UCT The Underground Utilities Event
25 YEARS
Underground Construction Technology | January 28-30, 2020 | Fort Worth, TX

Integrating Lessons Learned in Specifications Development

Track IV – Pressure Pipe

January 28, 2020

Matthew Coleman, City of Toronto

Paul Pasko, SEH

TORONTO

SEH

PRESENTATION OVERVIEW:

1) **Replace? Repair? Rehab?**
   - Making Effective Renewal Decisions
2) **Developing a Water Main Lining Project**
   - Design Criteria
   - Defining Project Scope
   - Servicing
   - Bidder Proof
   - Community Impacts
   - QA/QC Recommendations
3) **Lessons Learned**
   - ROW/Easements
   - What Ifs?
   - Approval Agency
   - Ongoing Maintenance
   - Independent lab testing of material properties
   - Mitigating Future Failures

Why do we need watermain rehabilitation?

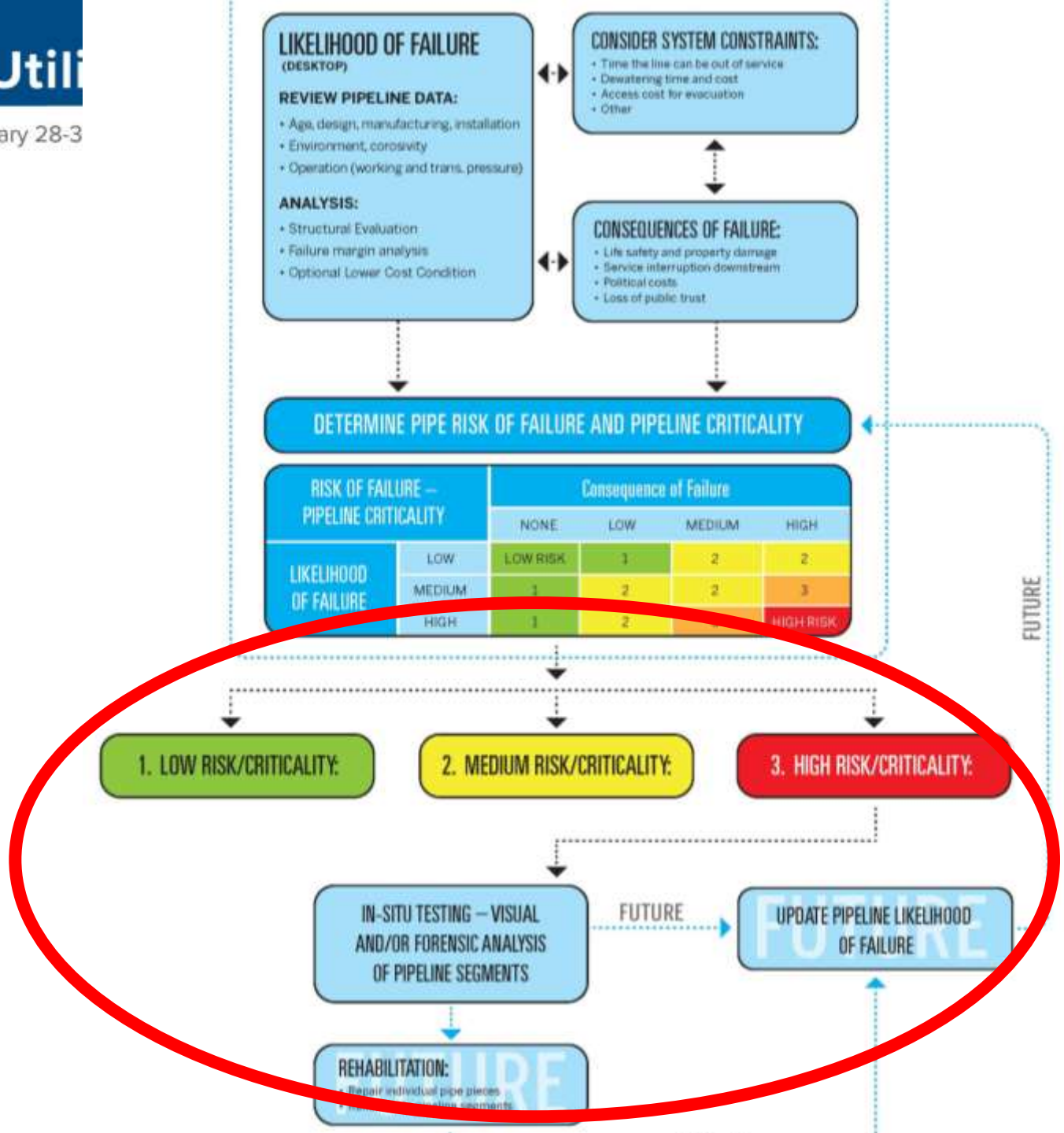
$20 000 000.00/year on break repairs

DETERMINE CORE RISK:
Probability X Consequence

- Maintain Asset Data
- Build Rating Criteria
- Prioritize on Risk
- Alternatives Analysis

Invest in your
CRITICAL ASSETS

Maximize ratio of
RISK REDUCED / COST



Traditional Measurement of Pressure Pipe Condition

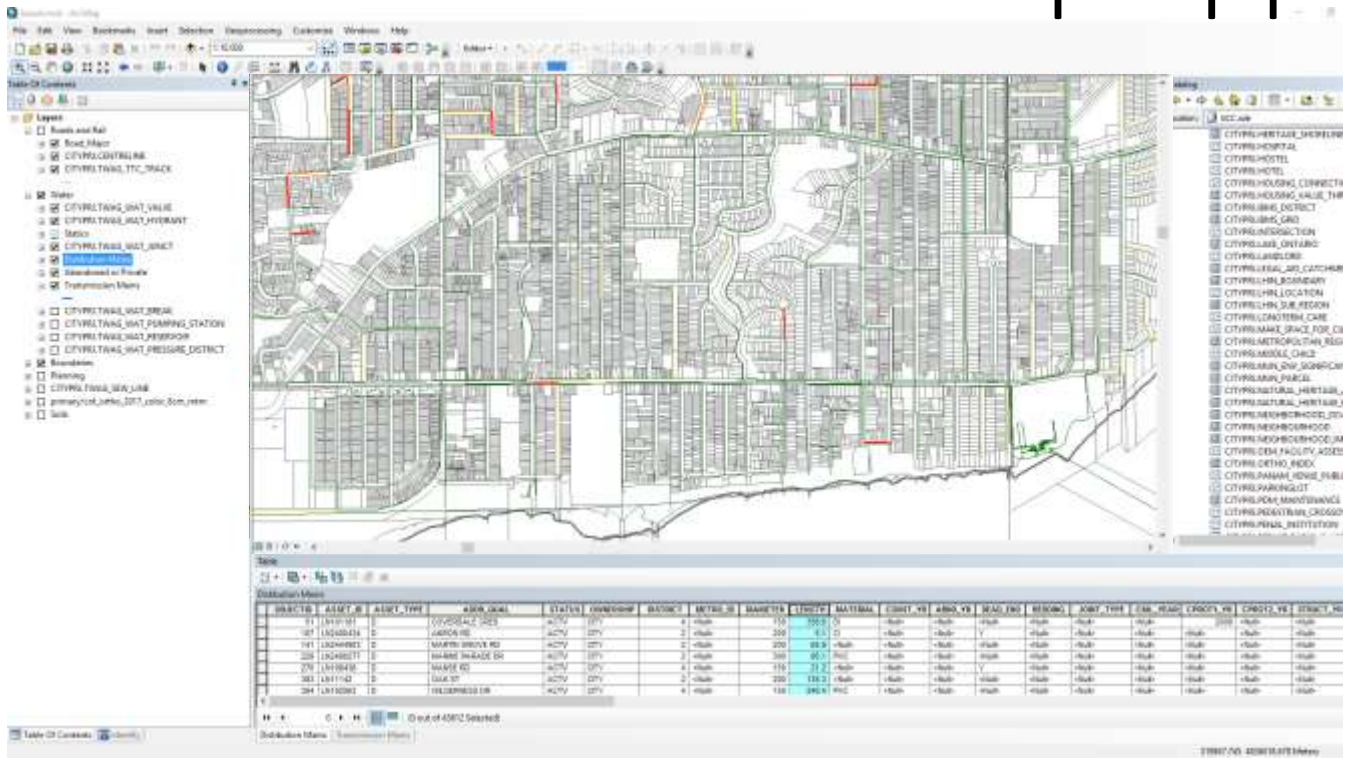
Direct

- Visual inspection (CCTV or manned entry)
- Sampling
- Nondestructive testing
- Age and material

