided as follows:

- (a) Arrange for the manufacturer of the resin to forward a reference sample of each type of resin proposed for use on the works to a test laboratory designated by the Contract Administrator to be used as a comparative reference sample for infrared spectrum testing.
- (b) When requested by the Contract Administrator, deliver a representative sample from each resin batch to be used on the project before adding the catalyst from the wet-out facility to a test laboratory designated by the Contract Administrator.
- (c) The Contract Administrator will arrange and pay for an infrared analysis of the samples, if required for the project.

E11.5.4 Submit a liner impregnation (wet out) protocol that provides information on the following a minimum of five (5) Business Days prior to wet out of liners:

- (a) Resin impregnation method.
- (b) Designated location of the wet out facility.
- (c) Documentation that the resin to be used has not exceeded its shelf life as recommended by the manufacturer of the resin.
- (d) Volume and weight of resin to be impregnated into each liner and repair section including the proposed excess allowance for polymerization and migration (typically 7%) into cracks and joints of the host pipe.
- (e) Roller gap setting required to provide the final installed CIPP thickness based on the proposed volume of resin.
- (f) Details of the wet-out procedure for internal point repair CIPP.

E11.5.5 Submit a liner installation protocol that provides information on the following a minimum of ten (10) Business Days prior to installation of CIPP:

- (a) Proposed main line and sewer service flow control arrangements in accordance with E7. Note, flow control plans may be submitted separate from the liner installation protocol.
- (b) Installation and curing method complete with proposed equipment.
- (c) A full curing protocol, including:
  - (i) Curing times (heat up, curing, cool down)
  - (ii) Curing temperatures
  - (iii) Inversion and cure pressures (minimum and maximum)

- (iv) Rate of travel of the UV light train and amount of lamps in operation in the case of UV cures.
- (d) Provide the maximum allowable axial and longitudinal tensile stress for the fabric tube and the arrangement for monitoring pull-in forces during installation if liner insertion is to be by pull-in methods.
- (e) Number and location of heat source monitor gauges.
- (f) Number and location of thermistors to be used for monitoring the temperature of the liner during the curing process.
- (g) Estimated length of time required to reinstate the main line sewer and sewer services.
- (h) A single installation procedure may be submitted, but any differences in installation procedures between proposed liners shall be clearly identified.

## E11.6 Design of CIPP Liners

### E11.6.1 Design Objectives

- (a) Maximizing the structural enhancement of the sewer by installing a close-fit CIPP.
- (b) Maximise the internal diameter of the rehabilitated sewer with as little impact on the hydraulic capacity of the sewer as possible.
- (c) Reducing infiltration and exfiltration.
- (d) Preventing root intrusion.
- (e) Providing sufficient chemical resistance to prevent further sewer pipe degradation related to the conveyance of sewage.
- (f) Minimizing sewer service disruption during rehabilitation.
- (g) Minimizing the time required to complete the sewer rehabilitation.
- (h) Minimizing disturbance to pavements and boulevards.
- (i) Minimizing disruption to vehicular and pedestrian traffic.
- (j) Minimizing the impact of construction on commercial, industrial, and institutional facilities.
- (k) Additional design objectives for internal point repair CIPP include:
  - (i) Providing a smooth transition between the internal point repair CIPP and the host pipe to prevent the build-up of solids and minimize wear on the repair due to routine sewer cleaning and other maintenance activities.
  - (ii) Filling any existing voids outside the sewer at the point of repair.
- (l) Select a CIPP product and construction approach for rehabilitation with the intent towards maximizing the achievement of these design objectives.

### E11.6.2 General

- (a) Utilize materials with chemical and mechanical properties that are capable of providing a minimum design life of 50 years based on the waste stream present.
- (b) Size CIPP in accordance with the design objectives to provide a close-fit to the host pipe with no annulus except for the maximum allowable diametric shrinkage due to curing permitted in ASTM D5813.
- (c) Design features of internal point repair CIPP shall include:
  - (i) Design internal point repair CIPP as a gravity pipe in a fully deteriorated pipe condition and the depth of cover calculated based on the specific location of the repair in the sewer or sewer service.
  - (ii) Tapered end sections to promote a smooth transition from the repair to the host pipe.
  - (iii) A means to facilitate flow through by-pass of existing dry weather flow during the course of the repair.

- (d) Long-term values for flexural modulus of elasticity and flexural strength will be considered to be the projected value at 50 years of a continuous application of the design load based on the specific resin and felt composite as established by ASTM D2990 based on an applied stress level of 25% of the yield strength of the liner and approved for use in the pre-qualification process. The Contractor shall provide supporting long term test data conforming to ASTM D2990 for any resin and felt composites not approved for use in the prequalification process.
- (e) The Contractor shall also provide short term test data on the modulus of elasticity and flexural strength of the in place composite structure conforming to ASTM D790 for any resin and felt composites not approved for use in the prequalification process.

E11.6.3 Minimum Loading Assumptions:

- (a) Unless otherwise specified, the following parameters shall be used to determine the design pressures exerted on the exterior of the liner.
- (b) External hydrostatic and soil loads shall be calculated as specified herein using the following parameters:
  - (i) Unless otherwise specified, the groundwater table shall be assumed to be 2.0 m below the existing ground surface.
  - (ii) External hydrostatic pressure shall in all circumstances be calculated to the invert of the existing host pipe.
  - (iii) Calculate soil loads based on saturated soil unit weight of  $18.85 \text{ kN/m}^3$  ( $1922 \text{ kg/m}^3$ ).
  - (iv) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (c) Applied external soil loads shall be estimated using the total vertical and horizontal soil stresses applied at the centroid of the CIPP liners critical section. Soil pressures shall be estimated using the depth of soil at the centroid of the critical section and the saturated unit weight of the backfill soils.
- (d) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (e) The following live loads shall be included in the design:
  - (i) Sewers crossing beneath rail lines: Where identified, applied soil pressures from a Cooper E80 rail load shall be estimated and utilized in the design of the CIPP liner. Rail loads shall include a track allowance dead load of 297 kg/m. Applied rail loads at depth shall be calculated using the Boussinesq solution for distribution of soil stresses from surface point loads. Impact factors for rail loads shall be calculated in accordance with the AREMA Manual for Railway Engineering.
  - (ii) All other sewers: The applied soil pressures from an AASHTO HS 25 design truck unless a higher or lower value is indicated in the contract specifications shall be estimated and utilized in the design of the CIPP liner. Applied soil pressures from AASHTO design truck loads shall be estimated in accordance with AASHTO LRFD Bridge Design Specifications, Seventh Edition (2014).
- (f) Unless otherwise specified, applied soil pressures at depth caused by superimposed surface loads shall be calculated using the Boussinesq solution for distribution of stresses from surface point loads.
- (g) The following external groundwater pressure shall be used in the design of partially and fully deteriorated liners. The pressures are based on the following sewer invert depths and relates to pressure at invert of the liner:
  - (i) Higgins Ave (6.40 m): 0.0431 MPa
  - (ii) Dawson Road (8.20 m): 0.0608 MPa
- (h) The following externally applied pressures at the crown shall be used in the design of fully deteriorated liners. The pressures are based on the following sewer invert depths:

- (i) Higgins Ave (6.40 m): 0.0909 MPa
- (ii) Dawson Road (8.20 m): 0.1068 MPa
- (i) The following externally applied (horizontal) pressures at the centroid of the critical section shall be used in the design of fully deteriorated liners. The pressures are based on the following sewer invert depths:
  - (i) Higgins Ave (6.40 m): 0.0620 MPa
  - (ii) Dawson Road (8.20 m): 0.0808 MPa
- (j) Any changes to the sewer invert depths based on field investigations must be relayed to the Contract Administrator and appropriate adjustments made to the design pressures.

#### E11.6.4 Hydraulic Design Checks

- (a) Perform a design check to confirm that the full flow hydraulic capacity of the CIPP will be equal to or greater than the existing sewer. Use “Manning’s” formula with assumed ‘n’ value of 0.012 for the CIPP and the following ‘n’ values for the existing sewers:
  - (i) Higgins Ave – 0.019
  - (ii) Dawson Road – 0.025
- (b) Alternatively to the use of the Manning’s formula, the Colebrook-White equation may be used to assess full flow hydraulic capacity. Perform a design check to confirm the full flow hydraulic capacity of the CIPP liner is equal to or greater than the existing sewer. Use the “Colebrook-White” formula with assumed “ks” value of 0.03 mm for the CIPP. The “ks” value for the existing sewer may be estimated based on observed condition of the pipeline using Tables C.1 (a) and (b) of Volume I, Appendix C – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition. The following ks values may be assumed for the existing sewers:
  - (i) Higgins Ave – 15 mm
  - (ii) Dawson Road – 60 mm

#### E11.6.5 Existing Sewer Design Conditions

- (a) The assessment of the liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed as part of the City of Winnipeg’s Sewer Inspection Program. Copies of these video inspections are available to the Contractor upon request in accordance with E10.3.1.
- (b) The site specific repair requirements applicable for each lining location can be found in E10.
- (c) The following design conditions are applicable:
  - (i) Higgins Ave – Fully Deteriorated Design
  - (ii) Dawson Road – Partially Deteriorated Design

#### E11.6.6 Non-Circular CIPP Design – General

- (a) All non-circular CIPP designs shall be undertaken in accordance with Section 5 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4<sup>th</sup> Edition as a Type II non-circular liner using the following equations and as modified herein:
  - (i) Check for long term permissible flexural stress:  $H_1 = (340 * S_L * (t/L)^2) / N$

Where:

- $H_1$  Permissible external pressure applied to critical section (m of water)
- $S_L$  Maximum long-term flexural stress (MPa)
- t Wall thickness (mm)
- L Length of critical section (mm)
- N Safety Factor

(ii) Check for long term permissible deflection:  $H_2 = R \cdot 236 \cdot E_L \cdot (t/L)^3$

Where:

- $H_2$  Permissible external pressure applied to critical section (m of water)
- R Shape Factor
- $E_L$  Maximum long-term flexural modulus (MPa)
- t Wall thickness (mm)
- L Length of critical section (mm)

(b) Design checks shall be undertaken with applied loads on the following critical sections where h = the internal height of the liner and w = the internal width of the liner.

(i) Egg shaped sewers:

- ◆ Length for 3:2 egg sewers:  $2h/3$
- ◆ Length for 4:3 egg sewers:  $3h/4$
- ◆ Orientation = Vertical
- ◆ Centroid location = Length/2 from invert

(c) A minimum safety factor (N) of 2 shall be applied to long term flexural stress design checks for CIPP liners.

(d) A shape factor (R) of 0.5 shall be used for all long term deflection checks on CIPP liners.

(e) Assume the liner to be flexible with no bond to the host pipe.

#### E11.6.7 Non-Circular CIPP Design - Partially Deteriorated Condition

(a) Liners designated as partially deteriorated shall be designed to accommodate hydrostatic groundwater conditions only. External soil (dead) and live loads need not be considered.

(b) The following minimum design checks shall be undertaken:

- (i) Short term flexural stress and deformation checks (only required if secondary grouting is contemplated).
- (ii) Long term flexural stress and deformation checks due to external hydrostatic pressure.

#### E11.6.8 CIPP Non-Circular Design - Fully Deteriorated Condition

(a) Liners designated as fully deteriorated shall be designed to accommodate full overburden (dead and live loads) and hydrostatic pressures.

(b) The following minimum design checks shall be undertaken:

- (i) Short term flexural stress and deformation checks (only required if secondary grouting is contemplated); and,
- (ii) Long term flexural stress and deformation checks due to, external hydrostatic pressure, external dead, and live loading.

### E11.7 Materials

#### E11.7.1 Non-Reinforced CIPP Products

(a) Non-Reinforced CIPP products shall conform to the requirements of ASTM F1216 and D5813.

#### E11.7.2 Reinforced CIPP Products

(a) Reinforced CIPP products shall conform to the requirements of ASTM F2019 and D5813. Notwithstanding ATSM F2019, the fabric tube may be reinforced with either glass or carbon fibres, as required to achieve the desired short and long term material properties and may be installed via inversion methods.

## E11.8 Construction Methods

### E11.8.1 Verification of Existing Sewer Dimensions

- (a) Verify dimensional requirements of each sewer to be rehabilitated prior to design and manufacture of the CIPP tube in accordance with E9.2.1.

### E11.8.2 Sewer Cleaning

- (a) Remove loose debris, solid debris, roots, and grease in accordance with CW 2140 in order to adequately prepare the sewer for lining.

### E11.8.3 Sewer Preparation and Repairs Prior to Lining

- (a) Perform sewer preparation and repairs as indicated in the specification and drawings.
- (b) Complete the following internal host pipe repairs in accordance with E10 of this specification:
  - (i) Fill in holes and patch deteriorated sections of the host sewer pipe wall.
  - (ii) Fill voids in the surrounding backfill flush with the inside surface of the sewer pipe.
  - (iii) Reshape host sewer pipe invert to the original dimension and cross section at locations where the invert has completely deteriorated.
  - (iv) Remove intruding sewer services in accordance with CW 2140.
  - (v) Sewer service grouting in accordance with E10.

### E11.8.4 Sewer Repairs to be Done By Others

- (a) Sewer repairs shown on the Drawings as "To Be Done By Others" or identified prior to sewer lining will be completed before lining work starts.

### E11.8.5 Manhole, Lift Station, and Catch Basin Modifications

- (a) Remove and replace manhole frames, covers, rungs and risers required to facilitate the CIPP installation in accordance with E10 and CW 2130.

### E11.8.6 Installation of CIPP

- (a) Install liners by inversion methods in accordance with ASTM F1216 or by pull-in methods in accordance with ASTM F1743 or ASTM F2019.
- (b) Full segment and partial full segment CIPP shall be cured by hot water, steam, or UV light sources.
- (c) Carry out workmanship in accordance with ASTM D5813.
- (d) Trim ends of CIPP neatly to fit flush with interior vertical surface and manhole benching and seal to make watertight.
- (e) Fill annular spaces where the CIPP does not make an adequate seal with the host pipe at manholes, termination points and sewer services due to broken or misaligned pipe with a resin-rich mixture compatible with the CIPP.
- (f) Extend limits for internal point repairs a minimum of 300 millimetres in each direction beyond the limits of the defect to be repaired. Extend internal point repairs that terminate at sewer service services a minimum distance of 300 millimetres beyond the limit of the service.
- (g) Ensure termination points of internal point repairs provide a smooth and uniform flow transition to the host pipe for the full circumference of the repair.

### E11.8.7 Reinstatement of Sewer Services

- (a) Reinststate all active and unable to determine sewer services including CB leads and utility drains to 100% of the original cross sectional area.
- (b) Cut out openings for sewer services from inside the lined sewer by manual means or with a television camera and a remote controlled cutting device.
- (c) Remove sharp edges from opening cut outs and provide a smooth rounded lip.

- (d) Sewer Service Grouting
  - (i) Grout sewer services to provide a smooth transition into the new host pipe without a loss of cross sectional area. Fill any voiding between the liner and the sewer service.
  - (ii) Locations of additional sewer service grouting will be identified by the Contract Administrator during review of Post Lining Video Inspection.
  - (iii) Complete sewer service grouting in accordance with E10.
- (e) Ensure that all cut-outs for sewer connections are removed from the sewer and are prevented from being washed into the sewer system downstream of the repair location.

#### E11.8.8 Annulus Grouting

- (a) Complete annulus grouting in accordance with E10 where identified by the Contract Administrator during the Post Lining Video inspection.

#### E11.8.9 CIPP Closures

- (a) At CIPP launch shafts where CIPP liners cannot practically provide a fully restored sewer invert the Contractor shall restore the existing host pipe as follows:
  - (i) Restore the invert up to the interface with cast-in-place concrete closure using a hand layup, bonded FRP liner in accordance with E13, a resin rich repair product compatible with the liner, or an approved cementitious repair product in accordance with E12.5.3.
  - (ii) Invert restoration shall be completed in accordance with the product manufacturer's recommendations with flow control measures in place and shall be permitted to cure sufficiently prior to exposure to sewage. The closure shall be constructed to a thickness equaling the thickness of the liner. The closure shall not result in a low spot or sump within the sewer.
  - (iii) Provide a smooth and level transition from CIPP to the closure location.
  - (iv) The obvert of the host pipe shall be restored with a cast in place concrete closure as shown on the Drawings and in accordance with E7. The cast-in-place concrete closure shall be formed from within the sewer to provide a smooth and level transition from the new CIPP liner.

#### E11.9 Quality Control/Quality Assurance (Qa/Qc)

##### E11.9.1 Quality Control Records

- (a) Maintain the following Quality Control records of the work and provide to the Contract Administrator after completion of the work.
  - (i) Summary of the resin impregnation process including:
    - ◆ Volume of resin supplied.
    - ◆ Excess quantity of resin added during the wet out to account for polymerization and migration into the host pipe.
    - ◆ Roller gap setting.
    - ◆ Resin catalyst(s) used.
    - ◆ Time and location of the wet out.
    - ◆ Means taken to store and transport the resin impregnated CIPP from the wet out facility to the job site.
  - (ii) Means of curing liners.
  - (iii) Continuous log of pressure maintained in the liner during the curing period.
  - (iv) Pulling force used to pull or winch CIPP into place in the host sewer and measured liner elongation.
  - (v) Continuous log of temperature at boiler in and out and at all thermistors placed between the host pipe and the liner at all manholes during the initial cure, cure, and cool down periods.

- (vi) Where specified, the Contractor shall install the CIPP liners complete with a fibre optic thermal sensing cable (to be left in place) that is capable of continuously monitor curing temperatures along the entire length of CIPP liner. The cable and recording equipment shall be capable of temperature readings every 450 mm in real time. Curing data logs shall be submitted to the Contract Administrator with the Quality Control records.
- (vii) For UV cures, monitoring shall also include the rate of travel of the UV assembly and the amount of lamps in operation during the curing process.

