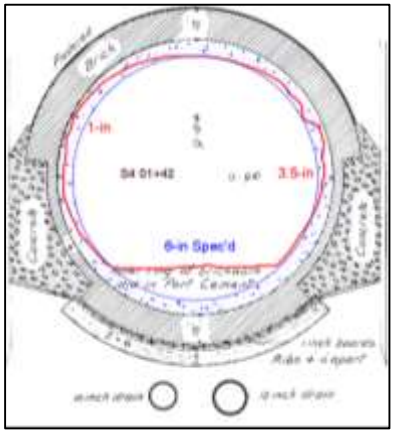
Hazen



North Metropolitan Sewer
Sections 4, 5, 6, and 186 Study

LiDAR Scanning and Strategies to Guide Rehabilitation Planning

January 28, 2019

About the NMS…

- 120 (+/-) years old
- Conveys flow to the Winthrop Terminal Facility (135 MGD during wet weather)
- Two previous rehabilitation efforts

And then this happened…

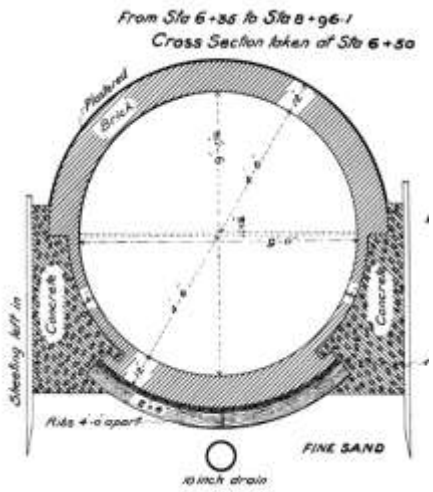
- Large piece of plastic discovered on inlet screen to Winthrop Terminal
- MWRA video inspection unit locates source
- Contractor hired to remove additional loose liner

- Videos showed peeling epoxy liner
- Contractor noted shotcrete was soft in places
- The only way to understand extent of the issue was a manned inspection and internal scan
- RFQP issued