Indirect

- Failure history
- Leakage level
- Flow testing
- Soil resistivity

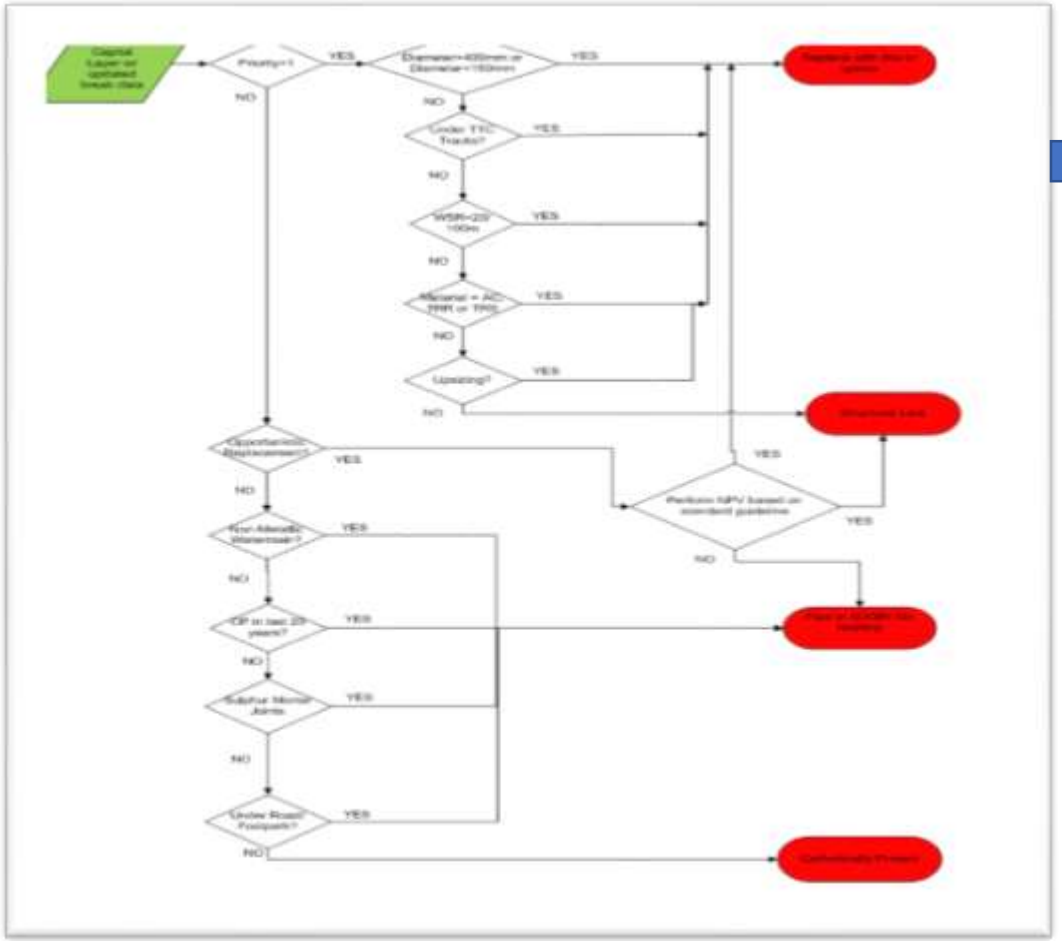
Toronto Water: Desktop Approach



Replace? Repair? Rehab?

Making Effective Renewal Decisions

Replace vs Reline vs Slipline



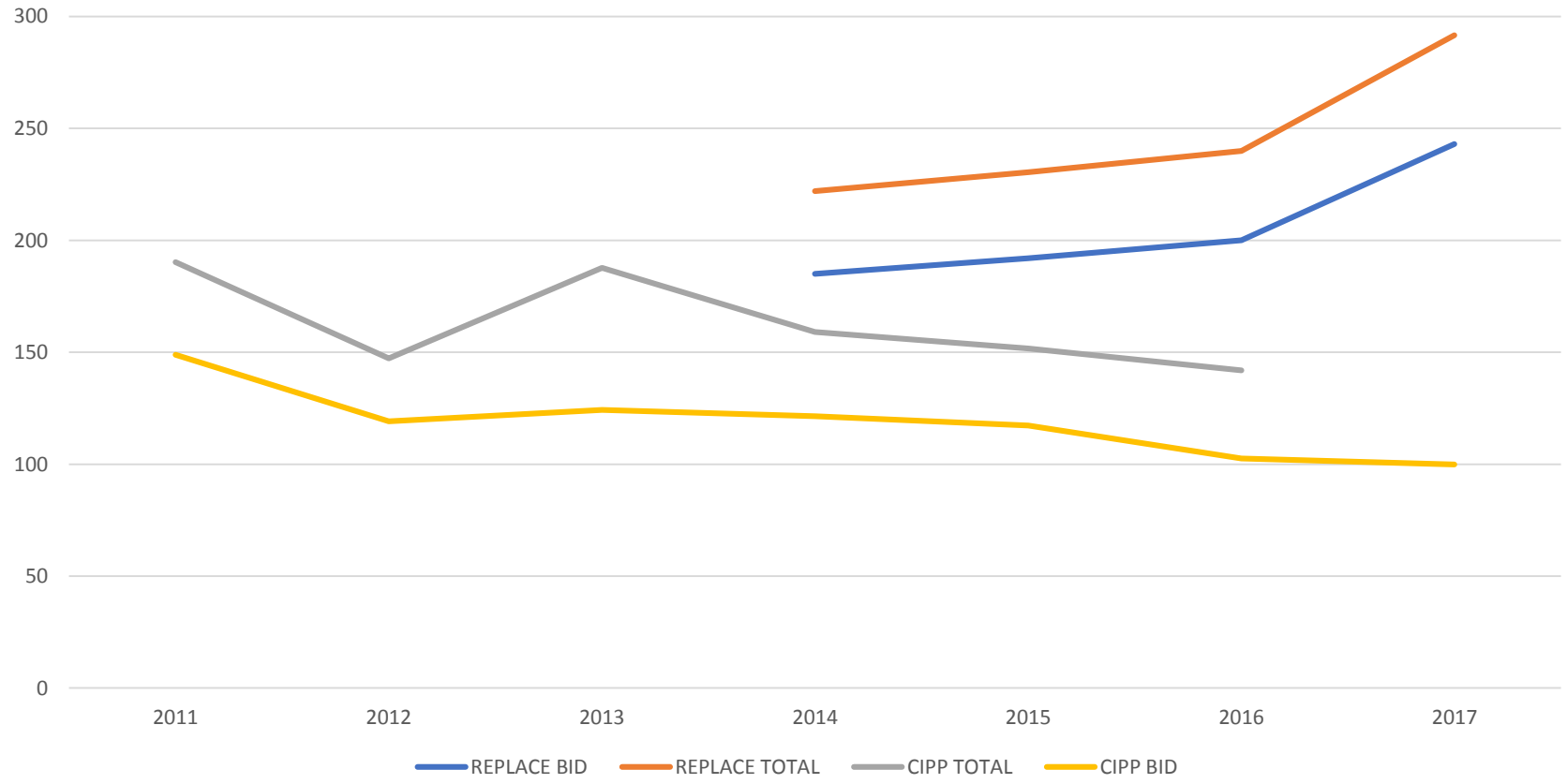
SQL Query on GIS

```
"OWNERSHIP" = 'CITY' AND "STATUS" = 'ACTV'
AND "CONST_YR" < 2000 AND "WS_PER_100"
<0.1 AND "DIAMETER" > 149 AND
"DIAMETER" <= 400 AND "MATERIAL" <> 'AC'
AND "MATERIAL" <> 'TRR' AND P_Priority > 1
```

Bidding a Water Main Lining Project:

Budgeting/Estimating CIPP Rehab

RECENT CIPP WATER MAIN REHABILITATION
vs. OPEN TRENCH REPLACEMENT COSTS
(Madison, WI) ** Price Per Foot*



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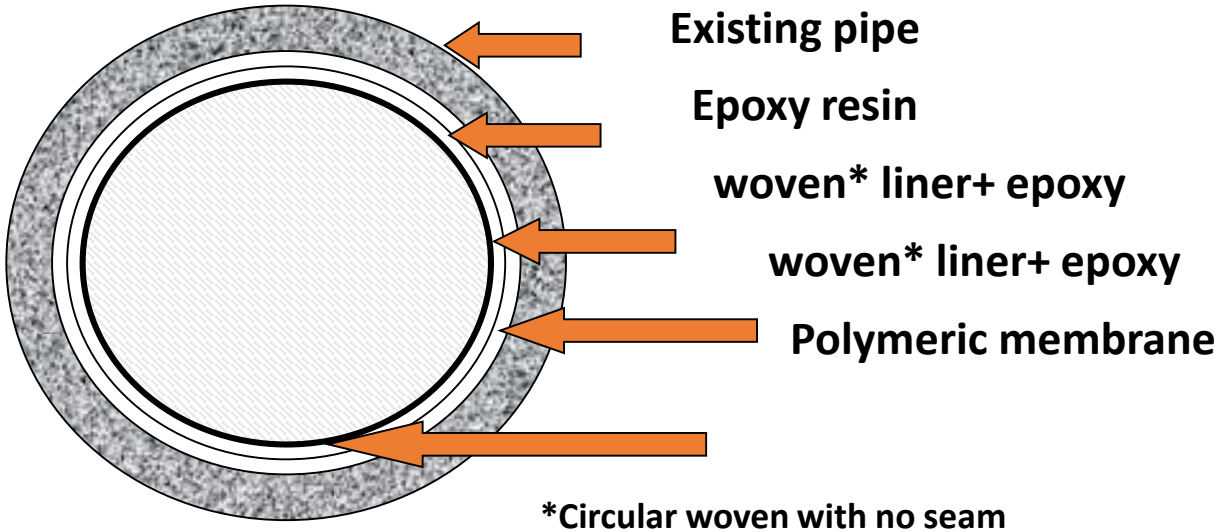