#### E11.9.2 CIPP Samples for Quality Assurance Purposes

- (a) The Contractor shall provide the following samples from each CIPP liner:
  - (i) Confined test sample in accordance with E11.9.2(h).
  - (ii) Plate sample in accordance with E11.9.2(i).
- (b) If it can be demonstrated that it is impractical to obtain confined test samples due to CIPP size and/or site specific conditions then results from test plate sample results modified in accordance with Clause E11.9.2(i)(vi) of this specification will be used to confirm flexural strength and flexural modulus.
- (c) Schedule the installation of liners for which confined pipe samples are impractical to obtain after a minimum of three (3) previous CIPP linings on the same project have been completed and confined pipe and test plate samples have been secured to provide collaborative testing.
- (d) The Contract Administrator will coordinate and pay for CIPP sample testing to confirm the CIPP flexural strength, flexural modulus and thickness in accordance with the requirements of ASTM D5813, D790, and ASTM D3567.
- (e) In larger sewer sizes where it is not possible to provide a full diameter confined test sample and upon the request of the Contract Administrator, the Contractor shall cut a sample directly from the installed CIPP liner in accordance with E11.9.2(j).
- (f) Where confined test samples cannot be obtained or where confined test samples forms do not match the inside dimensions of the host pipe the Contractor shall obtain and provide the Contract Administrator with pre and post lining measurements taken in accordance with Clause E9.2.1 of this specification to confirm in-place liner thickness.
- (g) The Contract Administrator will review CIPP liner thickness results taken from test plates or unconfined samples on a case-by-case basis.
- (h) Confined Test Samples
  - (i) Provide necessary forms of the same diameter as the host pipe and secure a minimum 200 millimetre long full diameter confined test sample from each CIPP and internal point repair. Large diameter CIPP liners utilizing reinforcing may require a longer sample length, confirm with the Contract Administrator.
  - (ii) Locate the test sample from inside an intermediate manhole or at a termination point and invert through the form.
  - (iii) Confined test sample forms shall be covered with sand bags or a similar medium to form a heat sink and replicate the install conditions of the CIPP liner.
  - (iv) Cut the CIPP sample to coincide with multi-piece form if used for CIPP larger than 450 millimetres in diameter to facilitate removal from the manhole.
    - ◆ Identify the sewer where the liner sample is from on the form or sample itself if no form and provide to the Contract Administrator intact in the form.
- (i) Test Plate Samples
  - (i) Produce and provide to the Contract Administrator test plate samples of each CIPP liner installed.
  - (ii) Test plate samples shall be produced from a full thickness portion of the liner (where possible), shall contain the same resin and hardener ratios and volumes



- used in the CIPP liner wet-out. Ensure the test plate is clamped as close to the final installation thickness of the CIPP liner as possible.
- (iii) For unreinforced liners the minimum dimension of test plate sample shall be 300mm x 300mm.
  - (iv) For reinforced liners the test plate sample shall be sized to accommodate a 32:1 span to depth (liner thickness) ratio. Circumferential reinforcing fibres shall be orientated in the long dimension of the test plate sample. Minimum dimensions for the test sample shall be as follows. Confirm the required test plate size for reinforced liners with the Contract Administrator prior to installation of the CIPP liner.
    - ◆ Width: 6.5 times the thickness of the liner
    - ◆ Length: 35.2 times the thickness of the liner
  - (v) Prepare test plate samples on-site from the actual CIPP and cure in the following manner:
    - ◆ in a clamped mold placed in the downtube or manhole for water-cured liners.
    - ◆ In a clamped mold placed in a container filled with uniformly distributed steam from the installation manhole for steam-cured liners.
  - (vi) Flexural strength and flexural modulus results obtained from test plates will be reduced, if necessary, by the maximum percentage difference of the confined pipe and test plate samples prepared from the same CIPP system for a minimum of three (3) previous CIPP linings of similar size on the same project.
- (j) Direct Samples
- (i) Where directed, the Contractor shall obtain a sample of the installed CIPP liner from within the host pipe.
  - (ii) Direct samples of the CIPP liner shall be a minimum of 300mm x 300mm for unreinforced liners.
  - (iii) For reinforced liners the sample shall be sized to accommodate a 32:1 span to depth (liner thickness) ratio. Circumferential reinforcing fibres shall be orientated in the long dimension of the sample. Minimum dimensions for the test sample shall be as follows. Confirm the required test plate size for reinforced liners with the Contract Administrator prior to obtaining the sample.
    - ◆ Width: 6.5 times the thickness of the liner
    - ◆ Length: 35.2 times the thickness of the liner
  - (iv) Cut the test sample from a location where no defects were noted in the host pipe and at the 10:00 o'clock or 2:00 o'clock position in circular sewers. Direct samples from reinforced liners in non-circular sewers shall be oriented with the long dimension vertically in the straightest portion of the sewer or as directed by the Contract Administrator. Confirm sampling locations with the Contract Administrator prior to work.
  - (v) Grout the area where test sample was taken with a resin-rich repair product such as an epoxy based repair system that is compatible with the liner system and specifically designed for the nature, size and thickness of the patch being repaired to form a smooth watertight patch flush with liner.
  - (vi) Provide photographic evidence of the repair and ensure repairs at direct sampling locations are captured during subsequent CCTV inspections.

#### E11.9.3 Infrared Spectroscopy

- (a) The Contract Administrator may arrange for testing to compare the infrared spectrum of the resin field samples supplied from the wet-out to the reference spectrum generated from the resin sample provided by the resin manufacturer to verify installed material acceptability at no cost to the Contractor.

#### E11.10 Post Construction Design Review for Total Performance

- (a) The Contract Administrator will perform a post-construction design review to confirm that the completed CIPP meets the 50 year design life structural requirements prior to issuance of Total Performance. The design review will utilize the measured values for flexural strength, flexural modulus, and CIPP thickness from the confined pipe sample testing, directly obtained samples, or the reduced strength/modulus values obtained from the test plate testing in circumstances where confined pipe samples are not able to be secured.
- (b) CIPP strength values will be further reduced to account for creep based on the creep reduction values recommended in the pre-qualification submissions to assess the suitability of the liner to meet the 50 year design life requirement. The use of full enhancement factors in this analysis will be limited to liners that are confirmed by visual classification to be close-fit liners based on the post-lining sewer inspection.
- (c) The Contract Administrator will advise of any discrepancies between the constructed CIPP and the design requirements.
- (d) Defects in CIPP liners will be reviewed on a case by case basis by the Contract Administrator. The Contract Administrator will consult with the Contractor and taking into account the condition of the host pipe prior to lining, the CIPP installation conditions, and the long term use of the sewer to assess the structural and performance ramifications of the defects.
- (e) The Contractor shall:
  - (i) Perform necessary remedial measures to confirm that a CIPP deemed as structurally deficient will comply with the 50 year design life requirement such as confirmation of actual ovality, determination of a more representative groundwater elevation locally through monitoring, and supplemental strength testing and thickness measurements.
  - (ii) Repair sections of CIPP removed for supplemental testing by placing a full circumference internal point repair of the same thickness as the full segment liner over and extending 300 millimetres beyond each side of the cut section.
  - (iii) Install a supplemental CIPP of the required thickness to structurally enhance the installed CIPP if supplemental testing fails to confirm the CIPP will meet the 50 year design life requirement.
  - (iv) Review remedial action with the Contract Administrator prior to implementation.
  - (v) Perform further testing, monitoring and calculations and install structural enhancements at own cost.

#### E11.11 Measurement and Payment

##### E11.11.1 CIPP Installation

- (a) Liner installation will be measured on a length basis for each size and paid for at the Contract Unit Price for "Supply and Installation of Structural Sewer Liner". Length to be paid for will be the total length of CIPP supplied and installed in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Measurement will be made horizontally at grade, above the centreline of the pipe from centre to centre of manholes or termination of the liner where termination is not at a manhole location.
- (c) Eighty (80) percent of the payment will be made upon satisfactory completion of the CIPP installation work. The remaining twenty (20) percent of the payment will be made upon confirmation of the CIPP strength, delivery and acceptance of all required submissions, shop drawings, and reports, and rectification of all identified defects.
- (a) Payment for the supply and installation of CIPP liners shall include but is not limited to the following:
  - (i) Verification of existing sewer dimensions;
  - (ii) Submittals, including: CIPP designs, material samples, material testing, operations protocol, and construction protocol;

- (iii) All required sewer preparation work;
- (iv) Supply and installation of CIPP;
- (v) Transitions at liner termination;
- (vi) Provision of test samples;
- (vii) Quality control testing and records; and,
- (viii) Any other materials and labour specified herein.

**E11.11.2 Reinstatement of Sewer Services**

- (a) Reinstatement of sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Reinstatement of Sewer Services". Number of units to be paid for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Payment for sewer service reinstatement will occur after confirmation of sewer service reinstatement via review of the Post-Lining CCTV video. Payment will not be made until the Post-Lining inspection videos have been submitted and reviewed.

**E11.11.3 Quality Control Records**

- (a) Preparation of quality control records shall be considered incidental to the CIPP installation and will not be measured for payment. No separate payment shall be made.

**E11.11.4 Test Samples**

- (a) All work and materials required for the preparation, recovery, and repair of CIPP test samples shall be considered incidental to the CIPP installation and will not be measured for payment. No separate payment shall be made.

**E12. SEGMENTAL SLIPLINING WITH GRP COMPOSITES**

**E12.1 Description**

- (a) This Specification shall govern the supply and installation of GRP composite panels via segmental sliplining.
- (b) GRP sliplining may be used for both Partially Deteriorated and Fully Deteriorated host pipe conditions.

**E12.2 References:**

- (a) WRc Sewerage Rehabilitation Manual, 4th Edition;
- (b) IGN 4-34-02 – Specification for Glassfibre Reinforced Plastics (GRP) Sewer Linings;
- (c) ACI 229 – Report on Controlled Low-Strength Materials; and,
- (d) CSA A23.2 – Test Methods and Standard Practices for Concrete.

**E12.3 Submittals**

**E12.3.1** Installation of GRP panels shall not commence prior to submission and review of the submissions identified herein by the Contract Administrator.

**E12.3.2** Provide GRP liner designs for review by the Contract Administrator in accordance with E3 a minimum of five (5) Business Days prior to manufacturing of the GRP panels. GRP liner shop drawings shall including the following information and shall be sealed and signed by a Professional Engineer, registered in the Province of Manitoba and experienced in the design of trenchless rehabilitation systems. GRP designs shall include the following:

- (a) GRP panel thickness computations including all specified design checks identified in E12.4. Identify design assumptions based on a review of the Sewer Maintenance Inspection that differ from the information provided in the Specifications for the existing sewer design conditions. Design submissions shall include all calculations and shall be submitted on individual calculation sheets for each liner;

- (b) Name and manufacturer of the GRP panels;
- (c) GRP material properties used for design. Include all relevant testing information stipulated herein to confirm long term material properties used in design;
- (d) Grout mix design and relevant constituent properties for the grout mixture;
- (e) Pipe joint assembly requirements;
- (f) Panel blocking arrangement as it relates to short term buckling design checks;
- (g) Calculations showing the hydraulic capacity of the GRP lined sewer versus the existing sewer;
- (h) Host pipe measurements identified in E9.2.1, including the following:
  - (i) Sewer length;
  - (ii) Host pipe dimensions;
  - (iii) GRP panel dimensions; and,
  - (iv) Sewer invert depths.
- (i) Other information that may reasonably be required by the Contract Administrator to confirm the CIPP design proposed conforms to the specified requirements and design intent.

E12.3.3 For Type 1 designs, submit demonstration shear bond testing results in accordance with E3 a minimum of five (5) Business Days prior to commencement of lining work.

- (a) The testing report shall be submitted in accordance with IGN-4-34-02.

E12.3.4 Submit a construction protocol in accordance with E3 that provides information on the following a minimum of ten (10) Business Days prior to commencement of lining work. The construction protocol shall include the following:

- (a) Proposed main line and sewer service flow control arrangements in accordance with E7. Note, flow control plans may be submitted separate from the liner installation protocol.
- (b) Pipe assembly details including joint assembly method, liner placement methods, and blocking arrangements;
- (c) Bulkhead construction for grouting;
- (d) Construction methods for tapered transitions; and,
- (e) Detailed implementation schedule for panel assembly, annulus grouting, service reinstatement, and terminations.

E12.3.5 Submit a grouting protocol in accordance with E3 that provides information on the following a minimum of five (5) Business Days prior to commencement of liner installation. The grouting protocol shall include the following:

- (a) Grout sample testing results in accordance with E12.6.1.
- (b) Minimum and maximum grouting pressures as confirmed by submitted design calculations;
- (c) maximum allowable liner deflection/deformation as confirmed by submitted design calculations;
- (d) quality assurance and quality control program to verify grout physical characteristics;
- (e) grout supplier;
- (f) grouting equipment; and,
- (g) grouting procedures, including injection points, grout lift heights, means of confirming grout placement and complete filling of the annular space.

## E12.4 GRP Liner Design

### E12.4.1 Design Objectives

- (a) Maximizing the structural enhancement of the sewer by installing a structural section of sufficient quality and sufficient strength to address all relevant loading conditions and preclude further sewer deterioration.
- (b) Minimizing the hydraulic capacity impact of rehabilitation by maximizing the bore of the rehabilitated sewer.
- (c) Reducing infiltration and exfiltration that may compromise long term structural stability of the pipe.
- (d) Preventing root intrusion.
- (e) Providing sufficient chemical resistance to prevent sewer pipe degradation related to the conveyance of storm water or sewage.
- (f) Minimizing sewer service disruption during the rehabilitation process.
- (g) Minimizing the time required to complete the sewer rehabilitation.
- (h) Minimizing disturbance to pavements and boulevards.
- (i) Minimizing disruption to vehicular and pedestrian traffic.
- (j) Minimizing the impact of construction on commercial, industrial, and institutional facilities.

### E12.4.2 General

- (a) Utilize materials with chemical and mechanical properties that are capable of providing a minimum design life of 50 years based on the waste stream present.
- (b) Long-term values for flexural modulus of elasticity and flexural strength will be considered to be the projected value at 50 years of a continuous application of the design load based on the specific product. Verified long and short term values for flexural modulus, long term flexural strain (measured in the hood direction), long term tensile strength, and shear bond strength, all tested in accordance with IGN-4-34-02. The Contractor shall provide supporting short and long term test data.
- (c) Design full or partial segment GRP Segmental lining as either a Type I or Type II lining system in accordance with Section 4 or 5, respectively, of Volume II – Sewer Renovation, WRC Sewerage Rehabilitation Manual, 4th Edition and these specifications. Notwithstanding the above, where a Type II design is contemplated it shall be designed to accommodate full overburden load where specified.
- (d) Size GRP Segments in accordance with the design objectives to minimize annulus size and to maximise hydraulic capacity; with due consideration to meet reasonable constructability considerations.

### E12.4.3 Minimum Loading Assumptions:

- (a) Unless otherwise specified, the following parameters shall be used to determine the design pressures exerted on the exterior of the liner.
- (b) External hydrostatic and soil loads shall be calculated as specified herein using the following parameters:
  - (i) Unless otherwise specified, the groundwater table shall be assumed to be 2.0 m below the existing ground surface.
  - (ii) External hydrostatic pressure shall in all circumstances be calculated to the invert of the existing host pipe.
  - (iii) Calculate soil loads based on saturated soil unit weight of  $18.85 \text{ kN/m}^3$  ( $1922 \text{ kg/m}^3$ ).
  - (iv) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.

- (c) Applied external soil loads shall be estimated using the total vertical and horizontal soil stresses applied at the centroid of the GRP liners critical section. Soil pressures shall be estimated using the depth of soil at the centroid of the critical section and the saturated unit weight of the backfill soils.
- (d) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (e) The following live loads shall be included in the design:
  - (i) Sewers crossing beneath rail lines: Where identified, applied soil pressures from a Cooper E80 rail load shall be estimated and utilized in the design of the CIPP liner. Rail loads shall include a track allowance dead load of 297 kg/m. Applied rail loads at depth shall be calculated using the Boussinesq solution for distribution of soil stresses from surface point loads. Impact factors for rail loads shall be calculated in accordance with the AREMA Manual for Railway Engineering.
  - (ii) All other sewers: The applied soil pressures from an AASHTO HS 25 design truck unless a higher or lower value is indicated in the contract specifications shall be estimated and utilized in the design of the CIPP liner. Applied soil pressures from AASHTO design truck loads shall be estimated in accordance with AASHTO LRFD Bridge Design Specifications, Seventh Edition (2014).
- (f) Unless otherwise specified, applied soil pressures at depth caused by superimposed surface loads shall be calculated using the Boussinesq solution for distribution of stresses from surface point loads.
- (g) The following external groundwater pressure shall be used in the design of partially and fully deteriorated liners. The pressures are based on the following sewer invert depths and relates to pressure at invert of the liner:
  - (i) Higgins Ave (6.40 m): 0.0431 MPa
  - (ii) Dawson Road (8.20 m): 0.0608 MPa
- (h) The following externally applied pressures at the crown shall be used in the design of fully deteriorated liners. The pressures are based on the following sewer invert depths:
  - (i) Higgins Ave (6.40 m): 0.0909 MPa
  - (ii) Dawson Road (8.20 m): 0.1068 MPa
- (i) The following externally applied (horizontal) pressures at the centroid of the critical section shall be used in the design of fully deteriorated liners. The pressures are based on the following sewer invert depths:
  - (i) Higgins Ave (6.40 m): 0.0620 MPa
  - (ii) Dawson Road (8.20 m): 0.0808 MPa
- (j) Any changes to the sewer invert depths based on field investigations must be relayed to the Contract Administrator and appropriate adjustments made to the design pressures.

#### E12.4.4 Hydraulic Design Checks:

- (a) Perform a design check to confirm that the full flow hydraulic capacity of the GRP will be equal to or greater than the existing sewer. Use "Manning's" formula with assumed 'n' value of 0.011 for the GRP and the following 'n' values for the existing sewers:
  - (i) Higgins Ave – 0.019
  - (ii) Dawson Road – 0.025
- (b) Alternatively to the use of the Manning's formula, the Colebrook-White equation may be used to assess full flow hydraulic capacity. Perform a design check to confirm the full flow hydraulic capacity of the GRP liner is equal to or greater than the existing sewer. Use the "Colebrook-White" formula with assumed "ks" value of 0.03 mm for the GRP. The "ks" value for the existing sewer may be estimated based on observed condition of the pipeline using Tables C.1 (a) and (b) of Volume I, Appendix C –

Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition. The following ks values may be assumed for the existing sewers:

- (i) Higgins Ave – 15 mm
- (ii) Dawson Road – 60 mm

#### E12.4.5 Existing Sewer Design Conditions

- (a) The assessment of the liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed as part of the City of Winnipeg's Sewer Inspection Program. Copies of these video inspections are available to the Contractor upon request in accordance with E10.3.1.
- (b) The site specific repair requirements applicable for each lining location can be found in E10.
- (c) The following design conditions are applicable:
  - (i) Higgins Ave – Fully Deteriorated Design
  - (ii) Dawson Road – Partially Deteriorated Design

#### E12.4.6 Type I – Non-Circular Design

- (a) Type I Design shall be in accordance with Section 4 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition and the following minimum design checks.
  - (i) Long term tensile and shear interface capacity check due to external loading parameters identified herein.
  - (ii) Long term buckling/deformation checks due to hydrostatic pressure utilizing Type II design checks in accordance with E12.4.7.
- (b) Use the following minimum design assumptions.
  - (i) Rigid composite section, bond with host pipe required.
  - (ii) Existing trunk sewers have a wall thickness equal to 200 mm or greater.
  - (iii) External pressures due to grouting based on installers proposed construction protocol/method statement.
  - (iv) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressures with respect to both applied tensile stresses in the liner and shear bond with the grout material and host pipe.