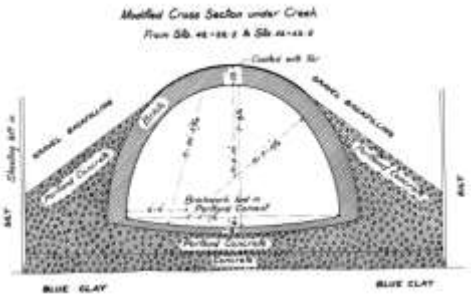
Project Location

Representative Pipe Cross Sections

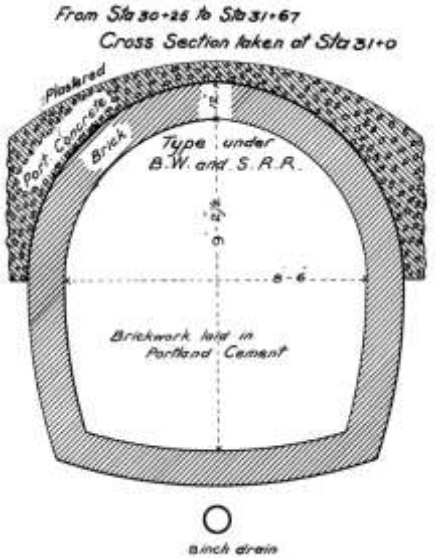
Circular Shape



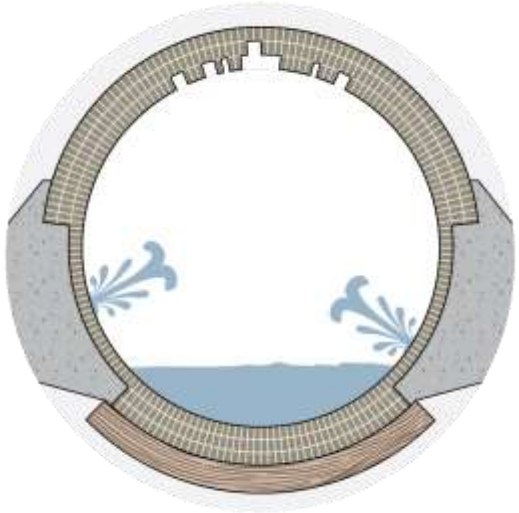
Dome Shape



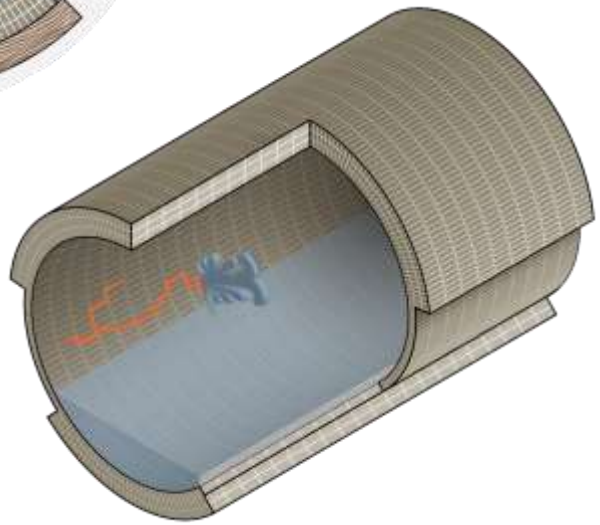
Horseshoe Shape



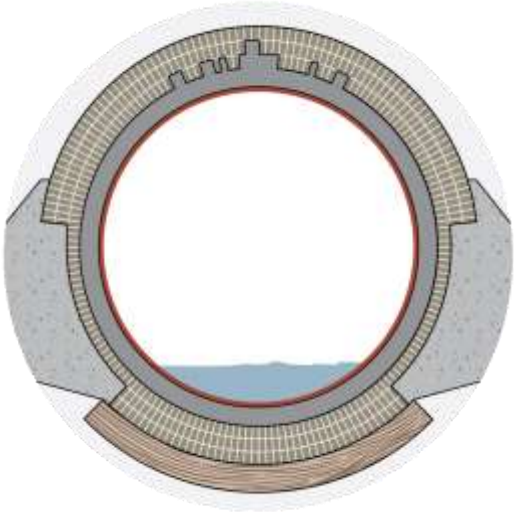
1980s – CCTV Inspection



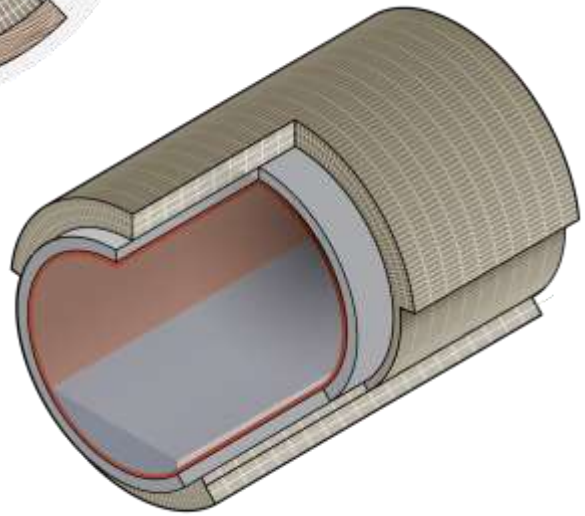
- Sewer constructed in 1890s
- Bricks missing
- Infiltration
- Deteriorating mortar



1992 – Phase 1 Rehabilitation

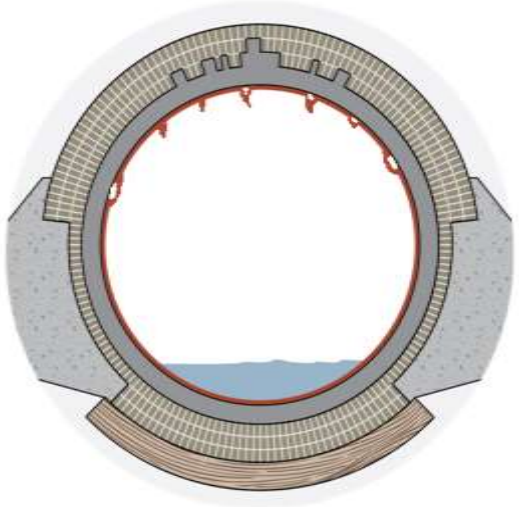


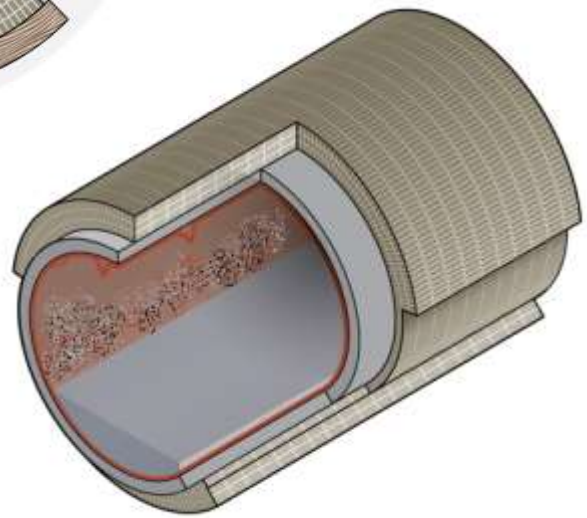
- 3,200 LF
- 5-6” shotcrete
- Wire mesh for structural support
- **60 mil epoxy coating**