*Circular woven with no seam

Note: not to scale

Installed diameters	6 to 24 in
Installed lengths	up to 500 feet
Hazen Williams Coefficient	>120
Maximum Working Pressure	150 psi

Developing a Water Main Lining Project

- **Design Criteria**
- Defining Project Scope
- Servicing
- Bidder Proof
- Community Impacts
- QA/QC Recommendations

ASTM INTERNATIONAL

Designation: F1

Standard Pra
Rehabilitatio
Inversion an

This standard is issued un
original adoption or, in the
superscript epsilon (ε) indi

RS BlueLine® Inversion Liner CIPP Wall Thickness Design

Designed in Accordance with ASTM F1216-07a

Project: Water Line Rehabilitation
Location: Toronto, Ontario CANADA
Designed By: Phil Kerridge
Date: Jan 29, 2019

Owner: City of Toronto
Contractor: Robert B. Somerville Co. Limited
Line Segment(s): 300 mm
Additional Information: 7.3 psi Vaccum

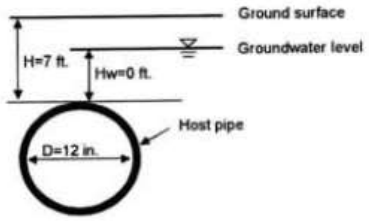
Design Assumptions:

- Shaded cells are user-defined
- See ASTM F1216, Appendix X1 for definitions

		Fully Deteriorated	
- Condition of host pipe			
- Inside diameter of host pipe (in)	D =	11.8	in
- Ovality of host pipe (%)	q =	2.0%	- Default value is 2%; range = 0.1%-10%
- Constrained soil modulus of native soil in the pipe zone (psi)	M_{sn} =	1,000	psi - See table below for recommended values

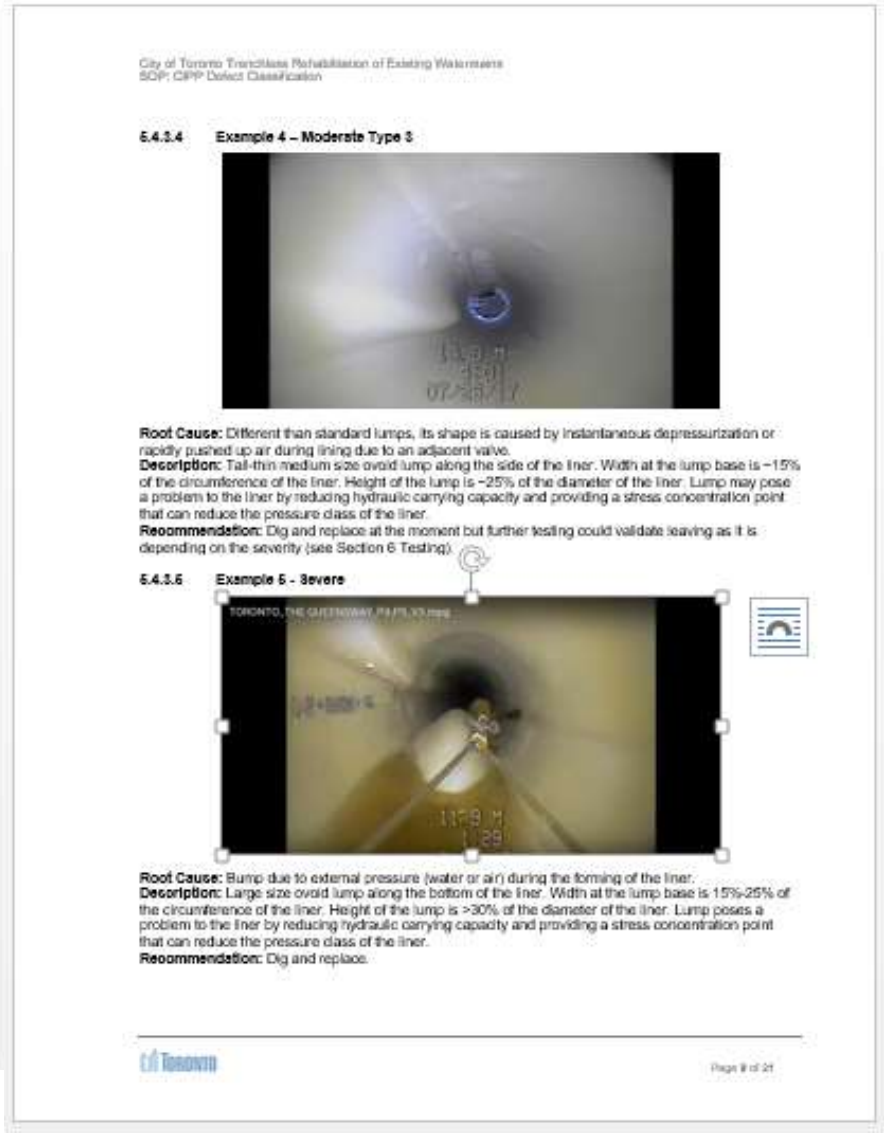
From Table 5.6 of *AWWA Manual of Water Practices M45, Second Edition*

Granular Native Soils		Cohesive Native Soils: Unconfined compressive strength (q_u)		Description	M_{sn}	
Blows/ft (per ASTM D1586)	Description	tons/sf	kPa		psi	kPa
> 0 - 1	very, very loose	> 0 - 0.125	0 - 13	very, very soft	50	0.3
1 - 2	very loose	0.125 - 0.25	13 - 25	very soft	200	1.4
2 - 4		0.25 - 0.50	25 - 50	soft	700	4.8
4 - 8	loose	0.50 - 1.0	50 - 100	medium	1,500	10.3
8 - 15	slightly compact	1.0 - 2.0	100 - 200	stiff	3,000	20.7
15 - 30	compact	2.0 - 4.0	200 - 400	very stiff	5,000	34.5
30 - 50	dense	4.0 - 6.0	400 - 600	hard	10,000	69.0
> 50	very dense	> 6.0	> 600	very hard	20,000	138.0



- Flexural modulus of Elasticity of CIPP, initial (psi)	E =	400,000	psi - Minimum value is 250,000 psi per ASTM F1216
- Long-term retention of tensile properties (%)		50%	
- Long-term retention of flexural properties (%)		100%	- Default value is 50%
- Flex modulus of elasticity of CIPP, long-term (psi)	E_L =	400,000	psi - Determined from long-term retention %
- Design safety factor	N =	2.0	- Default value is 2.0
- Unit weight of soil (pcf)	δ_s =	120	lb/ft^3 - Applies to fully deteriorated designs only
- Unit weight of water (pcf)	δ_w =	62.4	lb/ft^3
- Depth of cover (ft)	H =	6.6	ft - Measured from ground surface to top of pipe
- Height of groundwater (ft)	H_w =	0.0	ft - Measured from top of pipe
- Is this an above ground installation?		No	- Pressure pipe applications only
- Internal pressure (psi)	P =	125.0	psi - Pressure pipe applications only; if no pressure, input 0
- Internal vacuum pressure (psi)	P_v =	7.3	psi - Default value is 0
- Diameter of hole or opening in original pipe wall (in)	d =	0.50	in - Pressure pipe applications only! If no pressure, input 0
- Poisson's ratio of CIPP	ν =	0.30	- Average value for CIPP per ASTM F1216
- Flexural strength of CIPP, initial (psi)	σ_i =	10,000	psi - Minimum value is 4,500 psi per ASTM F1216
- Flexural strength of CIPP, long-term (psi)	σ_L =	10,000	psi - Determined from long-term retention %
- Tensile strength of CIPP, initial (psi)	σ_T =	13,000	psi - Pressure pipe applications only
- Tensile strength of CIPP, long-term (psi)	σ_{TL} =	6,500	psi - Determined from long-term retention %
- Enhancement factor (dimensionless)	K =	7.0	- Minimum value recommended per ASTM F1216
- Surface live loading condition		HS-20	- AASHTO HS-20 or HS-25; Cooper E80 railway or airport loading

- Getting on the same page with contractors on what we expect as a finished product
- Toronto Specification 7.60: Cured-in Place Pipe Lining of Watermains
- https://www.toronto.ca/wp-content/uploads/2017/11/8fac-ecs-specs-pipespecs-TS_7.60_Jan2015.pdf
- Google: Toronto TS7.60 CIPP



City of Toronto Trenchless Rehabilitation of Existing Watermains
SOP: CIPP Defect Classification

6.4.3.4 Example 4 – Moderate Type 3

Root Cause: Different than standard lumps, its shape is caused by instantaneous depressurization or rapidly pushed up air during lining due to an adjacent valve.
Description: Tall-thin medium size ovoid lump along the side of the liner. Width at the lump base is ~15% of the circumference of the liner. Height of the lump is ~25% of the diameter of the liner. Lump may pose a problem to the liner by reducing hydraulic carrying capacity and providing a stress concentration point that can reduce the pressure class of the liner.
Recommendation: Dig and replace at the moment but further testing could validate leaving as it is depending on the severity (see Section 6 Testing).