#### E12.4.7 Type II - Non-Circular Design

- (a) All Type II non-circular designs shall be undertaken in accordance with Section 5 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4<sup>th</sup> Edition as a Type II non-circular liner using the following equations and as modified herein:
  - (i) Check for long term permissible flexural stress:  $H_1 = (340 * S_L * (t/L)^2) / N$

Where:

- $H_1$  Permissible external pressure applied to critical section (m of water)
- $S_L$  Maximum long-term flexural stress (MPa)
- t Wall thickness (mm)
- L Length of critical section (mm)
- N Safety Factor

- (ii) Check for long term permissible deflection:  $H_2 = R * 236 * E_L * (t/L)^3$

Where:

- $H_2$  Permissible external pressure applied to critical section (m of water)
- R Shape Factor
- $E_L$  Maximum long-term flexural modulus (MPa)

- t Wall thickness (mm)
- L Length of critical section (mm)

- (b) Design checks shall be undertaken with applied loads on the following critical sections where  $h$  = the internal height of the liner and  $w$  = the internal width of the liner.
  - (i) Egg shaped sewers:
    - ◆ Length for 3:2 egg sewers:  $2h/3$
    - ◆ Length for 4:3 egg sewers:  $3h/4$
    - ◆ Orientation = Vertical
    - ◆ Centroid location = Length/2 from invert
- (c) A minimum safety factor (N) of 2 shall be applied to long term flexural stress design checks for GRP liners.
- (d) The following shape factors (R) shall be used for all long term deflection checks on GRP liners:
  - (i) Straight critical section: 0.5
  - (ii) Curved critical section: 1.0
- (e) Assume the liner to be flexible with no bond to the host pipe.
- (f) Assume external pressures due to grouting based on the proposed construction protocol/method statement.

#### E12.4.8 Non-Circular Design - Partially Deteriorated Condition

- (a) Liners designated as partially deteriorated shall be designed to accommodate hydrostatic groundwater conditions only. External soil (dead) and live loads need not be considered.
- (b) The following minimum design checks shall be undertaken using Type II methods in accordance with E12.4.7:
  - (i) Short term flexural stress and deformation checks due to grouting operation. Short term checks to address both external pressure and flotation; and,
  - (ii) Long term flexural stress and deformation checks due to external hydrostatic pressure.

#### E12.4.9 Non-Circular Design - Fully Deteriorated Condition

- (a) Liners designated as fully deteriorated shall be designed to accommodate full overburden (dead and live loads) and hydrostatic pressures.
- (b) The following minimum design checks shall be undertaken:
  - (i) Short term flexural stress and deformation checks due to grouting operation using Type II design methods in accordance with E12.4.7. Short term checks to address both external pressure and flotation;
  - (ii) Long term flexural stress and deformation checks due to external hydrostatic stress, dead, and live loading as noted below using Type 1 or Type II design methods in accordance with E12.4.6 and E12.4.7.

### E12.5 Materials

#### E12.5.1 GRP Composite Liner Product

- (a) Constituent materials and manufacturing of GRP segments shall conform to IGN 4-34-02.
- (b) Joints:
  - (i) Joints shall meet the requirements of IGN 4-34-02, Section 7.
  - (ii) Joints shall be capable of withstanding internal and external hydrostatic pressures. Assume both internal and external water levels at ground surface for the purposes of joint hydrostatic integrity.



- (iii) Longitudinal joints shall be rigid and assembled using a structural adhesive permitting full transference of tensile forces.
- (c) Appearance Criteria
  - (i) Each GRP panel shall be reviewed relative to Table 3 of Appendix G of IGN 4-34-02 for confirmation that all external and internal surfaces are within final allowable defect limits.
- (d) GRP Liners shall meet the greater of the Performance Requirements noted in Table 1 of Section 8 of IGN No. 4-34-02 or the project specific design requirements. The manufacturer shall demonstrate type testing results to confirm conformance with both the IGN specification and production run testing. Type testing shall be required for confirmation of all short and long term properties in Table 1 (Section 9, Clauses 9.2, 9.3, 9.4, 9.5, and 9.6), while production run tests are also required to substantiate short term properties for short term flexural modulus and strength.
- (e) Shear bond testing shall be carried out on production run pipe samples in accordance with E12.6.2. The Contractor shall provide a minimum of ten (10) 150 x 150 mm samples of the liner meeting the requirements of IGN No. 4-34-02, clause D3.2 for the purposes of completing the shear bond testing. Any samples not used for the initial shear bond testing shall be available for casting shear bond samples on site in accordance with E12.6.2(e).
- (f) Approved Manufacturers:
  - (i) Channeline International;
  - (ii) Hobas Pipe;
  - (iii) Flowtite; or,
  - (iv) approved equal in accordance with B7.

#### E12.5.2 Annular Grout

- (a) The proposed annular grout shall have material properties that permit grouting to occur without voiding within the annulus and has sufficient mechanical properties to achieve the desired structural intent where Type 1 liners are proposed.
- (b) Grouts shall conform to the requirements of ACI 229.
- (c) Grout parameters and mechanical properties shall be provided through demonstration testing in accordance with E12.6.1.

#### E12.5.3 Transitions

- (a) Transitions shall be completed using a polymer concrete grout compatible with the liner and grouting materials.
- (b) Approved products:
  - (i) Sikatop 123 as manufactured by Sika Canada Inc., or
  - (ii) approved equal in accordance with B7.

#### E12.6 Quality Control/Quality Assurance (Qc/Qa) and Testing

##### E12.6.1 Quality control for cementitious grouting materials shall conform to CSA A23.2, except as modified herein:

- (a) Confirm the viscosity of the grout mixture in accordance with CSA A23.2, Test Method 1B to ensure conformance with the submitted grouting plan and shear bond tests. Flow properties of grout shall be checked a minimum of once per production run, for every 25 m<sup>3</sup>, or once per 30 minutes, whichever is more frequent.
- (b) Confirm the density of the grout mixture in accordance with CSA A23.2, Test Method 6C. Grout density shall be measured and recorded once per production run, for every 25 m<sup>3</sup>, or once per 30 minutes, whichever is more frequent. The density shall be maintained within +/- 10 % of the design density.

- (c) Prepare and test quality control samples for compressive strength and density in accordance with CSA A23.2, Test Method 1B. Prepare a minimum of two (2) test cubes for each production run, or every 25 m<sup>3</sup>, whichever is more frequent. The Contractor shall arrange to have test cubes tested at an approved testing facility in accordance with CSA A23.2, Test Method 1B.

#### E12.6.2 Shear Bond Testing

- (a) Shear bond testing for Type I liner designs shall be undertaken in accordance with Appendix D of IGN-4-34-02. Shear bond testing is only required for Type I GRP liner designs. Intent of shear bond testing is to verify the shear bond values used in the GRP liner design.
- (b) One set of shear bond testing as per Clause D.3.2 of IGN No. 4-34-02 for each combination of grout and liner product.
- (c) Test samples shall be cast with the same grout mix and constituent materials as those proposed in the grouting submission. The grout mixture used for the shear bond testing shall be tested in accordance with E12.6.1 and results included in the shear bond testing report.
- (d) A shear bond testing report shall be prepared and submitted to the Contract Administrator in accordance with E12.3.3.
- (e) Where inconsistencies are present with the proposed grout, the grout used for the shear bond testing, or the quality control tests completed in the field the Contract Administrator may require shear bond samples to be cast during the grouting operation or cores taken for the purposes of shear bond testing.
- (f) Accepted Testing Facilities:
  - (i) University of Waterloo, Center for Advancement of Trenchless Technologies. Testing to be completed under the direction of Dr. Mark Knight (1-519-888-4567 Ext:36919) or approved alternative testing facility in accordance with B7.

#### E12.6.3 Quality Control Records

- (a) Maintain the following Quality Control records of the work and provide to the Contract Administrator after completion of the work.
  - (i) Summary of the GRP Segment manufacturing records, including:
    - ◆ All QA/QC testing carried out in accordance with IGN 4-34-02; and,
    - ◆ A certificate of compliance in accordance with Appendix H of IGN 4-34-02 for each GRP liner design.
  - (ii) A grouting summary including all QA testing reports identified herein; and,
  - (iii) Results of any additional shear bond testing in accordance with E12.6.2.

#### E12.7 Sewer Preparation

E12.7.1 Sewers shall be prepared for lining in accordance with E10.3.

E12.7.2 The following are required for Type I rehabilitation system where grout bond with the host pipe is required:

- (a) The host pipe shall be thoroughly cleaned using water jetting or other acceptable methods prior to lining in accordance with WRC, Sewerage Rehabilitation Manual, Section 9.2.3. The host pipe shall be free of organic materials, biological slim, roots, soft encrustation, and grease; and,
- (b) Any repairs to the host pipe shall be completed with a competent cementitious material compatible with the host pipe, grout, and liner. Repairs shall not compromise the intended structural behaviour or performance of the rehabilitated structure.

E12.7.3 Infiltration shall be stopped or reduced to the level required to successfully complete the grouting operations.

## E12.8 Installation of GRP Liners

### E12.8.1 GRP Panel Installation.

- (a) Assemble GRP panels in accordance with approved installation protocol submission.
- (b) Profile of alignment shall be offset to invert of pipe to as great a degree as possible leaving largest annulus at crown.
- (c) Securely fasten panels in-place to facilitate construction and sufficiently to assure that panels are not displaced during grouting operations. Ensure that temporary support system minimizes point loads and other features that may cause damage to GRP liner during grouting operations.
- (d) The contractor shall take every effort to prevent the accumulation of debris and sewage between the liner and the host pipe. Sewer services shall not be permitted to discharge into the annulus at any time.

### E12.8.2 Annulus Grouting

- (a) Where a Type I rehabilitation system is proposed, all debris and contaminants between the liner and the host pipe shall be removed via flushing or other acceptable methods prior to grouting.
- (b) Carry out annulus grouting in accordance with approved grouting protocol submission. Monitor the liner during grouting operations to ensure short-term deflections do not exceed the allowable maximums and that the liner is not displaced during grouting operations.
- (c) The Contractor is responsible for confirming that annulus is fully grouted.
- (d) Temporary wooden plugs may be used to plug grouting ports during grouting. Upon completion, the holes shall be repaired using a resin-rich repair product such as an epoxy based repair system that is compatible with the liner system and specifically designed for the nature, size and thickness of the patch being repaired to form a smooth watertight patch flush with liner.
- (e) General grouting requirements:
  - (i) Estimate the volume of grout required, including an overfill allowance based on grout properties, sewer geometry and condition, and previous experience with grout mixture;
  - (ii) By-pass or pump through any sewer flows that occur during grouting operations;
  - (iii) Minimize infiltration (or its effects) to the extent required to successfully complete the grouting operations;
  - (iv) Inject from the downstream end of the renovated section;
  - (v) Inject from the invert towards the crown;
  - (vi) Provide air vents at the high points;
  - (vii) Monitor and record the injection pressures;
  - (viii) Inspect the lining for signs of distortion or flotation;
  - (ix) Monitor and record the volume of grout injected and compare with the estimate (with due consideration of an overfill allowance); and,
  - (x) Regularly monitor for grout leaks in sections of sewer upstream and downstream, drain connections (via inspection chambers), particularly if the volume of grout injected exceeds the estimated grout take.
- (f) The volume to be grouted at any one time can be varied to suit the various constraints such as the workability of the grout, design of the lining (including flotation), capacity of the mixing and pumping equipment, rate of installation of the lining, and the necessity for over pumping.
- (g) Sections should be grouted during the shift immediately following their installation provided that the stop ends and any lateral connections have attained sufficient strength.

- (h) Grout should either be injected through a minimum of three preformed holes (nominally 50 mm diameter) located in the haunches and crown of the lining or through pipes cast into the crown and invert of the stop ends. The former method is preferable because, in the event of a blockage, grouting can recommence at the adjacent panel. The grout should be injected from the lowest vent hole and successive holes plugged as air free grout is seen to issue from them. If the major dimension of the lining exceeds 1000 mm consideration should be given to the provision of more grout holes.
- (i) Bulkheads:
  - (i) Bulkheads shall be constructed at the termination of the liner to facilitate lining and shall be temporary or permanent in nature.
  - (ii) If permanent, the bulkhead shall be constructed from cementitious materials consistent with the design of the rehabilitation system and the liner termination transitions.
  - (iii) Bulkheads shall include ports, located at regular intervals around the circumference of the host pipe for the purposes of confirming complete grouting of the annulus. Ports shall be located at the following minimum locations:
    - ◆ 4 and 8 o'clock position (max of 0.5 m above invert)
    - ◆ Springline of the host pipe
    - ◆ 2 and 10 o'clock position
    - ◆ Crown of the host pipe
  - (iv) Grout inspection ports shall be removed upon completion of the lining works and adequately plugged using fittings compatible with the port (HDPE or PVC) or a suitable cementitious product. Construction of the liner termination transition shall completely envelope the grout inspection ports such that no portion of the ports is visible upon completion of the work.

#### E12.8.3 Transitions at Liner Termination

- (a) At transition terminations, the interface between the exterior surface of the liner and the host pipe shall be made watertight. The transition shall extend a minimum of 1.00 m into the host pipe from the end of the liner (unless otherwise shown on the Drawings) and provide a gradual transition from the host pipe to the lined section. Grouted transition shall match the GRP liner internal diameter and taper to a thickness of no more than 13 mm where meeting the host pipe.
- (b) Preparation of the host pipe and installation of the approved cementitious grouting product shall follow the manufacturer's recommendations.
- (c) Transitions shall be constructed while flow bypass arrangements are in place and shall be permitted to cure sufficiently prior to exposure to sewage.

#### E12.8.4 Reinstatement of Sewer Connections

- (a) Reinstatement of sewer connections shall be made in a watertight manner that precludes leakage or infiltration at the connection between the host pipe and the liner.
- (b) Reinstatement of live sewer connections shall be to 100% of the original cross sectional area.
- (c) Remove sharp edges from opening cut outs and provide a smooth rounded lip.
- (d) Sewer Service Grouting
  - (i) Fill voids between the liner and the host pipe at sewer service openings with a non-shrink, watertight cementitious or resin rich grout compatible with the liner system, or other approved grouting product to form a smooth watertight connection.

#### E12.8.5 GRP Closures

- (a) GRP closures shall be constructed from full segment GRP panels and shall result in a uniform interior surface.

- (b) The obvert of the host pipe shall be restored with a cast in place concrete closure as shown on the Drawings and in accordance with E7. The cast-in-place concrete closure shall be cast directly against the new GRP liner panel.

#### E12.9 Post Construction Design Review for Total Performance

- (a) The Contract Administrator will perform a post-construction design review to confirm that the completed liner meets the design objectives relative to structural requirements prior to Total Performance. The design review will utilize all reported Quality Control testing records provided in accordance with E12.6.3.
- (b) The Contract Administrator will advise of any discrepancies between the constructed GRP and the design requirements.
- (c) Defects in GRP liners will be reviewed on a case by case basis by the Contract Administrator. The Contract Administrator will consult with the Contractor and taking into account the condition of the host pipe prior to lining, the GRP installation conditions, and the long term use of the sewer to assess the structural and performance ramifications of the defects.
  - (i) The Contractor shall:
    - ◆ Perform necessary remedial measures to confirm that a liner deemed to be structurally deficient will comply with the 50 year design life requirement such as determination of a more representative groundwater elevation locally through monitoring, undertake additional measurements to confirm install conditions, and supplemental sampling and strength testing.
    - ◆ Repair sections of GRP removed for supplemental by insertion of extra GRP panel material using an acceptable structural adhesive or repairing with a resin-rich repair product such as an epoxy based repair system that is compatible with the liner system and specifically designed for the nature, size and thickness of the patch being repaired to form a smooth watertight patch flush with liner.
    - ◆ Install a supplemental liner to structurally enhance the installed GRP liner if supplemental testing fails to confirm the GRP will meet the 50 year design life requirement.
    - ◆ Review remedial action with the Contract Administrator prior to implementation.
    - ◆ The Contractor shall perform further testing, monitoring, calculations, and install structural enhancements at their own cost.

#### E12.10 Measurement and Payment

##### E12.10.1 GRP Sliplining

- (a) Liner installation will be measured on a length basis for each size and paid for at the Contract Unit Price for "Supply and Installation of Structural Sewer Liner". Length to be paid for will be the total length of GRP liner supplied and installed in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Measurement will be made horizontally at grade, above the centreline of the pipe from centre to centre of manholes or termination of the liner where termination is not at a manhole location.
- (c) Payment for the supply and installation of GRP liners shall include but is not limited to the following:
  - (i) Verification of existing sewer dimensions;
  - (ii) Submittals, including: GRP designs, material samples, material testing, operations protocol, and construction protocol;
  - (iii) All required sewer preparation work;
  - (iv) Supply and installation of GRP liner;

- (v) Grouting of GRP liner;
- (vi) Transitions at liner termination;
- (vii) Provision of test samples;
- (viii) Quality control testing and records; and,
- (ix) Any other materials and labour as specified herein.

- (d) Payment for the supply and installation of GRP liners will be made on the following payment schedule;
  - (i) Thirty percent (30%) payment upon delivery of the GRP panels to Winnipeg and inspection/acceptance by the Contract Administrator.
  - (ii) Eighty percent (80%) payment upon installation and completion of the grouting operations.
  - (iii) One hundred percent (100%) payment upon completion of all work incidental to the GRP liner installation, confirmation of QA testing results, delivery and acceptance of all required submissions, shop drawings, and reports, rectification of all identified defects, and acceptance by the Contract Administrator.

#### E12.10.2 Reinstatement of Sewer Services

- (a) Reinstatement of sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Reinstatement of Sewer Services". Number of units to be paid for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Payment for sewer service reinstatement will occur after confirmation of sewer service reinstatement via review of the Post-Lining CCTV video. Payment will not be made until the Post-Lining inspection videos have been submitted and reviewed.

#### E12.10.3 Quality Control Records

- (a) Preparation of quality control records shall be considered incidental to the GRP liner installation and will not be measured for payment. No separate payment shall be made.

#### E12.10.4 Quality Control Sampling and Testing

- (a) All work and materials required for the preparation, recovery, and repair of GRP and grouting test samples shall be considered incidental to the GRP liner installation and will not be measured for payment. No separate payment shall be made.

### **E13. BONDED FRP LINERS**

#### E13.1 Description

- (a) This specification covers the supply and installation bonded, hand applied FRP sewer liners.
- (b) Bonded FRP sewer rehabilitation may be used for both Partially Deteriorated and Fully Deteriorated host pipe conditions.

#### E13.2 References:

- (a) ACI 440.2R – Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures;
- (b) ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials;
- (c) ASTM D3039 – Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials;
- (d) ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers;

- (e) ASTM E2092 – Standard Test Method for Distortion Temperature in Three-Point Bending by Thermomechanical Analysis.