6.4.3.6 Example 5 - Severe

Root Cause: Bump due to external pressure (water or air) during the forming of the liner.
Description: Large size ovoid lump along the bottom of the liner. Width at the lump base is 15%-25% of the circumference of the liner. Height of the lump is >30% of the diameter of the liner. Lump poses a problem to the liner by reducing hydraulic carrying capacity and providing a stress concentration point that can reduce the pressure class of the liner.
Recommendation: Dig and replace.

Project Scope Considerations

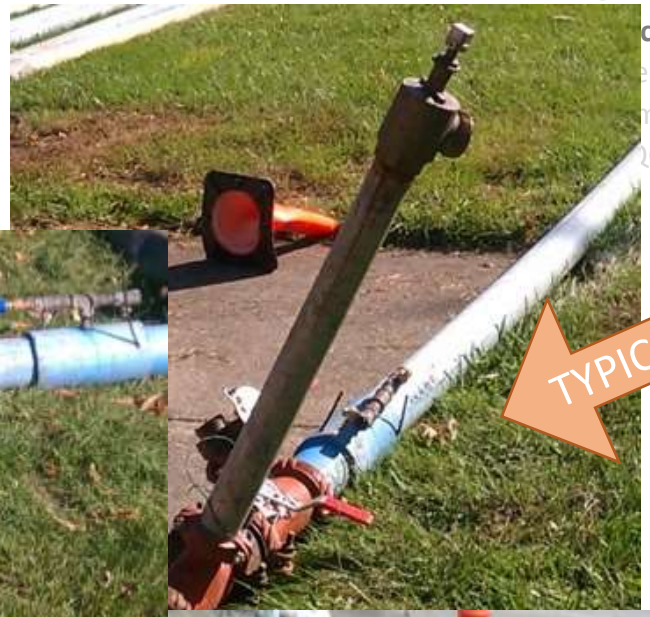
- **Multi-Location vs. Concentrated Area**
- Joint-Municipality Agreement
- Ongoing Service Agreement (Multi-Year)
- Civil/Site Work Options

Establishing Project Limits

- Valve Locations
- Locating Access Pits
  - Hydrant Feeds for Temp. Water Supply
  - Typical Max Spacing 600-800-FT
- **Staging and Storage Areas**
  - **offer alternative location if site can't accommodate**

Maintaining Service

- **Temporary Bypass Water Systems**
- Pressure / Source
- Fire Protection
- Water Quality
- Metering
- 24-hr on-call
- Access & Ramps
- House Connections
- Freezing



Developing a Water Main Lining Project

- Design Criteria
- Defining Project Scope
- **Servicing**
- Bidder Proof
- Community Impacts
- QA/QC Recommendations

Bidders Proof of Responsibility

A Bidder will not be considered as a qualified contractor for this project unless the Bidder receives a rating of at least 10 points, as determined by the Owner, using the following system for assigning or deducting points:

1.0 CIPP Work	
Experience in installation of CIPP trunk water main pipe lining and similar to this project in terms of lineal footage within the last three years, to the satisfaction of the Owner	5 points
➢ For each additional project qualifying under the above category	1 point each
Experience of the assigned job superintendent in supervising CIPP trunk water main pipe lining projects while under traffic similar in size and functions within the last three years, to the satisfaction of the Owner	5 points
➢ For each additional CIPP project supervised that qualifies under the above category	1 point each
History of initiating change orders (not at the owner's request) that total more than 5% of the original bid within the last five years	Deduct 2 points for each confirmed project
History of complaints regarding completion deadlines or the quality of the work of projects within the last five years	Deduct 2 points for each confirmed project
2.0 Site Work	
Experience in street reconstruction/utility projects entailing aspects of open cut excavations, installations of temporary water systems, paving operations, restoration and traffic control similar in scope to this project within the last three years	0 points for three (3) or more projects Deduct 2 points for each project less than three (3)
Experience of the assigned job superintendent in supervising street reconstruction/utility projects entailing aspects of open cut excavations, installations of temporary water systems, paving operations, restoration and traffic control similar in scope to this project within the last three years	0 points for three (3) or more projects Deduct 2 points for each project less than three (3)
History of initiating change orders (not at the owner's request) that total more than 5% of the original bid within the last three years	Deduct 2 points for each confirmed project
History of complaints regarding completion deadlines or the quality of the work of projects within the last three years	Deduct 2 points for each confirmed project

The Owner may give partial credit for points or deducts depending upon the nature of the projects.

The object of the request for the Bidder's qualifications is to make it possible for the Owner to have exact information of the financial ability, equipment and personnel available and past performance and experience of the Bidder, in order to reduce the hazards involved in awarding a Contract to a party apparently not qualified to perform it, and to select only those Bidders qualified to properly complete the work.

Bid Award Letter
April 14, 2014
Page 6

Qualifications of Bidder				
Paragraph	Bidder			
	Pember[1]		Fer-Pal[2]	
	Points	Comment	Points	Comment
control similar in scope to this project within the last three years				
Experience of the assigned job superintendent in supervising street reconstruction/utility projects entailing aspects of open cut excavations, installations of temporary water systems, paving operations, restoration and traffic control similar in scope to this project within the last three years	-6	Pember did not identify a superintendent in Section 2.3.1. Therefore score -2 points for each of up to 3 projects not identified for an unidentified superintendent	-	
History of initiating change orders (not at the owner's request) that total more than 5% of the original bid within the last three years	0		-	
History of complaints regarding completion deadlines or the quality of the work of projects within the last three years	0		-	
Total Points	5		34	

[1] Scored both sections 1.0 and 2.0 because Pember will complete paragraph 2.0 Site Work themselves, while subcontracting with Michels Corporation to complete paragraph 1.0 CIPP Work.
[2] Scored only section 1.0 because Fer-Pal will complete both paragraphs 1.0 CIPP and 2.0 Site Work themselves.

Conclusions
Based on our review of submitted proposal forms and Proofs, Fer-Pal gives the City its best chance to realize the value in its choice to use CIPP method to rehabilitate its water main thus receiving our recommendation of award in the amount of $818,885.80. Fer-Pal is a very able Contractor with both the experience and leadership necessary to execute this project's very demanding schedule in a historic downtown while not impacting key downtown activities.

Please contact me with questions and comments at 952.912.2611 or ppasko@sehinc.com. We look forward to assisting the City with construction phase activities.

Sincerely,

SHORT ELLIOTT HENDRICKSON INC.

Paul J. Pasko III, PE
Project Manager

Enclosure
pjp3

Bidders Proof of Responsibility - continued

Re: Post-Bid Proof of Responsibility Review & Contract Award Recommendations - Hastings Downtown Watermain Lining

Nick Egger, P.E. to: Brent Pember 04/15/2014 05:21 PM
"epember@pembercompanies.com",
Cc: "nbowman@pembercompanies.com", Thomas Montgomery, Curt Wimpee, Paul Pasko III, Mark Peine

Thank you for the response Brent. I understand that you are frustrated and disappointed in the outcome and the direction we intend to take.

We will honor your request for a meeting, and we are available late morning on Thursday. Would the time of 11am work for you? We would be gathering at our Public Works Building rather than at City Hall.

Eric - Please let me know if 11am on Thursday is workable from your end.

Regards,

Nick Egger, P.E.
City Engineer

City of Hastings

Sent from my iPad

On Apr 15, 2014, at 12:16 PM, "Brent Pember" <bpember@pembercompanies.com< mailto:bpember@pembercompanies.com>> wrote:

Nick,

Obviously we disagree very strongly with the Proof of Responsibility summary provided by SEH. There were things that could have easily been clarified by SEH with a simple follow-up call to us (no product information, supervisor qualifications, etc..) but we didn't hear anything from them until this letter.

For SEH to grade Pember Companies at negative 6 points is an insult and quite frankly a joke. We have done many projects similar in scope in the City of Hastings alone. It wasn't too many years ago that the City of Hastings paid close to an extra $100,000 to use Pember Companies over one of our competitors.

Michels has similar objections to their score. We would like to setup a meeting at City Hall this week to discuss the scores. Eric Pember will be attending from our office. Please let Eric know when that meeting can take place and we will coordinate with Michels.

Thanks,

Brent

Brent Pember, P.E.
President
Pember Companies, Inc.
N4449 469th Street
Menomonie, WI 54751
Phone: 715.235.0316, ext. 30

Developing a Water Main Lining Project

- Design Criteria
- Defining Project Scope
- Servicing
- Bidder Proof
- **Community Impacts**
- QA/QC Recommendations

TORONTO Construction Update

September 19, 2019

Watermain Cleaning and Relining on Finch Avenue East from Alamosa Drive to east of Page Avenue OVERNIGHT WORK

Contract: 18TW-CTS-07CWD
Start Date: March 2019
End Date: November 2019
**Timeline is subject to change.*

The City of Toronto will be cleaning and structurally relining the watermain in your area starting in the month of March through November. During this process, the City will also replace the City-owned portion of any substandard water service pipes.

Phase 1 of this project on Linus Road and two sections of Finch Avenue East (Gaspe Road to Page Avenue and Leslie Street to Linus Road) was completed in January 2019. Restorations followed in Spring 2019. Phase 2 began in March 2019 on Finch Avenue East from Alamosa Drive to east of Page Avenue.

Beginning September 23, overnight work will commence in the area. Overnight work is required to complete the project and minimize disruption.

A map of the work area can be found on page 3 of this notice.

This project is part of the Council-approved Capital Works Program to renew our aging infrastructure, improve water distribution and reduce the risk of watermain breaks.

IMPORTANT INFORMATION ABOUT LEAD WATER SERVICES

If you live in a house/building that was built before the mid-1950s, your water service may be made of lead. Please read the attached fact sheet with important information about the risks of lead in drinking water, especially if someone in your house/building is pregnant, there are children under six years old, or there is an infant drinking formula made from tap water.

Please note: Lead pipes were not used in apartment buildings or other multi-residential buildings with more than six units.

WORK DETAILS

In the first few weeks, the City's contractor will move equipment on-site and prepare the work area before construction begins. Construction crews will then:

- Excavate pits in the road to access the watermain
- Install a temporary water supply system and attach your building to the supply
- Clean and structurally reline the existing watermain
- Replace any City-owned water service pipes that do not meet City standards (from the watermain to the private property line)
- Remove the temporary water supply and restore all work areas with asphalt, concrete or grass

WHAT TO EXPECT DURING CONSTRUCTION

- You may experience dust, noise and other inconveniences. The City will make efforts to reduce the impacts. We appreciate your patience
- Property owners should remove items located within City property limits (boulevard), such as landscaping and / or decorative objects
- The City will not be responsible for damage to any privately owned items on City property

Page 1 of 3

CIPP Liner Verification:

PRECONSTRUCTION

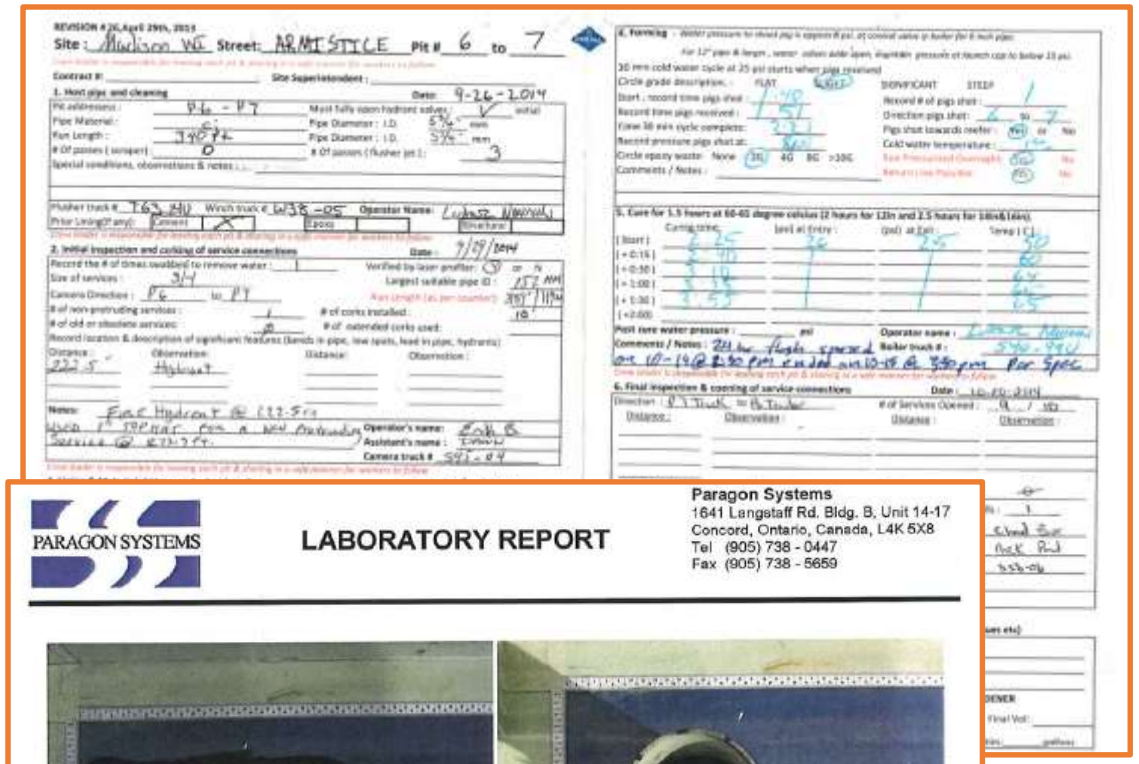
- Design/Submittals
- Confirm Plans

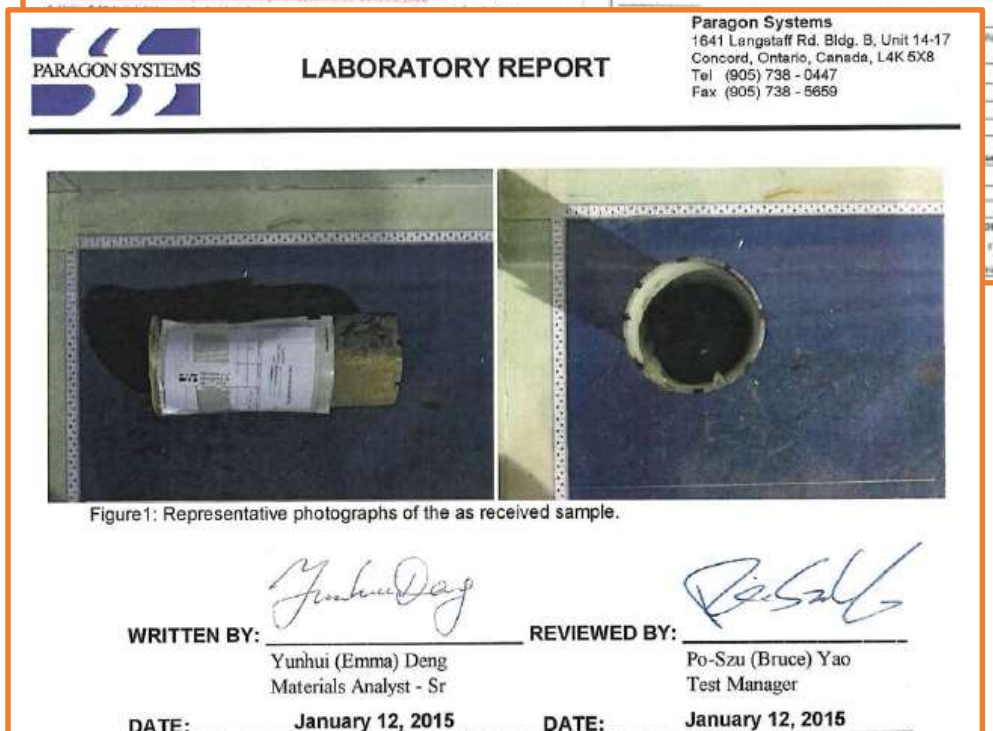
CONSTRUCTION

- Installation logs
  - NSF 61
  - Pressure Tests

POST-CONSTRUCTION

- Physical Properties
- Water Quality
  - Bacteriological
  - VOC/BPA





PARAGON SYSTEMS

LABORATORY REPORT

Paragon Systems
1641 Langstaff Rd. Bldg. B, Unit 14-17
Concord, Ontario, Canada, L4K 5X8
Tel (905) 738 - 0447
Fax (905) 738 - 5659

Figure1: Representative photographs of the as received sample.