### E13.3 Submittals

E13.3.1 Installation of Bonded FRP liners shall not commence prior to submission and review of the submissions identified herein by the Contract Administrator.

#### E13.3.2 Design Submission and Shop Drawings

- (a) Provide a design submission and shop drawings for review by the Contract Administrator in accordance with E3 a minimum of fifteen (15) Business Days prior to starting lining operations. Designs shall be completed by personnel experienced in the design of FRP liners for gravity applications. Designs and all Shop Drawings shall be stamped by a Professional Engineer, registered to practice engineering in the Province of Manitoba. Temporary submissions to facilitate project schedule by Engineers with registration pending in the Province of Manitoba will be considered with the proviso that all final submissions shall be sealed by a Professional Engineer, registered to practice engineering in the Province of Manitoba. The design submission shall include the following:
- (i) Bonded FRP thickness computations including all specified design checks identified in E13.4. Identify design assumptions based on a review of the Sewer Maintenance Inspection that differ from the information provided in the Specifications for the existing sewer design conditions. Designs for each liner shall be submitted on separate calculation sheets;
  - (ii) Summary of design and loading conditions;
  - (iii) Number of layers and orientation of fibres;
  - (iv) Estimated finished thickness;
  - (v) Name and manufacturer of the FRP materials and resin proposed;
  - (vi) Physical properties of the composite liner material:
    - ◆ Composite Ultimate Tensile Strength (ASTM D3039)
    - ◆ Tensile Modulus (ASTM D3039)
    - ◆ Flexural Modulus (ASTM D790)
    - ◆ Supporting documentation to verify the use of any time dependent properties (e.g. creep in long term flexure for buckling resistance, hoop stress, etc.)
  - (vii) Confirmation of durability of the liner design relative to the exposed service conditions;
  - (viii) Calculations showing the hydraulic capacity of the FRP lined sewer versus the existing sewer;
  - (ix) Host pipe measurements identified in E9.2.1, including the following:
    - ◆ Sewer length
    - ◆ Host pipe dimensions
    - ◆ Sewer invert depths
  - (x) Other information that may reasonably be required by the Contract Administrator to confirm the FRP design proposed conforms to the specified requirements and design intent.

#### E13.3.3 Materials Submission

- (a) Submit sufficient information on the raw resin and reinforcing fibre material proposed for use in accordance with E3 a minimum of fifteen (15) Business Days prior to starting lining operations for evaluation of the applicability of quality assurance procedures as per Chapter 7 of ACI 440.2R.
- (b) Submit the product name, manufacturer, and properties for the proposed resin, including:

- (i) Mixing and application requirements, including ambient and substrate temp, relative humidity
  - (ii) Accelerators, retarders or other additives proposed
  - (iii) Pot Life vs temperature
  - (iv) Gel time
  - (v) Cure time vs cure temperatures for all expected cure ranges
  - (vi) Normal operating temperature range (min and max)
  - (vii) Heat-distortion temperature, per ASTM E2092
  - (viii) Tensile strength, modulus of elasticity, and ultimate strain, per ASTM D3039
  - (ix) Cohesive strength
  - (x) Adhesion to Concrete, per ASTM D4541
  - (xi) Fourier transform infrared spectroscopy (FTIR) report output from the resin manufacturer such that blind testing could be carried out on site at the City's expense to confirm that the same resin is indeed being incorporated into the works.
- (c) Name and manufacturer of the FRP fabric, and relevant fabric properties
- (d) MSDS sheets for all products requiring them

#### E13.3.4 Detailed Liner Installation Procedure

- (a) The Contractor shall submit a detailed step-by-step procedure of all key liner preparation and installation activities and processes in accordance with E3 a minimum of ten (10) Business Days prior to starting lining operations. This procedure submission shall include as a minimum:
- (i) Proposed main line and sewer service flow control arrangements in accordance with E7. Note, flow control plans may be submitted separate from the liner installation protocol.
  - (ii) Identification of any services and support required to complete installation.
  - (iii) List of equipment that will be available and used for the project.
  - (iv) Material handling, storage and disposal requirements for all raw materials and project waste.
  - (v) Details of pipeline preparation for acceptance of the liner, including procedures for:
    - ◆ Cleaning the pipe surfaces.
    - ◆ Repairing the pipe surfaces to satisfactory cross section or profile.
    - ◆ Creating and maintaining environmental conditions to facilitate installation of the liner.
  - (vi) Details of liner preparation and installation:
    - ◆ A sufficiently concise, detailed timeline listing all key steps in the preparation, transfer and installation of the liner. The level of detail provided shall be sufficient to facilitate "near-continuous monitoring of progress by the Contract Administrator or their representative during the course of the shutdown.
    - ◆ Estimated pot life (catalyzed stability) of the system at various temperatures.
    - ◆ Details of the wet-out procedure
    - ◆ Resin impregnation method.
    - ◆ Designated locations for wet out facilities on-site.
    - ◆ Volume and weight of resin to be impregnated into each liner and repair section
    - ◆ Roller gap setting required to provide the final installed FRP thickness based on the proposed volume of resin.



- ◆ Method of transferring prepared liner components from the preparation site to the installation site inside the pipeline.
- ◆ Method of applying liner components to the pipeline.
- ◆ Protection systems to protect liner from damage during construction
- (vii) Liner curing requirements:
  - ◆ Monitoring requirements
  - ◆ Number of stages and anticipated time for each stage of the lay-up and curing periods based on resin supplier's recommendations.
  - ◆ Minimum curing requirements to facilitate pipe reinstatement including a graduated table of anticipated strength gain with time
- (viii) Weather protection procedures:
  - ◆ Hot or cold weather protection for epoxies and impregnated liners during storage mixing, impregnation and transportation
  - ◆ Protection of work and materials from elements including rain, snow, fog, wind and others
  - ◆ Contingency planning for inclement weather, including transportation, protection of pipeline access points, staging areas to ensure the works can progress in all weather conditions reasonably prevalent during work windows.
- (ix) Estimated length of time required to reinstate the pipeline.

#### E13.3.5 Qa/Qc Plan

- (a) The Contractor shall submit a quality management plan in accordance with E3 a minimum of ten (10) Business Days prior to starting lining operations. The plan shall consist of the following:
  - (i) Name and relevant experience of Quality Control Supervisors and staff that will be present on-site to perform the required quality control activities.
  - (ii) Example Quality Control Record forms to adequately document requirements of the Quality Assurance/ Quality Control section of this specification. Documentation shall demonstrate compliance with ACI 440.2R Section 7.1.
  - (iii) Proposed on site quality control testing program.
  - (iv) Proposed independent test laboratory and relevant certifications.

#### E13.4 Design of Bonded FRP Liners

##### E13.4.1 Design Objectives

- (a) Maximizing the structural enhancement of the sewer by installing a bonded FRP liner.
- (b) Maintain or increase the hydraulic capacity of the rehabilitated sewer.
- (c) Reduce infiltration and exfiltration.
- (d) Prevent root intrusion.
- (e) Provide sufficient chemical resistance to prevent further sewer pipe degradation related to the conveyance of sewage.
- (f) Minimize disturbance to pavements and boulevards.
- (g) Minimize disruption to vehicular and pedestrian traffic.
- (h) Minimize the impact of construction on commercial, industrial, and institutional facilities.

##### E13.4.2 General

- (a) Utilize materials with chemical and mechanical properties that are capable of providing a minimum design life of 50 years based on the waste stream present.

- (b) Long-term values for flexural modulus of elasticity, flexural strength, and tensile strength will be considered to be the projected value at 50 years of a continuous application of the design load based on the specific materials proposed for use. Physical properties shall be verified by an accredited testing agency.
- (c) Long term design properties used for the design shall be determined in accordance with ACI 440.2R.

E13.4.3 Minimum Loading Assumptions:

- (a) Unless otherwise specified, the following parameters shall be used to determine the design pressures exerted on the exterior of the liner.
- (b) External hydrostatic and soil loads shall be calculated as specified herein using the following parameters:
  - (i) Unless otherwise specified, the groundwater table shall be assumed to be 2.0 m below the existing ground surface.
  - (ii) External hydrostatic pressure shall in all circumstances be calculated to the invert of the existing host pipe.
  - (iii) Calculate soil loads based on saturated soil unit weight of  $18.85 \text{ kN/m}^3$  ( $1922 \text{ kg/m}^3$ ).
  - (iv) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (c) Applied external soil loads shall be estimated using the total vertical and horizontal soil stresses applied at the centroid of the liners critical section. Soil pressures shall be estimated using the depth of soil at the centroid of the critical section and the saturated unit weight of the backfill soils.
- (d) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (e) The following live loads shall be included in the design:
  - (i) Sewers crossing beneath rail lines: Where identified, applied soil pressures from a Cooper E80 rail load shall be estimated and utilized in the design of the CIPP liner. Rail loads shall include a track allowance dead load of 297 kg/m. Applied rail loads at depth shall be calculated using the Boussinesq solution for distribution of soil stresses from surface point loads. Impact factors for rail loads shall be calculated in accordance with the AREMA Manual for Railway Engineering.
  - (ii) All other sewers: The applied soil pressures from an AASHTO HS 25 design truck unless a higher or lower value is indicated in the contract specifications shall be estimated and utilized in the design of the CIPP liner. Applied soil pressures from AASHTO design truck loads shall be estimated in accordance with AASHTO LRFD Bridge Design Specifications, Seventh Edition (2014).
- (f) Unless otherwise specified, applied soil pressures at depth caused by superimposed surface loads shall be calculated using the Boussinesq solution for distribution of stresses from surface point loads.
- (g) The following external groundwater pressure shall be used in the design of partially and fully deteriorated liners. The pressures are based on the following sewer invert depths and relates to pressure at invert of the liner:
  - (i) Higgins Ave (6.40 m): 0.0431 MPa
  - (ii) Dawson Road (8.20 m): 0.0608 MPa
- (h) The following externally applied pressures at the crown shall be used in the design of fully deteriorated liners. The pressures are based on the following sewer invert depths:
  - (i) Higgins Ave (6.40 m): 0.0909 MPa
  - (ii) Dawson Road (8.20 m): 0.1068 MPa

- (i) The following externally applied (horizontal) pressures at the centroid of the critical section shall be used in the design of fully deteriorated liners. The pressures are based on the following sewer invert depths:
  - (i) Higgins Ave (6.40 m): 0.0620 MPa
  - (ii) Dawson Road (8.20 m): 0.0808 MPa
- (j) Any changes to the sewer invert depths based on field investigations must be relayed to the Contract Administrator and appropriate adjustments made to the design pressures.

#### E13.4.4 Hydraulic Design Checks

- (a) Perform a design check to confirm that the full flow hydraulic capacity of the FRP will be equal to or greater than the existing sewer. Use "Manning's" formula with assumed 'n' value of 0.011 for the FRP and the following 'n' values for the existing sewers:
  - (i) Higgins Ave – 0.019
  - (ii) Dawson Road – 0.025
- (b) Alternatively to the use of the Manning's formula, the Colebrook-White equation may be used to assess full flow hydraulic capacity. Perform a design check to confirm the full flow hydraulic capacity of the CIPP liner is equal to or greater than the existing sewer. Use the "Colebrook-White" formula with assumed "ks" value of 0.03 mm for the FRP. The "ks" value for the existing sewer may be estimated based on observed condition of the pipeline using Tables C.1 (a) and (b) of Volume I, Appendix C – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition. The following ks values may be assumed for the existing sewers:
  - (i) Higgins Ave – 15 mm
  - (ii) Dawson Road – 60 mm

#### E13.4.5 Existing Sewer Design Conditions

- (a) The assessment of the liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed as part of the City of Winnipeg's Sewer Inspection Program. Copies of these video inspections are available to the Contractor upon request in accordance with E10.3.1.
- (b) The site specific repair requirements applicable for each lining location can be found in E10.
- (c) The following design conditions are applicable:
  - (i) Higgins Ave – Fully Deteriorated Design
  - (ii) Dawson Road – Partially Deteriorated Design

#### E13.4.6 Type 1 – Non-Circular Design

- (a) Type I Design shall be in accordance with Section 4 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition and the following minimum design checks.
  - (i) Long term tensile and shear interface capacity check due to external loading parameters identified herein.
- (b) Use the following minimum design assumptions.
  - (i) Rigid composite section, bond with host pipe required.
  - (ii) Existing trunk sewers have a wall thickness equal to 200 mm or greater.
  - (iii) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressures.

#### E13.4.7 Type II - Non-Circular Design

- (a) All Type II non-circular designs shall be undertaken in accordance with Section 5 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4<sup>th</sup> Edition as a Type II non-circular liner using the following equations and as modified herein:

- (i) Check for long term permissible flexural stress:  $H_1 = (340 * S_L * (t/L)^2) / N$

Where:

- $H_1$  Permissible external pressure applied to critical section (m of water)  
 $S_L$  Maximum long-term flexural stress (MPa)  
 $t$  Wall thickness (mm)  
 $L$  Length of critical section (mm)  
 $N$  Safety Factor

- (ii) Check for long term permissible deflection:  $H_2 = R * 236 * E_L * (t/L)^3$

Where:

- $H_2$  Permissible external pressure applied to critical section (m of water)  
 $R$  Shape Factor  
 $E_L$  Maximum long-term flexural modulus (MPa)  
 $t$  Wall thickness (mm)  
 $L$  Length of critical section (mm)

- (b) Design checks shall be undertaken with applied loads on the following critical sections where  $h$  = the internal height of the liner and  $w$  = the internal width of the liner.

- (i) Egg shaped sewers:

- ◆ Length for 3:2 egg sewers:  $2h/3$
- ◆ Length for 4:3 egg sewers:  $3h/4$
- ◆ Orientation = Vertical
- ◆ Centroid location = Length/2 from invert

- (c) A minimum safety factor ( $N$ ) of 2 shall be applied to long term flexural stress design checks for FRP liners.

- (d) A shape factor ( $R$ ) of 0.5 shall be used for all long term deflection checks on FRP liners:

- (e) Assume the liner to be flexible with no bond to the host pipe.

#### E13.4.8 Non-Circular Design - Partially Deteriorated Condition

- (a) Liners designated as partially deteriorated shall be designed to accommodate hydrostatic groundwater conditions only. External soil (dead) and live loads need not be considered.

- (b) Long term external hydrostatic design checks shall be undertaken using either bond strength between the liner and host pipe or Type II buckling checks in accordance with E13.4.7.

#### E13.4.9 Non-Circular Design - Fully Deteriorated Condition

- (a) Liners designated as fully deteriorated shall be designed to accommodate full overburden (dead and live loads) and hydrostatic pressures.

- (b) The following minimum design checks shall be undertaken:

- (i) External hydrostatic design checks shall be undertaken using either bond strength between the liner and host pipe or Type II buckling checks in accordance with E13.4.7; and,
- (ii) Long term external hydrostatic, soil, and live loading Type I design checks in accordance with E13.4.6.

#### E13.5 Materials

- (a) Constituent materials for the FRP composite structure shall conform to ACI 440.2R.
- (b) The composite FRP fabric shall be reinforced with either glass or carbon fibres and specifically designed for repair and strengthening of concrete or similar structural elements.

- (c) The epoxy resin used for bonding the FRP fabric shall be compatible with the composite fabric and designed as a complete system for application on concrete structures. Only two part 100% solids, ambient cure epoxy resin systems shall be permitted.
- (d) Field thickened epoxy matrix, which is compatible with composite system's resin matrix, may be used to patch "bugholes" and fill voids.

#### E13.6 Construction Methods

E13.6.1 The installation of the FRP liner is a bond critical application that requires a complete bond between the FRP system and the pipe mortar lining.

#### E13.6.2 Verification of Existing Sewer Dimensions

- (a) Verify dimensional requirements of each sewer to be rehabilitated prior to design in accordance with E9.2.1.

#### E13.6.3 Surface Preparation:

- (a) Prepare the concrete surface per FRP manufacturer's recommendations and as specified herein. Surface preparation shall promote continuous intimate contact between the FRP and concrete by providing a clean, dry, uniform surface. The surface of the concrete shall be prepared with hydro blasting to remove scale and to provide a rough profile for bonding of the epoxy in accordance with the epoxy manufacturer's recommendations. The surface shall be prepared to a minimum Concrete Repair Institute concrete surface profile (CSP) level 3.
- (b) Surface preparation shall remove all surface latent materials such as: grime, scale, sand, and cement, etc. The purpose of the surface preparation is to expose the core aggregate of the concrete substrate. The prepared surface will provide a uniform exposure of the core's course aggregate such that the surface will be void of surface latent materials, such as the sand and cement cured between the form-work and core concrete during the original concrete pour which took place at the time of pipe manufacturing.
- (c) The Contractor shall examine the existing conditions to identify potential obstructions and constraints, manhole locations, shall verify dimensions and geometry and shall repair all flaws and cracks in the concrete core that may compromise the performance of the FRP system.
  - (i) Prepare and fill all voiding, holes, and discontinuities in the host pipe wall to form a smooth uniform interior surface consistent with the design assumptions.
  - (ii) Prepare, fill, prime, and treat joints and cracks in substrate.
  - (iii) Fill all voids in the concrete host pipe greater than 12 mm in depth with an epoxy repair grout.
  - (iv) Fill and seal all visible cracks with an epoxy grout.
  - (v) Repair damaged portions of the pipeline, locations of missing invert, and spalled concrete to form a smooth, uniform and competent substrate for application of the FRP liner.
- (d) Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, moisture and other contaminants incompatible with epoxy resin.
- (e) Remove fins, ridges, mortar, and other projections that could cause voids behind the installed bands or damage the woven fiber fabrics. Fill honeycomb, aggregate pockets, holes, and other voids. Repair uneven surfaces by filling with grout or other material approved by the Contract Administrator.
- (f) Prevent wash water from sections being cleaned from contaminating previously cleaned or repaired sections.
- (g) After cleaning, carefully inspect the pipe surface for defects, including cracking, delamination or spalling of concrete surface, and record. Repair any surface defects in accordance to manufacturer instructions.

(h) All leakage and infiltration shall be sealed prior to lining.

E13.6.4 Accurately layout circumferential FRP alignment markings to ensure fabrics are aligned to the proposed layout.

E13.6.5 Environmental Conditions:

- (a) The installation of a FRP system requires temperature and moisture control. In conditions with an ambient air temperature less than 10°C, auxiliary clean heat sources may be used to raise the ambient temperature to a desired level.
- (b) The presence of moisture inhibits the adhesion of epoxies to concrete surfaces. Portable barriers and blowers shall be erected at the repair locations to dehumidify the concrete surface in the pipe. The environment shall be maintained to meet the recommendation of the project manufacturer. Surface moisture shall not exceed that used for surface bonding qualifications and no more than 3.0°C above dew point.
- (c) Monitor installation conditions including temperature, humidity and surface moisture to ensure they are within allowable parameters of the system.
- (d) Water leakage through cracks or joints in the host pipe must be stopped by the Contractor prior to installation of FRP panels. Leakage which cannot be stopped by injection with chemical injection (epoxy or polyurethane) or application of hydraulic cement shall be reviewed with the Contract Administrator.
- (e) Proper dust control and ventilation shall be provided to meet OH&S requirements.
- (f) The work area is a confined space that will require an entry permit in accordance with OH&S regulations. The Contractor is responsible for the training of all personnel, air testing, safety equipment and complying with the requirements of OH&S.
- (g) Epoxy resins (including primers) shall be mixed according to the FRP system manufacturer's installation instructions.
- (h) Mixed epoxy resins that exceed the pot life specified by the manufacturer shall not be used.