WRITTEN BY: Yunhui (Emma) Deng, Materials Analyst - Sr — DATE: January 12, 2015

REVIEWED BY: Po-Szu (Bruce) Yao, Test Manager — DATE: January 12, 2015

Certified to NSF/ANSI 61

Physical Properties Testing Analysis

- Confirm Desi
  Performance
  - Tensile
  - Flexural (b
  - Thickness

RS BlueLine® Inversion Liner CIPP Wall Thickness Design
Designed in Accordance with ASTM F1216-07a

Project: Water Line Rehabilitation
Location: Toronto, Ontario CANADA
Designed By: Phil Kerridge
Date: Jan 29, 2019

Owner: City of Toronto
Contractor: Robert B. Somerville Co. Limited
Line Segment(s): 300 mm
Additional Information: 7.3 psi Vaccum

Design Assumptions:

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- Inside diameter of host pipe (in)	D =	11.8 in	- See ASTM F1216, Appendix X1 for definitions
- Ovality of host pipe (%)	q =	2.0%	- Default value is 2%; range = 0.1%-10%
- Constrained soil modulus of native soil in the pipe zone (psi)	M_{sn} =	1,000 psi	- See table below for recommended values

From Table 5.6 of *AWWA Manual of Water Practices M45, Second Edition*

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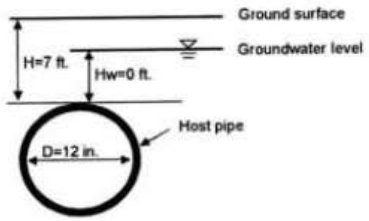
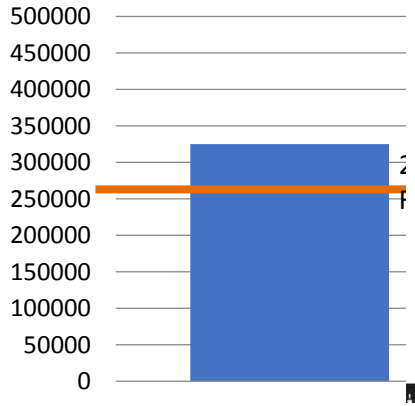
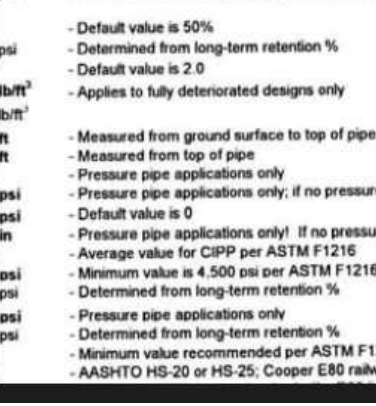


- Flexural modulus of Elasticity of CIPP, initial (psi)	E =	400,000 psi	- Minimum value is 250,000 psi per ASTM F1216
- Long-term retention of tensile properties (%)		50%	- Default value is 50%
- Long-term retention of flexural properties (%)		100%	
- Flex modulus of elasticity of CIPP, long-term (psi)	E_L =	400,000 psi	- Determined from long-term retention %
- Design safety factor	N =	2.0	- Default value is 2.0
- Unit weight of soil (pcf)	δ_s =	120 lb/ft³	- Applies to fully deteriorated designs only
- Unit weight of water (pcf)	δ_w =	62.4 lb/ft³	
- Depth of cover (ft)	H =	6.6 ft	- Measured from ground surface to top of pipe
- Height of groundwater (ft)	H_w =	0.0 ft	- Measured from top of pipe
- Is this an above ground installation?		No	- Pressure pipe applications only
- Internal pressure (psi)	P =	125.0 psi	- Pressure pipe applications only; if no pressure, input 0
- Internal vacuum pressure (psi)	P_V =	7.3 psi	- Default value is 0
- Diameter of hole or opening in original pipe wall (in)	d =	0.50 in	- Pressure pipe applications only! If no pressure, input 0
- Poisson's ratio of CIPP	ν =	0.30	- Average value for CIPP per ASTM F1216
- Flexural strength of CIPP, initial (psi)	σ_I =	10,000 psi	- Minimum value is 4,500 psi per ASTM F1216
- Flexural strength of CIPP, long-term (psi)	σ_L =	10,000 psi	- Determined from long-term retention %
- Tensile strength of CIPP, initial (psi)	σ_T =	13,000 psi	- Pressure pipe applications only
- Tensile strength of CIPP, long-term (psi)	σ_{TL} =	6,500 psi	- Determined from long-term retention %
- Enhancement factor (dimensionless)	K =	7.0	- Minimum value recommended per ASTM F1216
- Surface live loading condition		HS-20	- AASHTO HS-20 or HS-25; Cooper E80 railway or airport loading