E13.6.6 Bonded FRP Panel Installation

- (a) The application of the FRP system including topcoat shall be performed in accordance with the manufacturer's instructions. The Contractor shall follow all OH&S and local health and safety requirements, especially confined space entry permit requirements.
- (b) Install system in accordance to manufacturer's written instructions. Monitor quality of installation and ensure tight bonds between substrate and successive layers of FRP.
- (c) The epoxy coating shall be installed only on surfaces that have been roughened by hydro/abrasive blasting. After the surface is properly prepared and the surface of the concrete is dry, a high solids epoxy primer shall be applied to the concrete lining. The cleaned and prepared surfaces must be protected against recontamination until the FRP system is applied.
- (d) The wet-layup method shall be the only approved method for FRP installation. The Contractor shall utilize a fabric saturator and rolling mechanism such that the epoxy saturated fabric is transported to the point of application through the manhole, which is then applied to the surface of the pipe in a wet lay-up process. No dry-layup application of the FRP fabric shall be permitted.
- (e) The saturation machine shall be properly calibrated to ensure proper fiber resin ratio. Weight comparison, fabric to resin weight ratio shall follow the manufacturer's recommendations. The saturated fabric shall be weighed periodically to ensure the saturator is calibrated properly, such that the total weight of the resin absorbed by the fabric equals the weight of the dry fabric. This weight comparison is called the fabric to resin weight ratio. The allowable variance in the fabric to resin weight ratio is  $\pm 10\%$ .
- (f) After fiber saturation, the FRP composite material shall sit still on spool in a clean area as required by the manufacturer's recommendations to allow for epoxy permeation into fiber material.

- (g) The Contractor shall apply the FRP material in accordance with the approved submittal for the FRP system. Saturated fabric shall be pressed into the surface to achieve intimate contact. Entrapped air between layers shall be released or rolled without wrinkling of the fibers.
- (h) A misalignment of more than 12 mm per 300 mm will be rejected. Any fabric kinks, folds or severe waviness shall not be permitted. There shall be a minimum circumferential overlap of 300 mm between layers to ensure a full transfer of load through shear.
- (i) When multiple ply installation is required, the sequence and stacking shall follow the special instructions in the construction documents. Each ply shall be installed before the onset of complete gelation of the previous layer. Multiple plies can also be applied in several days and after the previous ply is cured, provided that the surface is roughened by sanding and is cleaned from dust and residue.
- (j) FRP layers shall be terminated in stages before the limit of the pipe sections to be rehabilitated. The full design thickness must be achieved no more than 50 mm from the joint.
- (k) Following the application of the FRP layers, a final epoxy coating in accordance with the manufacturer's recommendation shall be applied over the composite material to seal the surface. The thickness of the final epoxy layer shall be based on the design by the manufacturer.
- (l) The final seal coat shall be cured prior to putting the pipe back into service.

#### E13.6.7

##### Curing

- (a) All FRP areas shall be cured using the curing schedule recommended by the manufacturer. Curing times and methods shall be submitted and reviewed by the Contract Administrator prior commencing with installation.
- (b) The Installer's work schedule shall allow sufficient time between completion of repairs and placing the pipeline into service so that the FRP completes sufficient cure before being exposed to water based on the cure temperature versus time relationship provided by the manufacturer, unless adequacy of lesser percent cure is proven by test data.
- (c) The Contractor shall check the cure progress by performing hardness tests on the FRP system and based on the percent completion versus Barcol or Shore D hardness relationship provided by the manufacturer, and inform the Contractor Administrator.
- (d) Curing shall take place in a dry environment to prevent amine blush. If heating is used, direct-fired gas or kerosene heater shall not be permitted. Only electric or indirect-fired heaters shall be permitted.
- (e) Curing at elevated temperatures is strongly encouraged. This not only minimizes the risk of amine blush but reduces the required curing time and increases the glass transition temperature of the epoxy. Satisfactory performance of the curing schedules used shall be proven by the manufacturer with documentation of previous satisfactory applications or thermal test results indicating the curing behavior of the epoxy.
- (f) Exhaust fumes from vehicles or equipment shall be kept away from FRP applied areas during curing.

#### E13.6.8

##### Remediation

- (a) Small defects with a diameter between 12 mm and 100 mm will be repaired using low pressure epoxy injection, as long as the defect is local and does not extend through the complete thickness of the laminate. Small entrapped voids or surface discontinuities, smaller than 12 mm in diameter will not be considered defects
- (b) In the case of larger defects, the surrounding area, to an extent of at least 20 mm in all directions, will be carefully removed with a grinder. The area will be wiped, cleaned, and thoroughly dried prior to being repaired using patch material with the

same characteristics as the original laminate and extending at least 150 mm on all sides of the removed area.

- (c) If the final surface coating has areas with visible cracking, the local surface will be lightly sanded, and a new coating with appropriate primer will be applied, based on manufacturer's recommendations. The coating will extend at least 25 mm beyond the limit of the defect.
- (d) If the surface coating shows signs of blistering, the entire area with blisters, as well as the surrounding area to a distance of at least 300 mm, will be carefully sanded. In no case will a blistered surface be recoated without complete removal of the existing coating. The area will be wiped clean and then dried thoroughly. Once dry, the area can be re-coated following the application of the primer coat, if required by the manufacturer.

#### E13.6.9 Closures

- (a) At access shafts where FRP liners cannot practically provide a fully restored sewer invert and obvert the Contractor shall restore the existing host pipe as follows:
  - (i) Restore the invert up to the interface with cast-in-place concrete closure using a hand layup, bonded FRP liner.
  - (ii) The closure shall not result in a low spot or sump within the sewer.
  - (iii) Provide a smooth and level transition from liner to the closure location.
  - (iv) The obvert of the host pipe shall be restored with a cast in place concrete closure as shown on the Drawings and in accordance with E7. The cast-in-place concrete closure shall be formed from within the sewer to provide a smooth and level transition from the new liner.

#### E13.6.10 Reinstatement of Sewer Services

- (a) Reinstatement of all active and unable to determine sewer services including CB leads and utility drains to 100% of the original cross sectional area.
- (b) Cut out openings for sewer services from inside the lined sewer by manual means or with a television camera and a remote controlled cutting device.
- (c) Remove sharp edges from opening cut outs and provide a smooth rounded lip.
- (d) Sewer Service Grouting
  - (i) Grout sewer services to provide a smooth transition into the new host pipe without a loss of cross sectional area. Fill any voiding between the host pipe/liner and the sewer service.
  - (ii) Locations of additional sewer service grouting will be identified by the Contract Administrator during review of Post Lining Video Inspection.
  - (iii) Complete sewer service grouting in accordance with E10.
- (e) Ensure that all cut-outs for sewer connections are removed from the sewer and are prevented from being washed into the sewer system downstream of the repair location.

#### E13.7 Quality Assurance/Quality Control (Qa/Qc)

E13.7.1 Inspection, Evaluation and Acceptance of the installation shall generally follow guidelines as documented in Chapter 7 of ACI 440.2R.

#### E13.7.2 Onsite Quality Control Requirements:

- (a) The Contractor shall observe, monitor and document all phases of FRP application for compliance with the repair Drawings, specifications, and submitted procedures. Report all non-conformances to the Contract Administrator immediately, that prompt remedial action may be initiated.
- (b) All FRP composite applied areas shall be inspected in accordance with the manufacturer's specifications for voids, bubbles, and delaminations.



- (c) The Contractor shall provide a report signed by a Professional Engineer licensed to practice engineering in the Province of Manitoba, certifying that the installation is acceptable, complete with the testing reports and photographs.
- (d) The Contractor shall continually monitor and maintain complete construction record of the following:
- (e) Construction temperature and relative humidity (RH) in construction area during installation and curing
  - (i) Records of time of mixing of all primers, tack coats and fiber impregnating resins. Record final application times of all products and ensure that they are within the specified pot life parameters of the materials, at the temperature and RH of installation.
  - (ii) Monitor the mixing of all epoxy components for proper ratio and adherence to manufacturer's recommendations. Record batch numbers for fabric and epoxy used each day, and note locations of installation. Measure square footage of fabric and volume of epoxy used each day. Complete a project report and submit to the Contract Administrator and FRP composite system manufacturer at project completion.
  - (iii) Record all liner installations, including start and stop times of each pipe segment, installation crew, batch number records for all resins.
  - (iv) Submit and review quality control records with the Contract Administrator a minimum of twice per day. Note all deviations from installation and quality control plans and recommend any required remedial action.

#### E13.7.3

##### In-Situ Adhesion Tests

- (a) Direct tension adhesion testing of cored samples shall be conducted using the method described by ASTM D4541. The Contractor shall install one layer of FRP in a 600 mm by 600 mm area to be used as mock-ups of the installed FRP system in accordance with ASTM D4541. Prepare witness panels for testing, using same preparation, materials and construction techniques as used in construction. Cure panels in the same environment as construction works. The location shall be representative and selected jointly by the Contractor and the Contract Administrator and may be on adjacent non-repair pipe provided that surface preparation is the same as that to be used for the repair pipe. Mock-up shall be prepared on each type of concrete substrate or for each surface preparation technique used if variations in such conditions exist.
- (b) Prepare a minimum of one (1) mock-up areas per installation crew.
- (c) Pre-construction testing of mock-up panels shall be completed by the Contractor and submitted for review. Testing shall include a minimum of;
  - (i) Pull-off tests in accordance to ASTM D4541. A minimum of 3 test sets per crew shall be made. Minimum pull-off strength shall be 1380 kPa at the concrete interface. Pull-off tests of less than 1380 kPa that occur greater than 80% by area in the underlying concrete substrate may be acceptable provided a tight bond between the liner and substrate exists. Inter-laminar failures or failures at the concrete – liner interface are not acceptable.
  - (ii) Test tensile strength, modulus and ultimate strain in accordance to ACI 440.3R. Materials shall exhibit the minimum design properties specified and used in the design. A minimum of five (5) samples shall be taken from each witness panel.
  - (iii) All testing shall be completed in the presence of the Contract Administrator.

#### E13.7.4

##### Laboratory Testing

- (a) Sampling
  - (i) Record lot number of fabric and epoxy resin used, and location of installation. Measure square area of fabric and volume of epoxy used each day. Label each sample from each day's production.

- (ii) A "sample batch" shall consist of two 300 mm by 300 mm sample panels of cured composite. A minimum of two "sample batches" shall be made daily. The two "sample batches" will be taken at appropriate times during the day as to ensure the maximum material deviance in the components of the FRP composite as accepted by ICC AC 178.

(b) Preparation of Samples

- (i) Prepare sample on a smooth, flat, level surface covered with polyethylene sheeting, or 16 mil plastic film, prime with epoxy resin. Then place one-layer of saturated fabric and apply additional topping of epoxy. Cover with plastic film and squeegee out all bubbles.
- (ii) Samples shall be stored in a sample box and not moved for a minimum 48 hours after casting. The prepared, identified samples shall be given to a pre-approved and experienced testing agency. The testing agency shall be a qualified testing laboratory that is independent from the installer, capable of performing tests according to the ASTM standards. The laboratory shall then precondition samples for 48 hours at 60°C before testing.

E13.7.5 Laboratory Tension Tests

- (a) Testing specimens shall be cut from samples and tested for ultimate tensile strength, tensile modulus and percentage elongation as per ASTM D3039 in the longitudinal fiber direction.
- (b) Test a minimum of 15% of all samples as per ICC AC178. If one coupon fails, specimens from the same 300 mm x 300 mm sample will be tested. If these specimens also fail, the other 300 mm x 300 mm sample from the same "sample batch" will be tested. In the extreme case that this sample also fails, the remaining "sample batch" for that day will be tested and appropriate remediation shall be taken to ensure integrity of the system at locations from the failed "sample batch". In addition, 25% of the remaining samples shall be tested by the same criteria as per ICC AC178.
- (c) The results of the testing shall be carried out no later than two weeks after the completion of the FRP application and shall be supplied to the Contract Administrator within two weeks of laboratory testing.
- (d) FRP design values must be lower than the calculated mean determined from the test results received from the ASTM D3039 field test specimens. Acceptable minimum values for ultimate tensile strength, tensile modulus, and elongation shall not be below the submitted design values.
- (e) Any values below the submitted design values will require remediation.

E13.7.6 Post installation inspection of the pipe lining shall be completed in the presence of the Contract Administrator. The liner shall be inspected for defects and imperfections by visual and hammer tap surveys, including delamination from the concrete, inter layer delamination, bubbles, soft and uncured resins. Repair defects identified in the inspection by approved methods.

E13.8 Post Construction Design Review for Total Performance

- (a) The Contract Administrator will perform a post-construction design review to confirm that the completed FRP liner meets the 50 year design life structural requirements prior to issuance of Total Performance. The design review will utilize QA testing reports.
- (b) The Contract Administrator will advise of any discrepancies between the constructed FRP liner and the design requirements.
- (c) Defects in FRP liners will be reviewed on a case by case basis by the Contract Administrator. The Contract Administrator will consult with the Contractor and taking into account the condition of the host pipe prior to lining, the FRP installation conditions, and the long term use of the sewer to assess the structural and performance ramifications of the defects.

- (d) The Contractor shall:
- (i) Perform necessary remedial measures to confirm that a liner deemed as structurally deficient will comply with the 50 year design life requirement such as confirmation of actual ovality, determination of a more representative groundwater elevation locally through monitoring, and supplemental strength testing and thickness measurements.
  - (ii) Repair sections of FRP removed for supplemental testing by placing a full circumference internal point repair of the same thickness as the full segment liner over and extending 300 millimetres beyond each side of the cut section.
  - (iii) Install a supplemental FRP of the required thickness to structurally enhance the installed FRP liner if supplemental testing fails to confirm the FRP will meet the 50 year design life requirement.
  - (iv) Review remedial action with the Contract Administrator prior to implementation.
  - (v) Perform further testing, monitoring and calculations and install structural enhancements at own cost.

### E13.9 Measurement and Payment

#### E13.9.1 Bonded FRP Installation

- (a) Liner installation will be measured on a length basis for each size and paid for at the Contract Unit Price for "Supply and Installation of Structural Sewer Liner". Length to be paid for will be the total length of FRP supplied and installed in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Measurement will be made horizontally at grade, above the centreline of the pipe from centre to centre of manholes or termination of the liner where termination is not at a manhole location.
- (c) Payment for the supply and installation of FRP liners shall include but is not limited to the following:
  - (i) Verification of existing sewer dimensions;
  - (ii) Submittals, including: FRP designs, material samples, material testing, operations protocol, and construction protocol;
  - (iii) All required sewer preparation work;
  - (iv) Supply and installation of FRP liner;
  - (v) Test samples;
  - (vi) Quality control testing and records; and,
  - (vii) Any other materials and labour as specified herein.
- (d) Eighty (80) percent of the payment will be made upon satisfactory completion of the FRP installation work. The remaining twenty (20) percent of the payment will be made upon confirmation of the material strengths, delivery and acceptance of all required submissions, shop drawings, and reports, and rectification of all identified defects.
- (e) Where FRP liners are improperly installed due to negligence on the part of the Contractor, payment for the FRP liner will be withheld until the identified issues have been rectified.

#### E13.9.2 Reinstatement of Sewer Services

- (a) Reinstatement of sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Reinstatement of Sewer Services". Number of units to be paid for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Payment for sewer service reinstatement will occur after confirmation of sewer service reinstatement via review of the Post-Lining CCTV video. Payment will not be made until the Post-Lining inspection videos have been submitted and reviewed.

- E13.9.3 Quality Control Records
- (a) Preparation of quality control records shall be considered incidental to the liner installation and will not be measured for payment. No separate payment shall be made.

- E13.9.4 Quality Control Sampling and Testing
- (a) All work and materials required for the preparation, recovery, and repair of samples and liners for the purposes of quality control testing as specified herein shall be considered incidental to the FRP liner installation and will not be measured for payment. No separate payment shall be made.

## **E14. CENTRIFUGALLY CAST CONCRETE PIPE (CCCP)**

### **E14.1 Description**

- (a) This specification covers the supply and installation CCCP sewer liners.
- (b) CCCP sewer rehabilitation may be used for Partially Deteriorated host pipe conditions.

### **E14.2 References:**

- (a) ASTM C267 – Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes;
- (b) ASTM C469 – Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression; and,
- (c) CSA A23.2 – Test Methods and Standard Practices for Concrete.

### **E14.3 Approved Systems and Installers**

- (a) CentriPipe by AP/M Permaform or approved equal in accordance with B7.

### **E14.4 Submittals**

- E14.4.1 Installation of CCCP shall not commence prior to submission and review of the submissions identified herein by the Contract Administrator.

#### **E14.4.2 Design Submission and Shop Drawings**

- (a) Provide a design submission and shop drawings for review by the Contract Administrator in accordance with E3 a minimum of fifteen (15) Business Days prior to starting lining operations. Designs shall be completed by personnel experienced in the design of CCCP liners for gravity applications. Designs and all Shop Drawings shall be stamped by a Professional Engineer, registered to practice engineering in the Province of Manitoba. Temporary submissions to facilitate project schedule by Engineers with registration pending in the Province of Manitoba will be considered with the proviso that all final submissions shall be sealed by a Professional Engineer, registered to practice engineering in the Province of Manitoba. The design submission shall include the following:
  - (i) CCCP thickness computations including all specified design checks identified in E14.5. Identify design assumptions based on a review of the Sewer Maintenance Inspection that differ from the information provided in the Specifications for the existing sewer design conditions. Designs for each liner shall be submitted on separate calculation sheets;
  - (ii) Summary of design and loading conditions;
  - (iii) Estimated finished thickness;
  - (iv) Name and manufacturer of the cementitious liner material;
  - (v) Physical properties of the cementitious liner material in accordance with E14.8:
    - ◆ Compressive strength
    - ◆ Flexural strength

- ◆ Tensile strength
- ◆ Modulus of elasticity
- ◆ Stress vs. strain curves for all strength parameters
- (vi) Confirmation of durability of the liner design relative to the exposed service conditions;
- (vii) Calculations showing the hydraulic capacity of the CCCP lined sewer versus the existing sewer;
- (viii) Host pipe measurements identified in E9.2.1, including the following:
  - ◆ Sewer length
  - ◆ Host pipe dimensions
  - ◆ Sewer invert depths
- (ix) Other information that may reasonably be required by the Contract Administrator to confirm the CCCP design proposed conforms to the specified requirements and design intent.

#### E14.4.3 Detailed Liner Installation Procedure

- (a) The Contractor shall submit a detailed step-by-step procedure of all key liner preparation and installation activities and processes in accordance with E3 a minimum of ten (10) Business Days prior to starting lining operations. This procedure submission shall include as a minimum:
  - (i) Proposed main line and sewer service flow control arrangements in accordance with E7. Note, flow control plans may be submitted separate from the liner installation protocol.
  - (ii) Identification of any services and support required to complete installation.
  - (iii) List of equipment that will be available and used for the project.
  - (iv) Material handling, storage and disposal requirements for all raw materials and project waste.
  - (v) Details of pipeline preparation for acceptance of the liner, including procedures for:
    - ◆ Cleaning the pipe surfaces.
    - ◆ Repairing the pipe surfaces to satisfactory cross section or profile.
    - ◆ Creating and maintaining environmental conditions to facilitate installation of the liner.
  - (vi) Details of liner preparation and installation:
    - ◆ A sufficiently concise, detailed timeline listing all key steps in the preparation, transfer and installation of the liner. The level of detail provided shall be sufficient to facilitate “near-continuous monitoring of progress by the Contract Administrator or their representative during the course of the shutdown.
  - (vii) Estimated length of time required to reinstate the pipeline.

#### E14.4.4 Qa/Qc Plan

- (a) The Contractor shall submit a Quality Management Plan in accordance with E3 a minimum of ten (10) Business Days prior to starting lining operations. The Quality Management Plan shall consist of the following:
  - (i) Name and relevant experience of Quality Control Supervisors and staff that will be present on-site to perform the required quality control activities.
  - (ii) Example Quality Control Record forms to adequately document requirements of the Quality Assurance/ Quality Control section of this specification.
  - (iii) Proposed on site quality control testing program.
  - (iv) Proposed independent test laboratory and relevant certifications.

## E14.5 Design of CCCP Liners

### E14.5.1 Design Objectives

- (a) Maximizing the structural enhancement of the sewer by installing a CCCP liner.
- (b) Maintain or increase the hydraulic capacity of the rehabilitated sewer.
- (c) Reduce infiltration and exfiltration.
- (d) Prevent root intrusion.
- (e) Provide sufficient chemical resistance to prevent further sewer pipe degradation related to the conveyance of sewage.
- (f) Minimize disturbance to pavements and boulevards.
- (g) Minimize disruption to vehicular and pedestrian traffic.
- (h) Minimize the impact of construction on commercial, industrial, and institutional facilities.

### E14.5.2 General

- (a) Utilize materials with chemical and mechanical properties that are capable of providing a minimum design life of 50 years based on the waste stream present.
- (a) Long-term values for flexural modulus of elasticity, flexural strength, and tensile strength will be considered to be the projected value at 50 years of a continuous application of the design load based on the specific materials proposed for use. Physical properties shall be verified by an accredited testing agency.

### E14.5.3 Minimum Loading Assumptions:

- (a) Unless otherwise specified, the following parameters shall be used to determine the design pressures exerted on the exterior of the liner.
- (b) External hydrostatic and soil loads shall be calculated as specified herein using the following parameters:
  - (i) Unless otherwise specified, the groundwater table shall be assumed to be 2.0 m below the existing ground surface.
  - (ii) External hydrostatic pressure shall in all circumstances be calculated to the invert of the existing host pipe.
  - (iii) Calculate soil loads based on saturated soil unit weight of  $18.85 \text{ kN/m}^3$  ( $1922 \text{ kg/m}^3$ ).
  - (iv) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (c) Applied external soil loads shall be estimated using the total vertical and horizontal soil stresses applied at the centroid of the liners critical section. Soil pressures shall be estimated using the depth of soil at the centroid of the critical section and the saturated unit weight of the backfill soils.
- (d) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (e) The following live loads shall be included in the design:
  - (i) Sewers crossing beneath rail lines: Where identified, applied soil pressures from a Cooper E80 rail load shall be estimated and utilized in the design of the CIPP liner. Rail loads shall include a track allowance dead load of 297 kg/m. Applied rail loads at depth shall be calculated using the Boussinesq solution for distribution of soil stresses from surface point loads. Impact factors for rail loads shall be calculated in accordance with the AREMA Manual for Railway Engineering.
  - (ii) All other sewers: The applied soil pressures from an AASHTO HS 25 design truck unless a higher or lower value is indicated in the contract specifications shall be estimated and utilized in the design of the CIPP liner. Applied soil

pressures from AASHTO design truck loads shall be estimated in accordance with AASHTO LRFD Bridge Design Specifications, Seventh Edition (2014).

- (f) Unless otherwise specified, applied soil pressures at depth caused by superimposed surface loads shall be calculated using the Boussinesq solution for distribution of stresses from surface point loads.
- (g) The following external groundwater pressure shall be used in the design of partially deteriorated liners. The pressures are based on the following sewer invert depths and relates to pressure at invert of the liner:
  - (i) Higgins Ave (6.40 m): 0.0431 MPa
  - (ii) Dawson Road (8.20 m): 0.0608 MPa
- (h) Any changes to the sewer invert depths based on field investigations must be relayed to the Contract Administrator and appropriate adjustments made to the design pressures.

#### E14.5.4 Hydraulic Design Checks

- (a) Perform a design check to confirm that the full flow hydraulic capacity of the FRP will be equal to or greater than the existing sewer. Use "Manning's" formula with assumed 'n' value of 0.015 for the CCCP and the following 'n' values for the existing sewers:
  - (i) Higgins Ave – 0.019
  - (ii) Dawson Road – 0.025
- (b) Alternatively to the use of the Manning's formula, the Colebrook-White equation may be used to assess full flow hydraulic capacity. Perform a design check to confirm the full flow hydraulic capacity of the CCCP liner is equal to or greater than the existing sewer. Use the "Colebrook-White" formula with assumed "ks" value of 0.60 mm for the FRP. The "ks" value for the existing sewer may be estimated based on observed condition of the pipeline using Tables C.1 (a) and (b) of Volume I, Appendix C – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition. The following ks values may be assumed for the existing sewers:
  - (i) Higgins Ave – 15 mm
  - (ii) Dawson Road – 60 mm

#### E14.5.5 Existing Sewer Design Conditions

- (a) The assessment of the liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed as part of the City of Winnipeg's Sewer Inspection Program. Copies of these video inspections are available to the Contractor upon request in accordance with E10.3.1.
- (b) The site specific repair requirements applicable for each lining location can be found in E10.
- (c) The following design conditions are applicable:
  - (i) Higgins Ave – Fully Deteriorated Design
  - (ii) Dawson Road – Partially Deteriorated Design

#### E14.5.6 Non-Circular Design

- (a) Undertake CCCP design in accordance with CentriPipe Engineering Design Guide Version 3.0 and supplemental design information published in CentriPipe Technical Bulletin No. 4.
- (b) Designs shall include the following minimum design checks:
  - (i) Long term tensile, compressive, and shear capacity check due to external pressures identified herein.
  - (ii) Long term buckling/deformation checks due to hydrostatic pressures identified herein.

- (c) Liner resistance to external hydrostatic stress shall be designed as an independent structure without the need for bonding with the host pipe. Design may account for buckling confinement provided by the host pipe.
- (d) Third party verified material properties shall be used in design.
- (e) Liners shall not be allowed to crack under design hydrostatic pressure and deflections shall be limited to maintain strain values below the strain capacity of the cementitious liner material.
- (f) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressures.
- (g) Design checks shall be undertaken with applied loads on the following critical sections as a minimum where  $h$  = the internal height of the liner and  $w$  = the internal width of the liner.
  - (i) Horizontal Section:
    - ◆ Crown of pipe
  - (ii) Vertical Section:
    - ◆ Length for 3:2 egg sewers:  $2h/3$
    - ◆ Length for 4:3 egg sewers:  $3h/4$
    - ◆ Orientation: Vertical
    - ◆ Centroid location: Length/2 from invert
- (h) Minimum CCCP thickness: 25 mm

#### E14.6 Materials

##### E14.6.1 Centrifugally applied cementitious liner material:

- (a) Liner material shall consist of fine aggregate concrete composite material design for use with centrifugal applications and meeting the following minimum characteristics measured in accordance with E14.8:
  - (i) 24 hr Compressive Strength: 27 MPa (4000 psi)
  - (ii) 28 day Compressive Strength: 55 MPa (8000 psi)
  - (iii) 28 day Flexural Strength: 9 MPa (1340 psi)
  - (iv) Tensile Strength: 5.5 MPa (800 psi)
- (b) Sulphate resistance: No damage after 30 days with a 5% solution of  $H_2SO_4$  when tested in accordance with ASTM C267.
- (c) Liner material may incorporate steel or synthetic reinforcing fibres as required to achieve design tensile strengths.
- (d) Cementitious liner material shall incorporate protection against hydrogen sulfide gas related deterioration. Approved product: ConShield or approved equal in accordance with B7.
- (e) Approved Product: Permacast PL-8000 and PL-12000 w/ Crystal-X as manufactured by AP/M Permaform or approved equal in accordance with B7.

#### E14.7 Construction Methods

##### E14.7.1 Verification of Existing Sewer Dimensions

- (a) Verify dimensional requirements of each sewer to be rehabilitated prior to design in accordance with E9.2.1.

##### E14.7.2 Surface Preparation:

- (a) Prepare the concrete surface per the manufacturer's recommendations, E10.3, and as specified herein. Surface preparation shall promote continuous intimate contact between the CCCP and concrete by providing a clean, uniform surface.



- (b) The host pipe shall be thoroughly cleaned using water jetting or other acceptable methods prior to lining in accordance with WRC, Sewerage Rehabilitation Manual, Section 9.2.3. The host pipe shall be free of organic materials, biological slim, roots, soft encrustation, and grease.
- (c) All voiding and holes in the host pipe shall be filled and repaired with a competent cementitious material compatible with the host pipe and lining material to form a uniform and consistent substrate for application of the CCCP. Discontinuities in the host pipe shall be repaired and shaped to match the design cross section of the liner.
- (d) Any repairs to the host pipe shall be completed with a competent cementitious material compatible with the host pipe, grout, and liner. Repairs shall not compromise the intended structural behaviour or performance of the rehabilitated structure.
- (e) All leakage and infiltration shall be sealed prior to lining.

#### E14.7.3

##### Application:

- (a) The CCCP liner shall be installed in accordance with manufacturer's recommendations and as specified herein.
- (b) Application of the cementitious liner shall not commence until the host pipe has been inspected by the Contract Administrator.
- (c) The pipe shall be completely dewatered and free of debris, sewage, and other foreign material.
- (d) Services shall not be permitted to flow into the host pipe during the lining operation.
- (e) The sprayer head shall be centered in the pipe (circular host pipes) or positioned to provide as equal distribution as possible within non-circular pipes.
- (f) Design thicknesses shall be measured from the highest point on the host pipe in accordance with E14.8.2 and in a location with the lowest level of material placement (furthest from the sprayer head). CCCP material applied to fill holes and voids will not be considered part of the liner.
- (g) Transitions to the host pipe shall be tapered. Where liner thickness is greater than 50 mm, transitions shall be constructed in accordance with E12.8.3 using materials compatible with the CCCP liner or meeting the requirements of E12.8.3.

#### E14.7.4

##### Closures

- (a) At access shafts where CCCP liners cannot practically provide a fully restored sewer invert and obvert the Contractor shall restore the existing host pipe as follows:
  - (i) Restore the invert up to the interface with cast-in-place concrete closure using an approved cementitious repair product consistent with the CCCP liner or in accordance with E12.5.3.
  - (ii) Invert restoration shall be completed in accordance with the product manufacturer's recommendations with flow control measures in place and shall be permitted to cure sufficiently prior to exposure to sewage. The closure shall be constructed to a thickness equaling the thickness of the liner. The closure shall not result in a low spot or sump within the sewer.
  - (iii) Provide a smooth and level transition from liner to the closure location.
  - (iv) The obvert of the host pipe shall be restored with a cast in place concrete closure as shown on the Drawings and in accordance with E7. The cast-in-place concrete closure shall be formed from within the sewer to provide a smooth and level transition from the new liner.

#### E14.7.5

##### Reinstatement of Sewer Services

- (a) Reinstatement all active and unable to determine sewer services including CB leads and utility drains to 100% of the original cross sectional area.
- (b) Remove sharp edges from opening cut outs and provide a smooth rounded lip.

- (c) Sewer Service Grouting
  - (i) Grout sewer services to provide a smooth transition into the new host pipe without a loss of cross sectional area. Fill any voiding between the host pipe/liner and the sewer service.
  - (ii) Locations of additional sewer service grouting will be identified by the Contract Administrator during review of Post Lining Video Inspection.
  - (iii) Complete sewer service grouting in accordance with E10.

#### E14.8 Quality Assurance/Quality Control (Qa/Qc)

E14.8.1 Quality control for cementitious lining materials shall conform to CSA A23.2, except as modified herein:

- (a) Confirm the slump or viscosity (as appropriate) of the liner material a minimum of once per production run, for every 25 m<sup>3</sup>, or once per 30 minutes, whichever is more frequent. The intent is to ensure conformance with the submitted material properties.
  - (i) Slump Tests shall conform to CSA A23.2-5C.
  - (ii) Viscosity tests shall conform to CSA A23.2-1B.
- (b) Confirm the density of the plastic liner material in accordance with CSA A23.2-6C. Density shall be measured and recorded once per production run, for every 25 m<sup>3</sup>, or once per 30 minutes, whichever is more frequent. The density shall be maintained within +/- 10 % of the design density.
- (c) Prepare and test quality control samples for compressive strength and density in accordance with CSA A23.2-1B. Prepare a minimum of four (4) test cubes for each production run, or every 25 m<sup>3</sup>, whichever is more frequent. The Contractor shall arrange to have test cubes tested at an approved testing facility in accordance with CSA A23.2-1B. Two (2) samples shall be tested at 24 hours and Two (2) samples shall be tested at 28 days to confirm compressive strengths.
- (d) Prepare and test quality control samples for flexural strength in accordance with CSA A23.2-8C. Prepare a minimum of two (2) samples for each production run, or every 25 m<sup>3</sup>, whichever is more frequent. The Contractor shall arrange to have samples tested at an approved testing facility in accordance with CSA A23.2-8C.
- (e) Prepare and test quality control samples for tensile strength in accordance with CSA A23.2-13C. Prepare a minimum of two (2) test cylinders for each production run, or every 25 m<sup>3</sup>, whichever is more frequent. The Contractor shall arrange to have cylinders tested at an approved testing facility in accordance with CSA A23.2-13C.
- (f) Prepare and test quality control samples for modulus of elasticity in accordance with ASTM C469. Prepare a minimum of two (2) test cylinders for each production run, or every 25 m<sup>3</sup>, whichever is more frequent. The Contractor shall arrange to have cylinders tested at an approved testing facility in accordance with ASTM C469.
- (g) Where steel or synthetic fibres are utilised the fibre content shall be determined in accordance with CSA 23.2-16C. Tests for fibre content shall be completed for each production run, or every 25 m<sup>3</sup>, whichever is more frequent.
- (h) Where bond with the host pipe is required for structural performance, the bond and shear strength shall be tested in accordance with CSA A23.2-6B. A minimum of one bond test shall be completed per liner.

E14.8.2 Confirmation of CCCP thickness shall include the following minimum checks:

- (a) Gauges (consisting of guide strips or wires) shall be utilized to confirm the thickness of the CCCP liner. Gauges shall be placed at the invert, springline, and obvert of the pipe a minimum of every 5 m.
- (b) A minimum of one core shall be completed per liner to confirm placed liner thickness. Cores shall be completed and measured in the presence of the Contract Administrator.

E14.8.3 Quality Control Records

- (a) Maintain the following Quality Control records of the work including all testing identified herein and provide to the Contract Administrator after completion of the work.

E14.8.4 Post installation inspection of the pipe lining shall be completed in the presence of the Contract Administrator. The liner shall be inspected for defects and imperfections by visual and hammer tap surveys, including delamination from the host pipe, this spots. Repair defects identified in the inspection by approved methods.

E14.9 Post Construction Design Review for Total Performance

- (a) The Contract Administrator will perform a post-construction design review to confirm that the completed CCCP liner meets the 50 year design life structural requirements prior to issuance of Total Performance. The design review will utilize QA testing reports.
- (b) The Contract Administrator will advise of any discrepancies between the constructed CCCP liner and the design requirements.
- (c) Defects in CCCP liners will be reviewed on a case by case basis by the Contract Administrator. The Contract Administrator will consult with the Contractor and taking into account the condition of the host pipe prior to lining, the CCCP installation conditions, and the long term use of the sewer to assess the structural and performance ramifications of the defects.
- (d) The Contractor shall:
  - (i) Perform necessary remedial measures to confirm that a liner deemed as structurally deficient will comply with the 50 year design life requirement such as confirmation of actual ovality, determination of a more representative groundwater elevation locally through monitoring, and supplemental strength testing and thickness measurements.
  - (ii) Repair sections of CCCP removed for supplemental testing by patching with a cementitious material compatible with the liner.
  - (iii) Install a supplemental CCCP of the required thickness to structurally enhance the installed CCCP liner if supplemental testing fails to confirm the CCCP will meet the 50 year design life requirement.
  - (iv) Review remedial action with the Contract Administrator prior to implementation.
  - (v) Perform further testing, monitoring and calculations and install structural enhancements at own cost.

E14.10 Measurement and Payment

E14.10.1 CCCP Installation

- (a) Liner installation will be measured on a length basis for each size and paid for at the Contract Unit Price for "Supply and Installation of Structural Sewer Liner". Length to be paid for will be the total length of CCCP supplied and installed in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Measurement will be made horizontally at grade, above the centreline of the pipe from centre to centre of manholes or termination of the liner where termination is not at a manhole location.
- (c) Payment for the supply and installation of CCCP liners shall include but is not limited to the following:
  - (i) Verification of existing sewer dimensions;
  - (ii) Submittals, including: CCCP designs, material samples, material testing, operations protocol, and construction protocol;
  - (iii) All required sewer preparation work;
  - (iv) Supply and installation of CCCP liner;

- (v) Quality control testing and records; and
- (vi) Any other materials and labour as specified herein.

- (d) Eighty (80) percent of the payment will be made upon satisfactory completion of the CCCP installation work. The remaining twenty (20) percent of the payment will be made upon confirmation of the material strengths, delivery and acceptance of all required submissions, shop drawings, and reports, and rectification of all identified defects.

#### E14.10.2 Reinstatement of Sewer Services

- (a) Reinstatement of sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Reinstatement of Sewer Services". Number of units to be paid for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Payment for sewer service reinstatement will occur after confirmation of sewer service reinstatement via review of the Post-Lining CCTV video. Payment will not be made until the Post-Lining inspection videos have been submitted and reviewed.