LICENSED PROFESSIONAL ENGINEER
P. KERRIDGE
23513203
31 JAN 2019
PROVINCE OF ONTARIO

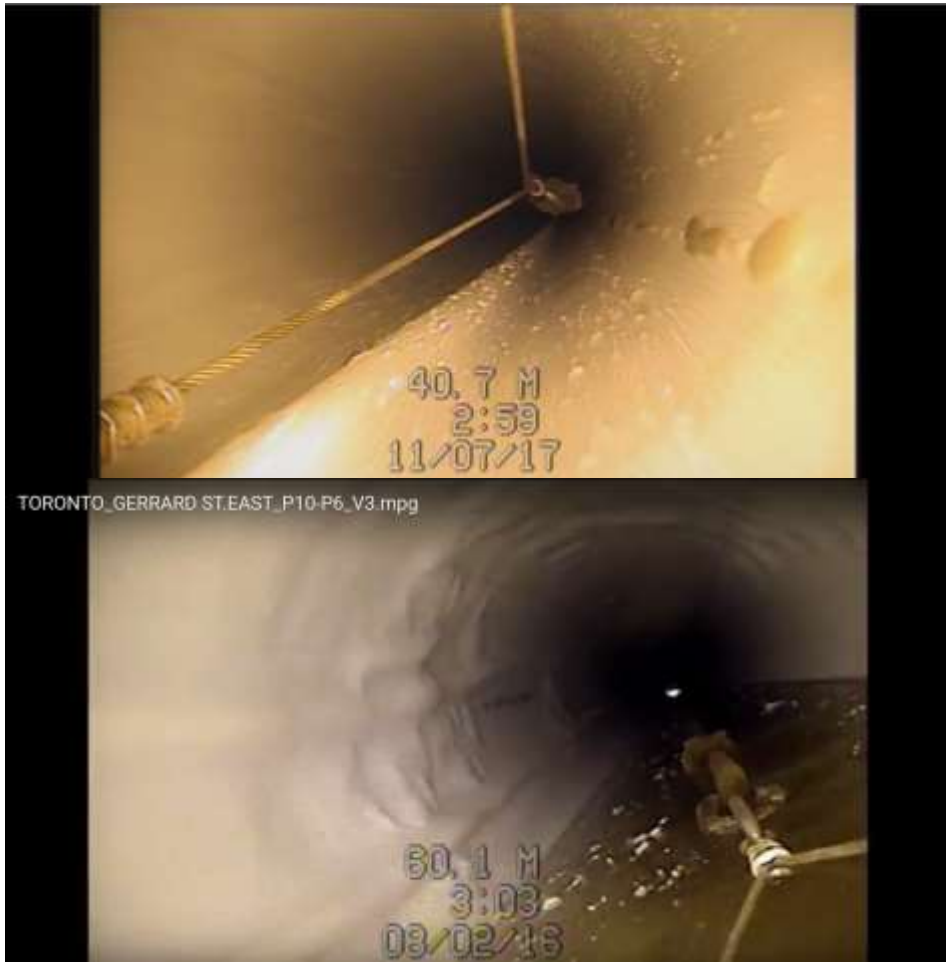
Flexural M



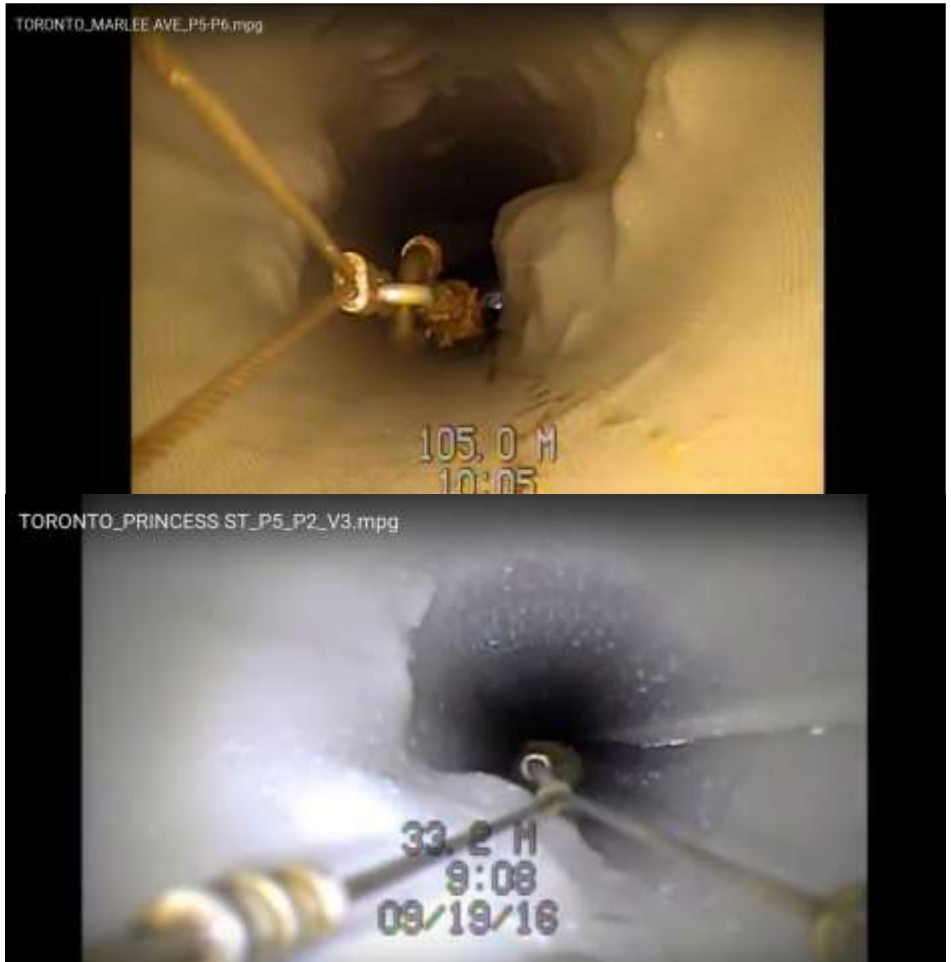


Defect Remediation

Benign



Cause for Remediation



Defect Remediation

Mis-drilled Service Reinstatement

PRESENTATION OVERVIEW:

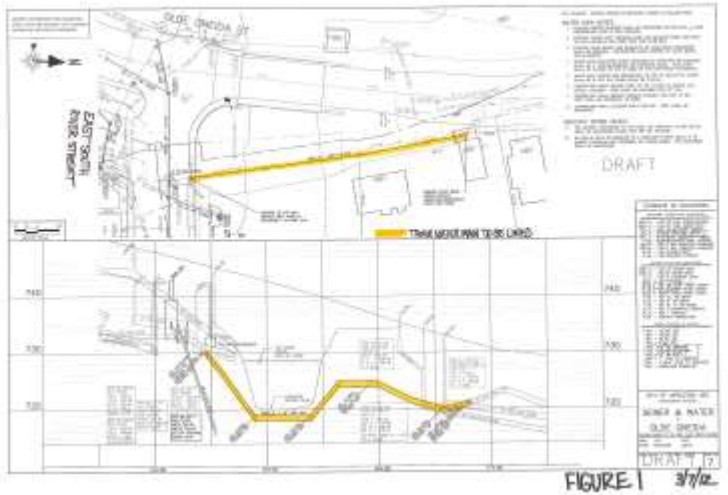
1) **Replace? Repair? Rehab?**
   - Making Effective Renewal Decisions
2) **Developing a Water Main Lining Project**
   - Design Criteria
   - Defining Project Scope
   - Servicing
   - Bidder Proof
   - Community Impacts
   - QA/QC Recommendations
3) **Lessons Learned**
   - ROW/Easements
   - What ifs?
   - Approval Agency
   - Ongoing Maintenance
   - Independent lab testing of material properties
   - Mitigating Future Failures

Easements:

Easements:

Lessons Learned

- ROW/Easements
- **What Ifs?**
- Approval Agency
- Ongoing Maintenance
- Independent lab testing
- Mitigating Future Failures



- "Experimental Basis" Approvals
- Communicate early intent to proceed with CIPP rehab
- Discuss intended scope
- Confirm design criteria
  - *All WM pipe = AWWA Pressure Class 150*
  - *100 psi working pressure*
  - *2.5 x safety factor,*
  - *50-year life*
- Confirm required testing
- Notice of Install/Reports
  - Primary Contacts:
    - Marvin Hansen, PE
    - Norm Hahn, PE

WISCONSIN
DEPT. OF NATURAL RESOURCES

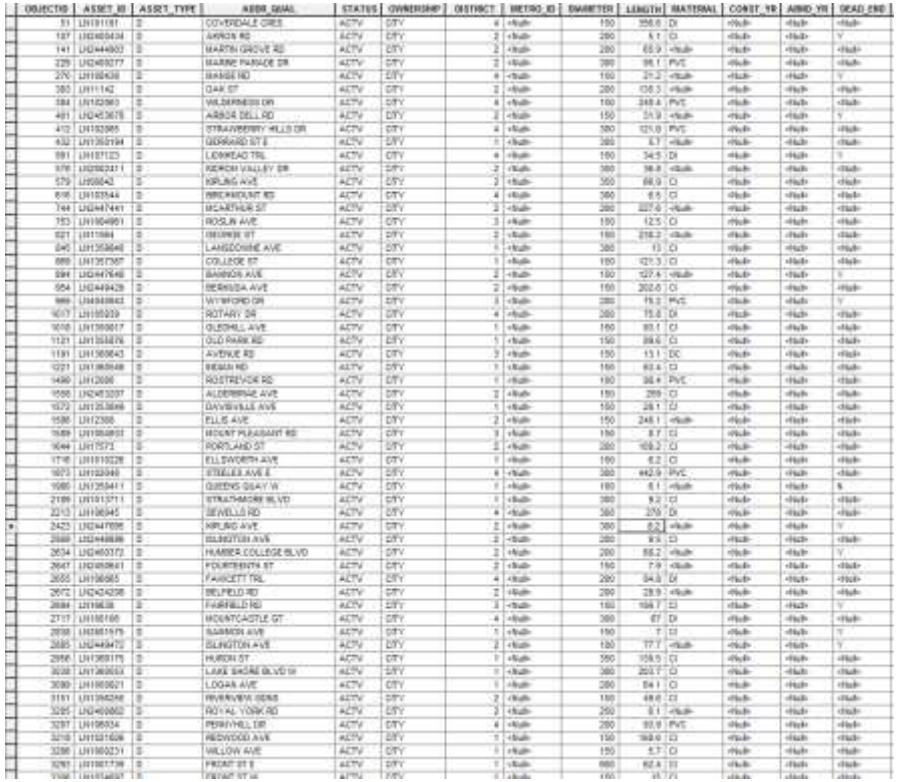
SUBJECT: WATER SYSTEM FACILITIES PLAN AND SPECIFICATION APPROVAL

Dear Ms. Witzel-Behl:

The Wisconsin Department of Natural Resources, Division of Water, Bureau of Drinking Water and Groundwater, is conditionally approving on an **"Experimental Basis"**, plans, specifications and special provisions for the following project. Information of sufficient detail to meet the requirements of s. NR 811.09 Wis. Adm. Code, was submitted for review.

Water system name: City of Madison
Date received: 08/15/2012
Engineering firm: City of Madison Water Utility

Receiving Data



- New geospatial data
- New assets
- Rehabilitation information
- Avoid duplication of entry by receiving information in the format required
- NO PAPER