#### E14.10.3 Quality Control Records

- (a) Preparation of quality control records shall be considered incidental to the liner installation and will not be measured for payment. No separate payment shall be made.

#### E14.10.4 Quality Control Sampling and Testing

- (a) All work and materials required for the preparation, recovery, and repair of samples and liners for the purposes of quality control testing as specified herein shall be considered incidental to the FRP liner installation and will not be measured for payment. No separate payment shall be made.

### **E15. SPIRAL WOUND PVC STRIP LINING**

#### E15.1 Description

- (a) This Specification shall govern the supply and installation of spiral wound PVC strip liners.
- (b) Spiral wound PVC strip liners may be used for Partially Deteriorated host pipe conditions only.

#### E15.2 References:

- (a) ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials;
- (b) ASTM D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds;
- (c) ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings;
- (d) ASTM D2152 - Standard Test Method for Adequacy of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion;
- (e) ASTM D2990 – Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep Rupture of Plastics;
- (f) ASTM F1697 – Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Strip for Machine Spiral Wound Liner Pipe Rehabilitation of Existing Sewers and Conduit;
- (g) ASTM F1698 – Standard Practice for Installation of Poly(Vinyl Chloride) (PVC) Profile Strip Liner and cementitious Grout for Rehabilitation of Existing Man-Entry Sewers and Conduits;
- (h) ASTM F1735 – Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Strip for Rehabilitation of Existing Man-Entry Sewers and Conduits;

- (i) ASTM F1741 – Standard Practice for Installation of Machine Spiral Wound Poly(Vinyl Chloride) (PVC) Liner Pipe for Rehabilitation of Existing Sewers and Conduits;
- (j) ACI 229 – Report on Controlled Low-Strength Materials; and,
- (k) CSA A23.2 – Test Methods and Standard Practices for Concrete.

### E15.3 Submittals

E15.3.1 Installation of spiral wound PVC strip liners shall not commence prior to submission and review of the submissions identified herein by the Contract Administrator.

E15.3.2 Provide PVC liner designs for review by the Contract Administrator in accordance with E3 a minimum of fifteen (15) Business Days prior to undertaking installation of the . PVC liner shop drawings shall including the following information and shall be sealed and signed by a Professional Engineer, registered in the Province of Manitoba and experienced in the design of trenchless rehabilitation systems. Temporary submissions to facilitate project schedule by Engineers with registration pending in the Province of Manitoba will be considered with the proviso that all final submissions shall be sealed by a Professional Engineer, registered to practice engineering in the Province of Manitoba. GRP designs shall include the following:

- (a) Structural computations including all specified design checks identified in E15.4. Identify design assumptions based on a review of the Sewer Maintenance Inspection that differ from the information provided in the Specifications for the existing sewer design conditions. Design submissions shall include all calculations and shall be submitted on individual calculation sheets for each liner;
- (b) Name and manufacturer of the PVC strip liner;
- (c) Shop drawings clearly showing the PVC liner section, joint details, steel reinforcing (if used), and PVC/grout/host pipe structure.
- (d) PVC liner material properties used for design. Include all relevant testing information stipulated herein to confirm long term material properties used in design;
- (e) Grout mix design and relevant constituent properties for the grout mixture;
- (f) Liner blocking arrangement as it relates to short term buckling design checks;
- (g) Calculations showing the hydraulic capacity of the lined sewer versus the existing sewer;
- (h) Host pipe measurements identified in E9.2.1, including the following:
  - (i) Sewer length;
  - (ii) Host pipe dimensions;
  - (iii) PVC liner dimensions; and,
  - (iv) Sewer invert depths.
- (i) Other information that may reasonably be required by the Contract Administrator to confirm the PVC design proposed conforms to the specified requirements and design intent.

E15.3.3 Where bonding with the grouted annulus or host pipe is required for structural capacity of the liner, submit demonstration test results a minimum of five (5) Business Days prior to commencement of lining work.

E15.3.4 Submit a construction protocol that provides information on the following a minimum of ten (10) Business Days prior to commencement of lining work. The construction protocol shall include the following:

- (a) Proposed main line and sewer service flow control arrangements in accordance with E7. Note, flow control plans may be submitted separate from the liner installation protocol.
- (b) Liner construction arrangement, including spool placement, direction of installation, access locations, assembly details, and blocking arrangements;

- (c) Bulkhead construction for grouting;
- (d) Construction methods for tapered transitions; and,
- (e) Detailed implementation schedule for liner installation, annulus grouting, service reinstatement, and terminations.

E15.3.5 Submit a grouting protocol that provides information on the following a minimum of five (5) Business Days prior to commencement of liner installation. The grouting protocol shall include the following:

- (a) Grout sample testing results in accordance with E12.6.1.
- (b) Minimum and maximum grouting pressures as confirmed by submitted design calculations;
- (c) maximum allowable liner deflection/deformation as confirmed by submitted design calculations;
- (d) quality assurance and quality control program to verify grout physical characteristics;
- (e) grout supplier;
- (f) grouting equipment; and,
- (g) grouting procedures, including injection points, grout lift heights, means of confirming grout placement and complete filling of the annular space.

#### E15.4 PVC Liner Design

##### E15.4.1 Design Objectives.

- (a) Maximizing the structural enhancement of the sewer by installing a structural section of sufficient quality and sufficient strength to address all relevant loading conditions and preclude further sewer deterioration.
- (b) Minimizing the hydraulic capacity impact of rehabilitation by maximizing the bore of the rehabilitated sewer.
- (c) Reducing infiltration and exfiltration that may compromise long term structural stability of the pipe.
- (d) Preventing root intrusion.
- (e) Providing sufficient chemical resistance to prevent sewer pipe degradation related to the conveyance of storm water or sewage.
- (f) Minimizing sewer service disruption during the rehabilitation process.
- (g) Minimizing the time required to complete the sewer rehabilitation.
- (h) Minimizing disturbance to pavements and boulevards.
- (i) Minimizing disruption to vehicular and pedestrian traffic.
- (j) Minimizing the impact of construction on commercial, industrial, and institutional facilities.

##### E15.4.2 General

- (a) Utilize materials with chemical and mechanical properties that are capable of providing a minimum design life of 50 years based on the waste stream present.
- (b) Long-term values for flexural modulus of elasticity, tensile strength, and flexural strength will be considered to be the projected value at 50 years of a continuous application of the design load based on the specific product. Verified long and short term values for flexural modulus, long term flexural strain (measured in the hood direction), long term tensile strength, and shear bond strength, all tested in accordance with E15.6.1. The Contractor shall provide supporting short and long term test data.
- (c) Design PVC liners using design methods submitted and reviewed by the Contract administrator meeting the requirements of E15.4.6.

- (d) Size PVC liners in accordance with the design objectives to minimize annulus size and to maximise hydraulic capacity; with due consideration to meet reasonable constructability considerations.

#### E15.4.3 Minimum Loading Assumptions:

- (a) Unless otherwise specified, the following parameters shall be used to determine the design pressures exerted on the exterior of the liner.
- (b) External hydrostatic and soil loads shall be calculated as specified herein using the following parameters:
  - (i) Unless otherwise specified, the groundwater table shall be assumed to be 2.0 m below the existing ground surface.
  - (ii) External hydrostatic pressure shall in all circumstances be calculated to the invert of the existing host pipe.
  - (iii) Calculate soil loads based on saturated soil unit weight of  $18.85 \text{ kN/m}^3$  ( $1922 \text{ kg/m}^3$ ).
  - (iv) A lateral earth pressure coefficient (K) of 0.33 shall be used to calculate pressures applied to vertical critical sections.
- (c) The following live loads shall be included in the design:
  - (i) Sewers crossing beneath rail lines: Where identified, applied soil pressures from a Cooper E80 rail load shall be estimated and utilized in the design of the CIPP liner. Rail loads shall include a track allowance dead load of 297 kg/m. Applied rail loads at depth shall be calculated using the Boussinesq solution for distribution of soil stresses from surface point loads. Impact factors for rail loads shall be calculated in accordance with the AREMA Manual for Railway Engineering.
  - (ii) All other sewers: The applied soil pressures from an AASHTO HS 25 design truck unless a higher or lower value is indicated in the contract specifications shall be estimated and utilized in the design of the CIPP liner. Applied soil pressures from AASHTO design truck loads shall be estimated in accordance with AASHTO LRFD Bridge Design Specifications, Seventh Edition (2014).
- (d) Unless otherwise specified, applied soil pressures at depth caused by superimposed surface loads shall be calculated using the Boussinesq solution for distribution of stresses from surface point loads.
- (e) The following external groundwater pressure shall be used in the design of partially deteriorated liners. The pressures are based on the following sewer invert depths and relates to pressure at invert of the liner:
  - (i) Higgins Ave (6.40 m): 0.0431 MPa
  - (ii) Dawson Road (8.20 m): 0.0608 MPa
- (f) Any changes to the sewer invert depths based on field investigations must be relayed to the Contract Administrator and appropriate adjustments made to the design pressures.

#### E15.4.4 Hydraulic Design Checks:

- (a) Perform a design check to confirm that the full flow hydraulic capacity of the PVC will be equal to or greater than the existing sewer. Use "Manning's" formula with assumed 'n' value of 0.011 for the PVC and the following 'n' values for the existing sewers:
  - (i) Higgins Ave – 0.019
  - (ii) Dawson Road – 0.025
- (b) Alternatively to the use of the Manning's formula, the Colebrook-White equation may be used to assess full flow hydraulic capacity. Perform a design check to confirm the full flow hydraulic capacity of the PVC liner is equal to or greater than the existing sewer. Use the "Colebrook-White" formula with assumed "ks" value of 0.03 mm for the GRP. The "ks" value for the existing sewer may be estimated based on observed condition of the pipeline using Tables C.1 (a) and (b) of Volume I, Appendix C –

Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition. The following ks values may be assumed for the existing sewers:

- (i) Higgins Ave – 15 mm
- (ii) Dawson Road – 60 mm

#### E15.4.5 Existing Sewer Design Conditions

- (a) The assessment of the liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed as part of the City of Winnipeg's Sewer Inspection Program. Copies of these video inspections are available to the Contractor upon request in accordance with E10.3.1.
- (b) The site specific repair requirements applicable for each lining location can be found in E10.
- (c) The following design conditions are applicable:
  - (i) Higgins Ave – Fully Deteriorated Design
  - (ii) Dawson Road – Partially Deteriorated Design

#### E15.4.6 Non-Circular Design - Partially Deteriorated Condition

- (a) Liners designated as partially deteriorated shall be designed to accommodate hydrostatic groundwater conditions only. External soil (dead) and live loads need not be considered.
- (b) The following minimum design checks shall be undertaken:
  - (i) The liners shall be checked for short term flexural stress, deformation, and buckling checks due to grouting operation; and,
  - (ii) Long term flexural stress, deformation, and buckling checks due to external hydrostatic pressure.
- (c) Design checks shall incorporate and meet the following requirements:
  - (i) Minimum factor of safety of 2 against exceeding long term allowable stress levels within the liner material
  - (ii) Minimum factor of safety of 2 against exceeding long term shear strength and mechanical bonding values.
  - (iii) Maximum deflection of 3% across the critical section.
  - (iv) Where considered, the existing trunk sewers shall be assumed to have a wall thickness equal to 200 mm or greater.
  - (v) External pressures due to grouting shall be based on installers proposed construction protocol/method statement.
- (d) Design of the sewer shall consider the following minimum critical sections. Design checks shall be undertaken with applied loads on the following critical sections where  $h$  = the internal height of the liner and  $w$  = the internal width of the liner.
  - (i) Egg shaped sewers:
    - ◆ Length for 3:2 egg sewers:  $2h/3$
    - ◆ Length for 4:3 egg sewers:  $3h/4$
    - ◆ Orientation = Vertical
    - ◆ Centroid location = Length/2 from invert
- (e) The use of ASTM F1741, Appendix X1 design methods alone will not be considered sufficient for the design of non-circular sewers. Notwithstanding, the use of ASTM F1741, Appendix X1 design calculations will be permitted for checking sufficiently curved critical sections, where the circular liner calculations are applicable.



## E15.5 Materials

### E15.5.1 PVC Strip Liner

- (a) PVC strip liner products and constituent materials shall conform to ASTM F1697 or ASTM F1735.
- (b) PVC materials shall conform to minimum cell classifications specified in ASTM F1697 or ASTM F1735 in accordance with ASTM F1784.
- (c) PVC joints shall be designed and assembled in such a way to create a water tight seal capable of withstanding internal and external hydrostatic pressure based on site conditions. For the purposes of joint design, assume internal and external water levels at ground surface.
- (d) PVC liners shall meet the greater of the mechanical properties outlined in ASTM F1697 and F1735 or project specific design requirements both in accordance with E15.6.1. The manufacturer shall demonstrate type testing results to confirm conformance with both the ASTM specifications and production run testing. Type testing shall be required for confirmation of all short and long term properties, while production run tests are also required to substantiate short term properties for short term flexural modulus and strength.
- (e) Where bonding (shear or otherwise) is required as part of the design the Contractor shall demonstrate adequate bonding through demonstration and type testing in accordance with E15.6.3.
- (f) Approved Manufacturers:
  - (i) Sekisui SPR Americas
  - (ii) Danby (Sancon Inc.); or,
  - (iii) approved equal in accordance with B7.

### E15.5.2 Annular Grout

- (a) The proposed annular grout shall have material properties that permit grouting to occur without voiding within the annulus and has sufficient mechanical properties to achieve the desired structural intent where Type 1 liners are proposed.
- (b) Grouts shall conform to the requirements of ACI 229.
- (c) Grout parameters and mechanical properties shall be provided through demonstration testing in accordance with E12.6.1.

### E15.5.3 Transitions

- (a) Transitions shall be completed using a polymer concrete grout compatible with the liner and grouting materials.
- (b) Approved products:
  - (i) Sikatop 123 as manufactured by Sika Canada Inc., or
  - (ii) approved equal in accordance with B7.

## E15.6 Quality Control/Quality Assurance (Qc/Qa) and Testing

### E15.6.1 The following testing shall be completed for the proposed PVC strip liner products in accordance with ASTM F1697 and ASTM F1735 and as modified herein:

- (a) Constituent PVC material properties in accordance with ASTM D1784 to confirm material properties of Table 1 of ASTM D1784. A minimum of one set of tests shall be performed per resin lot or production run, whichever is more frequent;
- (b) Long term material properties including, tensile strength and modulus of elasticity in accordance with ASTM D2990. Historical testing data for PVC resin classifications proposed in production run will be acceptable.
- (c) Width, height, and wall thickness measurements in accordance with ASTM D2122. A minimum of one set of measurements shall be performed from the production run for each proposed profile;

- (d) Stiffness and tangent modulus of elasticity in accordance with ASTM D790. A minimum of one set of measurements shall be performed from the production run for each proposed profile;
- (e) Extrusion quality in accordance with ASTM D2152. A minimum of one set of tests shall be performed per resin lot or production run, whichever is more frequent;

E15.6.2 Quality control for cementitious grouting materials shall conform to CSA A23.2, except as modified herein:

- (a) Confirm the viscosity of the grout mixture in accordance with CSA A23.2, Test Method 1B to ensure conformance with the submitted grouting plan and shear bond tests. Flow properties of grout shall be checked a minimum of once per production run, for every 25 m<sup>3</sup>, or once per 30 minutes, whichever is more frequent.
- (b) Confirm the density of the grout mixture in accordance with CSA A23.2, Test Method 6C. Grout density shall be measured and recorded once per production run, for every 25 m<sup>3</sup>, or once per 30 minutes, whichever is more frequent. The density shall be maintained within +/- 10 % of the design density.
- (c) Prepare and test quality control samples for compressive strength and density in accordance with CSA A23.2, Test Method 1B. Prepare a minimum of two (2) test cubes for each production run, or every 25 m<sup>3</sup>, whichever is more frequent. The Contractor shall arrange to have test cubes tested at an approved testing facility in accordance with CSA A23.2, Test Method 1B.

E15.6.3 Bond Testing

- (a) Bond testing (including shear of pull off testing) is required for any liner design which relies on bonding with the grout structure. The intent of bond testing is to verify the bond values used in the liner design and shall be completed in accordance with testing methods submitted and reviewed by the Contract Administrator.
- (b) Shear bond testing shall be completed using test methods analogues to the methods outlined in Appendix D of IGN-4-34-02.
- (c) Mechanical pullout testing shall be completed using methods analogues to the intended installation condition of the liner and replicate the liner's ability to restrain the liner from external hydrostatic stress.
- (d) One set of bond testing for each combination of grout and liner product is required.
- (e) Test samples shall be cast with the same grout mix and constituent materials as those proposed in the grouting submission. The grout mixture used for the shear bond testing shall be tested in accordance with E15.6.1 and results included in the bond testing report.
- (f) A bond testing report shall be prepared and submitted to the Contract Administrator in accordance with E15.3.3.
- (g) Where inconsistencies are present with the proposed grout, the grout used for the bond testing, or the quality control tests completed in the field the Contract Administrator may require bond samples to be cast during the grouting operation or cores taken for the purposes of bond testing.
- (h) Accepted Testing Facilities:
  - (i) The Contractor shall provide a facility for completion of required bond testing for review by the Contract Administrator.

E15.6.4 Quality Control Records

- (a) Maintain the following Quality Control records of the work and provide to the Contract Administrator after completion of the work.
  - (i) Summary of the PVC manufacturing records, including:
    - ◆ All QA/QC testing carried out in accordance with ASTM F1697 and ASTM F1735; and,

- ◆ A certificate of compliance in accordance with ASTM F1697 and ASTM F1735.
- (ii) A grouting summary including all QA testing reports identified herein; and,
- (iii) Results of any additional bond testing.

#### E15.7 Sewer Preparation

E15.7.1 Sewers shall be prepared for lining in accordance with E10.3.

E15.7.2 Infiltration shall be stopped or reduced to the level required to successfully complete the grouting operations.

#### E15.8 Installation of PVC Strip Liners

##### E15.8.1 PVC Strip Liner Installation.

- (a) Install PVC strip liners in accordance with approved installation protocol submission.
- (b) Profile of alignment shall be offset to invert of pipe to as great a degree as possible leaving largest annulus at crown.
- (c) Securely fasten panels in-place to facilitate construction and sufficiently to assure that panels are not displaced during grouting operations. Ensure that temporary support system minimizes point loads and other features that may cause damage to PVC liner during grouting operations.
- (d) The contractor shall take every effort to prevent the accumulation of debris and sewage between the liner and the host pipe. Sewer services shall not be permitted to discharge into the annulus at any time.

##### E15.8.2 Annulus Grouting

- (a) Where bond with the grout or host pipe is required, all debris and contaminants between the liner and the host pipe shall be removed via flushing or other acceptable methods prior to grouting.
- (b) Carry out annulus grouting in accordance with approved grouting protocol submission. Monitor the liner during grouting operations to ensure short-term deflections do not exceed the allowable maximums and that the liner is not displaced during grouting operations.
- (c) The Contractor is responsible for confirming that annulus is fully grouted.
- (d) Temporary wooden plugs may be used to plug grouting ports during grouting. Upon completion, the holes shall be repaired using one of the following:
  - (i) A resin-rich repair product such as an epoxy based repair system that is compatible with the liner system and specifically designed for the nature, size and thickness of the patch being repaired to form a smooth watertight patch flush with liner; or,
  - (ii) Fused PVC repair.
- (e) General grouting requirements:
  - (i) Estimate the volume of grout required, including an overfill allowance based on grout properties, sewer geometry and condition, and previous experience with grout mixture;
  - (ii) By-pass or pump through any sewer flows that occur during grouting operations;
  - (iii) Minimize infiltration (or its effects) to the extent required to successfully complete the grouting operations;
  - (iv) Inject from the downstream end of the renovated section;
  - (v) Inject from the invert towards the crown;
  - (vi) Provide air vents at the high points;
  - (vii) Monitor and record the injection pressures;

- (viii) Inspect the lining for signs of distortion or flotation;
  - (ix) Monitor and record the volume of grout injected and compare with the estimate (with due consideration of an overflow allowance); and,
  - (x) Regularly monitor for grout leaks in sections of sewer upstream and downstream, drain connections (via inspection chambers), particularly if the volume of grout injected exceeds the estimated grout take.
- (f) The volume to be grouted at any one time can be varied to suit the various constraints such as the workability of the grout, design of the lining (including flotation), capacity of the mixing and pumping equipment, rate of installation of the lining, and the necessity for over pumping.
- (g) Sections should be grouted during the shift immediately following their installation provided that the stop ends and any lateral connections have attained sufficient strength.
- (h) Grout should either be injected through a minimum of three preformed holes (nominally 50 mm diameter) located in the haunches and crown of the lining or through pipes cast into the crown and invert of the stop ends. The former method is preferable because, in the event of a blockage, grouting can recommence at the adjacent panel. The grout should be injected from the lowest vent hole and successive holes plugged as air free grout is seen to issue from them. If the major dimension of the lining exceeds 1000 mm consideration should be given to the provision of more grout holes.
- (i) Bulkheads:
- (i) Bulkheads shall be constructed at the termination of the liner to facilitate lining and shall be temporary or permanent in nature.
  - (ii) If permanent, the bulkhead shall be constructed from cementitious materials consistent with the design of the rehabilitation system and the liner termination transitions.
  - (iii) Bulkheads shall include ports, located at regular intervals around the circumference of the host pipe for the purposes of confirming complete grouting of the annulus. Ports shall be located at the following minimum locations:
    - ◆ 4 and 8 o'clock position (max of 0.5 m above invert)
    - ◆ Springline of the host pipe
    - ◆ 2 and 10 o'clock position
    - ◆ Crown of the host pipe
  - (iv) Grout inspection ports shall be removed upon completion of the lining works and adequately plugged using fittings compatible with the port (HDPE or PVC) or a suitable cementitious product. Construction of the liner termination transition shall completely envelope the grout inspection ports such that no portion of the ports is visible upon completion of the work.

### E15.8.3 Transitions at Liner Termination

- (a) At transition terminations, the interface between the exterior surface of the liner and the host pipe shall be made watertight. The transition shall extend a minimum of 1.00 m into the host pipe from the end of the liner (unless otherwise shown on the Drawings) and provide a gradual transition from the host pipe to the lined section. Grouted transition shall match the PVC liner internal diameter and taper to a thickness of no more than 13 mm where meeting the host pipe.
- (b) Preparation of the host pipe and installation of the approved cementitious grouting product shall follow the manufacturer's recommendations.
- (c) Transitions shall be constructed while flow bypass arrangements are in place and shall be permitted to cure sufficiently prior to exposure to sewage.

#### E15.8.4 Closures

- (a) At access shafts where PVC liners cannot practically provide a fully restored sewer invert and obvert the Contractor shall restore the existing host pipe as follows:
  - (i) Restore the invert up to the interface with PVC liner strips cast into mortar consistent with the liner structure, cast-in-place concrete closure using a hand layup, bonded FRP liner in accordance with E13, a resin rich repair product compatible with the liner, or an approved cementitious repair product in accordance with E15.5.3.
  - (ii) Invert restoration shall be completed in accordance with the product manufacturer's recommendations with flow control measures in place and shall be permitted to cure sufficiently prior to exposure to sewage. The closure shall be constructed to a thickness equaling the thickness of the liner. The closure shall not result in a low spot or sump within the sewer.
  - (iii) Provide a smooth and level transition from liner to the closure location.
  - (iv) The obvert of the host pipe shall be restored with a cast in place concrete closure as shown on the Drawings and in accordance with E7. The cast-in-place concrete closure shall be formed from within the sewer to provide a smooth and level transition from the new liner.

#### E15.8.5 Reinstatement of Sewer Services

- (a) Reinststate all active and unable to determine sewer services including CB leads and utility drains to 100% of the original cross sectional area.
- (b) Reinststate sewer connections in a watertight manner that precludes leakage or infiltration at the connection between the host pipe and the liner.
- (c) Remove sharp edges from opening cut outs and provide a smooth rounded lip.
- (d) Sewer Service Grouting
  - (i) Grout sewer services to provide a smooth transition into the new host pipe without a loss of cross sectional area. Fill any voiding between the liner and the sewer service.
  - (ii) Locations of additional sewer service grouting may be identified by the Contract Administrator during review of Post Lining Video Inspection.
  - (iii) Complete sewer service grouting in accordance with E10.
- (e) Ensure that all cut-outs for sewer connections are removed from the sewer and are prevented from being washed into the sewer system downstream of the repair location.

#### E15.9 Post Construction Design Review for Total Performance

- (a) The Contract Administrator will perform a post-construction design review to confirm that the completed liner meets the design objectives relative to structural requirements prior to Total Performance. The design review will utilize all reported Quality Control testing records provided in accordance with E15.6.
- (b) The Contract Administrator will advise of any discrepancies between the constructed PVC liner and the design requirements.
- (c) Defects in PVC liners will be reviewed on a case by case basis by the Contract Administrator. The Contract Administrator will consult with the Contractor and taking into account the condition of the host pipe prior to lining, the PVC installation conditions, and the long term use of the sewer to assess the structural and performance ramifications of the defects.
  - (i) The Contractor shall:
    - ◆ Perform necessary remedial measures to confirm that a liner deemed to be structurally deficient will comply with the 50 year design life requirement such as determination of a more representative groundwater elevation locally through monitoring, undertake additional measurements

to confirm install conditions, and supplemental sampling and strength testing.

- ◆ Repair sections of PVC removed for supplemental by repairing with a resin-rich repair product such as an epoxy based repair system that is compatible with the liner system and specifically designed for the nature, size and thickness of the patch being repaired to form a smooth watertight patch flush with liner or a fused PVC repair.
- ◆ Undertake structural enhancements to the liner structure if supplemental testing fails to confirm the PVC liner will meet the 50 year design life requirement.
- ◆ Review remedial action with the Contract Administrator prior to implementation.
- ◆ The Contractor shall perform further testing, monitoring, calculations, and install structural enhancements at their own cost.

#### E15.10 Measurement and Payment

##### E15.10.1 Verification of Existing Sewer and Liner Dimensions

- (a) Verification of existing sewer and PVC liner dimensions shall be considered incidental to the Work and will not be measured for payment. No separate payment will be made.

##### E15.10.2 Spiral Wound PVC Lining

- (a) Liner installation will be measured on a length basis for each size and paid for at the Contract Unit Price for "Supply and Installation of Structural Sewer Liner". Length to be paid for will be the total length of PVC liner supplied and installed in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Measurement will be made horizontally at grade, above the centreline of the pipe from centre to centre of manholes or termination of the liner where termination is not at a manhole location.
- (c) Payment for the supply and installation of PVC liners shall include but is not limited to the following:
  - (i) Verification of existing sewer dimensions;
  - (ii) Submittals, including: PVC liner designs, material samples, material testing, operations protocol, and construction protocol;
  - (iii) All required sewer preparation work;
  - (iv) Supply and installation of PVC liner;
  - (v) Grouting of PVC liner;
  - (vi) Transitions at liner termination;
  - (vii) Test samples;
  - (viii) Quality control testing and records; and,
  - (ix) Any other materials and labour as specified herein.
- (d) Payment for the supply and installation of PVC liners will be made on the following payment schedule;
  - (i) Eighty percent (80%) payment upon installation and completion of the grouting operations.
  - (iv) One hundred percent (100%) payment upon completion of all work incidental to the PVC liner installation, confirmation of QA testing results, delivery and acceptance of all required submissions, shop drawings, and reports, rectification of all identified defects, and acceptance by the Contract Administrator.

- (e) Where PVC liners are improperly installed due to negligence on the part of the Contractor, payment for the PVC liner will be withheld until the identified issues have been rectified.

**E15.10.3 Reinstatement of Sewer Services**

- (a) Reinstatement of sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Reinstatement of Sewer Services". Number of units to be paid for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Payment for sewer service reinstatement will occur after confirmation of sewer service reinstatement via review of the Post-Lining CCTV video. Payment will not be made until the Post-Lining inspection videos have been submitted and reviewed.

**E15.10.4 Quality Control Records**

- (a) Preparation of quality control records shall be considered incidental to the PVC liner installation and will not be measured for payment. No separate payment shall be made.

**E15.10.5 Quality Control Sampling and Testing**

- (a) All work and materials required for the preparation, recovery, and repair of PVC and grouting test samples shall be considered incidental to the PVC liner installation and will not be measured for payment. No separate payment shall be made.

**E16. CAST-IN-PLACE CONCRETE**

**E16.1 Description**

- (a) This Specification shall cover the construction of cast-in-place concrete trunk sewer closures.
- (b) All cast-in-place concrete shall be carried out in accordance with CW 2160 and CSA A23.1, except as amended or supplemented herein

**E16.2 Submissions**

**E16.2.1 Construction Method Submission**

- (a) No Work shall commence on construction of valve chamber until after the Contract Administrator's review of the Contractor's Construction Method submission.
- (b) The Contractor shall prepare for the Contract Administrator's review a Construction Method submission detailing:
  - (i) Construction sequence to be followed including all methods to be employed to ensure no damage occurs to existing structures or adjacent properties within or adjacent to excavation.
  - (ii) Proposed method of construction.
  - (iii) Specialized equipment to be used.
  - (iv) Any design revisions proposed to accommodate the Contractor's proposed construction method.
  - (v) Flow control considerations including details on the Contractor's proposed method of flow control.
  - (vi) The Contractor shall respond to any concerns that may be raised by the Contract Administrator after review of the Construction Method submission.

**E16.3 Materials**

- (a) Structural Concrete Mix Design
  - (i) Provide concrete mixed in accordance with requirements of CW 2160 and CSA-A23.2. Concrete shall conform to requirements of Type A concrete in accordance with Table CW 2160.1.

- (ii) Structural concrete design shall be in accordance with performance specification having the following properties:
  - ◆ Class of Exposure: S-1
  - ◆ Minimum Compressive Strength @ 28 days: 35 MPa
- (b) Hydrophilic Waterstop
  - (i) One-part polyurethane, extrudable swelling waterstop (bentonite-free). Sikaswell S-2 or approved equal in accordance with B7.

#### E16.4 Construction Methods

##### E16.4.1 Forming

- (a) The Contractor shall be responsible for the design and installation of all necessary shoring, bracing and formwork.
- (b) All shoring shall conform to CW 2160, CSA S269.3 and CSA C23.1.

##### E16.4.2 Cast-in-Place Concrete

- (a) All cast-in-place concrete shall conform to CW 2160, and CSA A23.1.

#### E16.5 Measurement and Payment

- (a) Supply and placement of cast-in-place concrete shall be considered incidental to "Pipeline Access Modifications" and will not be measured for payment. No separate payment will be made.

### **E17. REINFORCING STEEL**

#### E17.1 Description

- (a) This Specification shall cover all reinforcing steel work, in accordance with Specification CW 2160, except as amended or supplemented herein.

#### E17.2 Submittals

- (a) The Contractor shall submit reinforcing steel Shop Drawings in accordance with E2 a minimum of ten (10) Business Days prior to the fabrication of any reinforcing steel.

#### E17.3 Materials

##### E17.3.1 Reinforcing Steel

- (a) Further to CW 2160 Sentence 2.6 Materials: Reinforcing Steel, all reinforcing steel shall conform to the requirements of CSA G30.18, Grade 400.

##### E17.3.2 Bar Accessories

- (a) Bar accessories shall be of type approved by the Contract Administrator. They shall be made from a non-corroding material, and they shall not stain, blemish, or spall the concrete surface for the life of the concrete. Bar chairs are to be PVC; galvanized bar chairs are not acceptable.
- (b) Bar accessories shall include bar chairs, spacers, clips, wire ties, wire (18 gauge minimum), or other similar devices that may be approved by the Contract Administrator. Bar accessories are not shown on the Contract Drawings. The supply and installation of bar accessories shall be considered incidental to the supply and placing of reinforcing steel.

#### E17.4 Construction Methods

##### E17.4.1 Placing of Reinforcing Steel

- (a) Placement of reinforcing steel shall be completed in accordance with CW 2160, CSA A23.1, and CSA A23.3.
- (b) Lap splices in accordance with CSA A23.3



- (c) Reinforcing steel shall be placed accurately in the positions shown on the Contract Drawings. Carefully adjust the location of reinforcing steel adjacent to openings to frame those openings in accordance with good practice, and maintain the bar spacing intent.
- (d) Splices in reinforcing steel shall be made only where indicated on the Contract Drawings. Prior approval of the Contract Administrator shall be obtained where, in the opinion of the Contractor, other splices must be made. All splices shall have laps of at least 40 bar diameters. Welded splices shall not be used.
- (e) A minimum of twenty-four (24) hours notice shall be given to the Contract Administrator prior to the pouring of any concrete to allow for inspection of reinforcing steel.

#### E17.4.2 Quality Control

- (a) The Contractor shall provide, without charge, the samples of reinforcing steel required for quality control tests and provide such assistance and use of tools and construction equipment as is required.

#### E17.5 Measurement and Payment

- (a) Supply and placement of reinforcing steel shall be considered incidental to "Pipeline Access Modifications" and will not be measured for payment. No separate payment will be made.

### **E18. RESTORATION**

#### E18.1 Description

- (a) This Specification shall cover the restoration of all work sites.

#### E18.2 Restoration Works

- (a) Reconstruct concrete pavements in accordance with CW3310 and SD-213A.
- (b) Reconstruct asphalt pavements overlays in accordance with CW3410.
- (c) Reconstruct existing non reinforced concrete sidewalks with a 100 mm non-reinforced concrete conforming to CW3325 and SD-228A. The sidewalk shall be constructed with 100 mm (min) of compacted base material.
- (d) Reconstruct of the existing reinforced concrete sidewalks with a 150 mm reinforced concrete conforming to CW3235 and SD-237. The sidewalk shall be constructed with 100 mm (min) of compacted base material. To be used for private approaches.
- (e) Reconstruct concrete barrier curbs in accordance with CW3240 and SD-206A.
- (f) Sod all maintained grassed areas in accordance with CW3510.

#### E18.3 Measurement and Payment

##### E18.3.1 Concrete Slab Patches

- (a) Construction of "Concrete Slab Patches" shall be measured on a square metre basis as listed in Form B. Measurement will be made for each square metre of concrete slab acceptably replaced. Payment for "Concrete Slab Patching" shall include all base and sub base preparation, the supply and placement of concrete pavements, and all associated materials and labour to complete the work.

##### E18.3.2 Asphalt parking lot repairs

- (a) Construction of "Asphalt Parking Lots Repairs (c/w Concrete Slab Patches)" shall be measured on a square metre basis as listed in Form B. Measurement will be made for each square metre of parking lot acceptably repaired. Payment for "Asphalt Parking Lots Repairs" shall include all base and sub base preparation, the supply and placement of concrete pavements, asphalt pavements, and all associated materials and labour to complete the work.

(b) Construction of "Asphalt Parking Lots Repairs (w/o Concrete Slab Patches)" shall be measured on a square metre basis as listed in Form B. Measurement will be made for each square metre of parking lot acceptably repaired. Payment for "Asphalt Parking Lots Repairs" shall include the supply and placement of asphalt pavements, and all associated materials and labour to complete the work.

(c) The Contractor shall assume the Emterra Environmental parking lot consists of concrete pavement overlain with asphalt.

E18.3.3 Concrete Barrier Curb Replacement

(a) "Concrete Barrier Curb Renewal" shall be measured on a linear metre basis for. Measurement will be made for each linear metre of concrete curb acceptably replaced. Payment for "Concrete Barrier Curb Renewal" shall include all base and sub base preparation, and the supply and placement of concrete curbing.

E18.3.4 Supply and installation of sod using imported topsoil shall be measured and paid in accordance with CW 3510.

E18.3.5 Payment for restoration works will be limited to areas disturbed to facilitate construction. Surface restoration outside of the designated construction areas shall be at the Contractors expense.

## PART F - SECURITY CLEARANCE

### F1. SECURITY CLEARANCE

- F1.1 Each individual proposed to perform the following portions of the Work:
- (a) any Work on private property;
  - (b) any Work within City facilities other than:
    - (i) an underground structure such as a manhole;
    - (ii) in areas and at times normally open to the public;
  - (c) communicating with residents and homeowners in person or by telephone;
- F1.1.1 Each Individual shall be required to obtain a Police Information Check from the police service having jurisdiction at his/her place of residence. Or
- (a) BackCheck, forms to be completed can be found on the website at: <http://www.backcheck.net/>; or
  - (b) Commissionaires (Manitoba Division), forms to be completed can be found on the website at: <https://www.commissionaires.ca/en/manitoba/home> .
- F1.2 Prior to the award of Contact, and during the term of the Contract if additional or replacement individuals are proposed to perform Work, the Contractor shall supply the Contract Administrator with a Police Information Check obtained not earlier than one (1) year prior to the Submission Deadline, or a certified true copy thereof, for each individual proposed to perform such Work.
- F1.3 Any individual for whom a Police Information Check is not provided, or for whom a Police Information Check indicates any convictions or pending charges related to property offences or crimes against another person will not be permitted to perform any Work specified in F1.1.
- F1.4 Any Police Information Check obtained thereby will be deemed valid for the duration of the Contract subject to a repeated records search as hereinafter specified.
- F1.5 Notwithstanding the foregoing, at any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require an updated Police Information Check. Any individual who fails to provide a satisfactory Police Information Check as a result of a repeated Police Information Check will not be permitted to continue to perform any Work specified in F1.1.