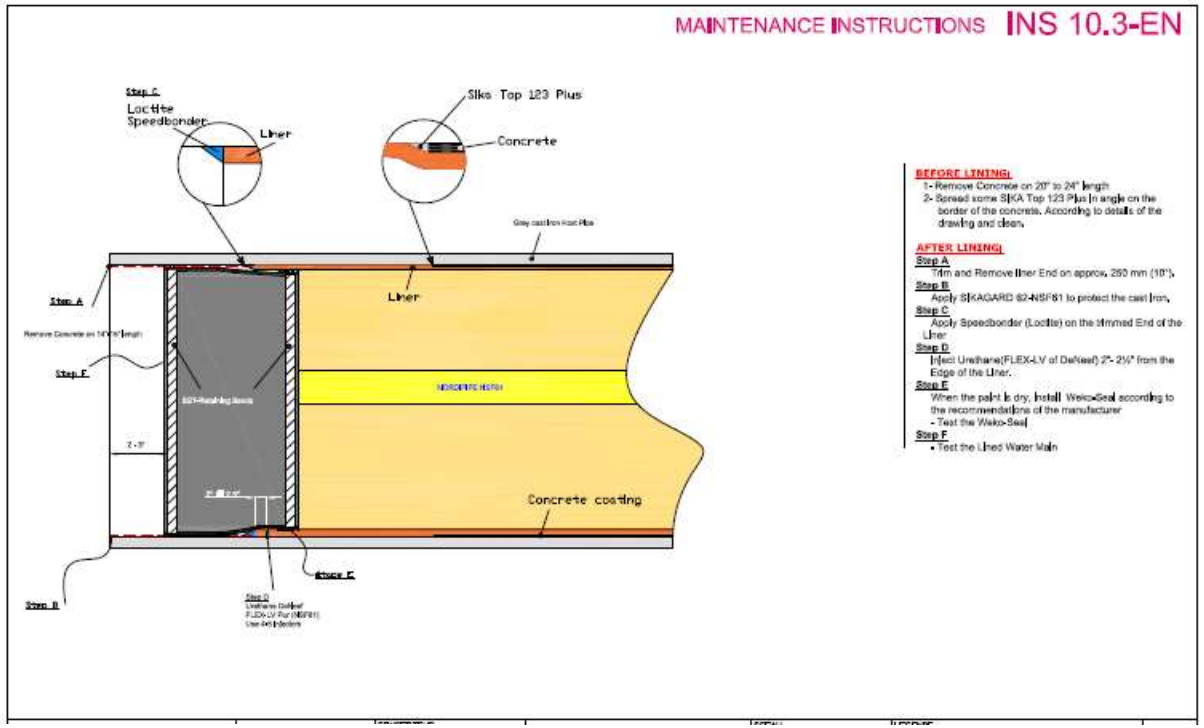
New tooling for tapping

Lessons Learned

- ROW/Easements
- What Ifs?
- Approval Agency

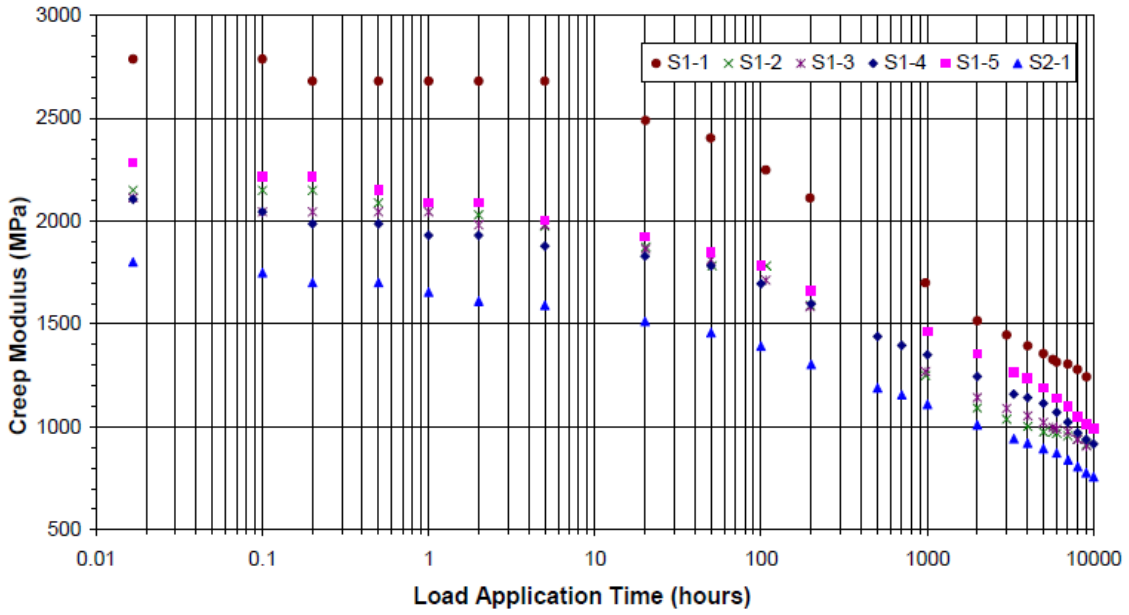
Lessons Learned

- ROW/Easements
- What Ifs?
- Approval Agency
- **Ongoing Maintenance**
- Independent lab testing
- Mitigating Future Failures



- Different materials prescribe different methods and materials to repair liners
- Need to consolidate to avoid confusion

- ASTM D2990, Standard Test Methods for Tensile Compressive and Flexural Creep and Creep-Rupture of Plastics



Lessons Learned

- ROW/Easements
- What Ifs?
- Approval Agency
- Ongoing Maintenance
- Independent lab testing
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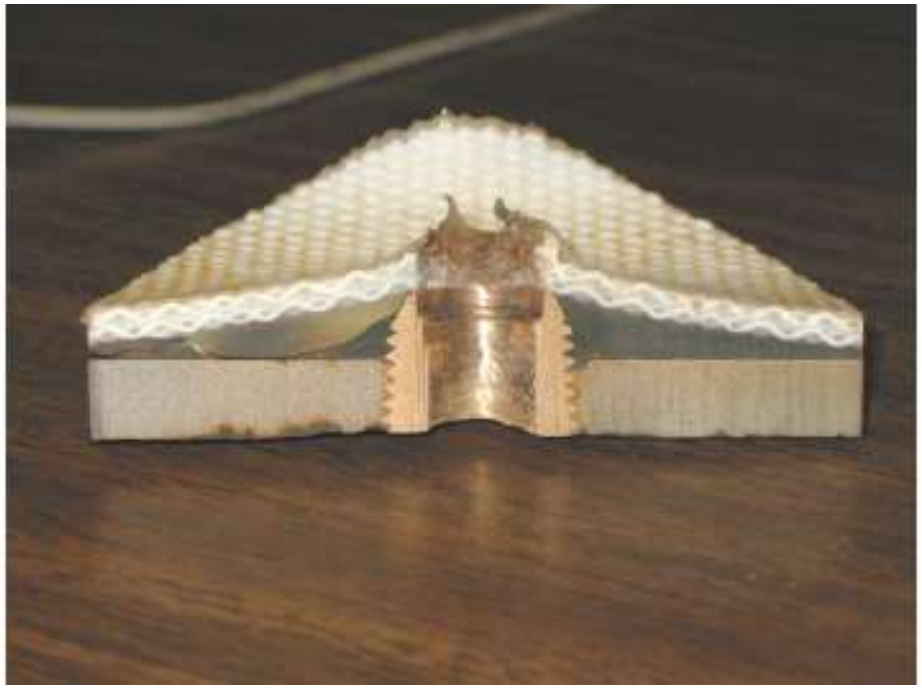

- Service connections might fail, lets go look!

Testing deflection properties

Documenting findings and improvements, circulate and communicate

Item	Location	Proposed by	Existing	Change
1	7.60.21	Randy Cooper		add in "Sharp edges", "around services" and "the pipeline shall also be dried and left free of visible moisture (free standing water) in both the pipe and pipe joints", and "pipe repairs approved by contract admin"
2	7.60.21	Mark Knight		"remove All rust, tuberculation" is over the top, you won't get all rust off. Use NACE cleaning level
3	7.60.21	Mark Knight		better define what we mean by bonding to the watermain surface
4	7.60.02.4b	Mark Knight	Third party verfication that the material proposed meets ASTM D1599, ASTM D2990...	Vague, there is no minimum. Change wording
5	7.60.02.4b	Sadesh Mahalingham	Third party verfication that the material proposed meets ASTM D1599, ASTM D2990...	In addition to this, the contractor should also submit the ASTM D2990- Creep testing for BOTH tensile and flexural. Just providing the flexural creep data is not sufficient as a tensile creep modulus result can be used to estimate the behavior of the material that is exposed to long term sustained and fluctuating internal pressure. Though no benchmark currently exist, I believe it would be prudent for the City to have the bidder supply third party studies relating to the liners performance under shear, bending and adhesion.
6	various	Sadesh Mahalingham	ASTM D1216-07 are being used.	Change all ASTM specifications to the current ones. ASTM F1216-16, ASTM F1743-17, ASTM F2019-11
7	7.60.28	Sadesh Mahalingham	bending up to 4% at the joints	Added in language to deflection, settlement or rotation that better predicts the CIPP liners threshold.
8	NEW	Sadesh Mahalingham		Rationality of the ASTM D2290
9	7.60.02.4b	Martin Bureau	ASTM D2990 testung	ASTM D2990 is a very broad standard. The Specification Document should clearly refer to creep modulus data (as opposed to creep-rupture) to be provided. Relevant stress levels for creep testing should be provided (e.g., between x% and y% of yield or maximum strength...). Also, long term properties are important both in a context to top load (liner bending) and internal pressure (positive or negative). Since the design guidelines employed in ASTM F1216 are based on flexural modulus for the former and tensile strength for the latter, it should be mandatory to provide long-term creep factor in both flexural and tensile modes.