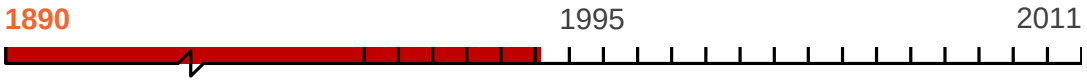


1994 or 1995

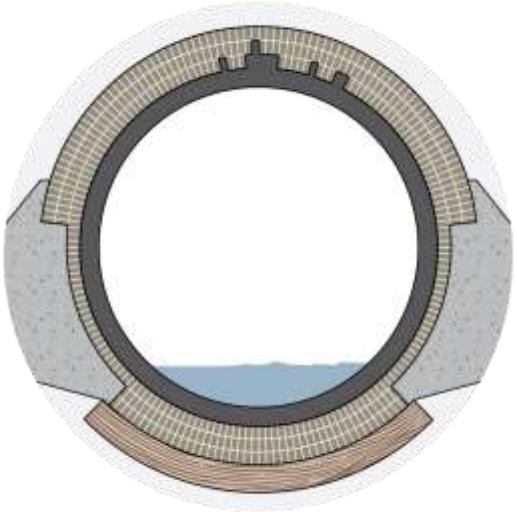
Epoxy delamination



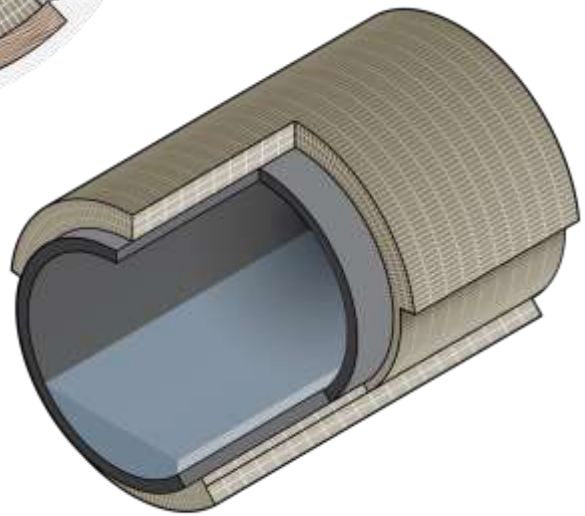


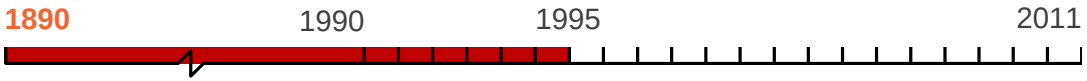


1995 – Phase 2 Rehabilitation



- 10,500 LF
- 3-4” shotcrete
- 8% microsilica (MS)
- No epoxy coating





Existing Condition - Investigations

- Pipe and Manhole inspections
  - CCTV (PACP)
  - Pipe walk and sounding
  - Petrographic Testing
  - LiDAR
- Hydraulics
- Corrosion
- Permitting
- Real estate/easements
- Project coordination


Hazen Memorandum

February 1, 2018 REVISED DRAFT

To: Massachusetts Water Resources Authority

Re: Sections 4, 5, 6 and 186 Study
MWRA Contract No. 7423

Sewer and Manhole Inspections and Evaluations Technical Memorandum (TASK 2.4.1)

1. Overview

The Study Area portion of the North Metropolitan Sewer consists of Massachusetts Water Resources Authority (MWRA) Sewer Sections 4, 5, 6, and 186. Sections 4, 5, and 6 are brick sewers, which were built between 1891 and 1892 in a variety of circular and horseshoe shapes. Flows from the Cities of Revere, Chelsea, and East Boston pass through the MWRA Curtain Pump Station and contribute to the North Metropolitan Trunk Sewer (NMS) upstream of the Bell Isle Inlet between the Towns of East Boston and Winthrop. Within Sections 4, 5, and 6, local Winthrop sewers contribute to the interceptor. At the downstream end of the sewer, the legacy Shirley Gut Siphon (Section 5 of 5) that spanned the narrow waterway between Shirley Point (Winthrop) and Deer Island was abandoned and replaced with Section 186 in 1999. The new approximately 600 foot long section of 108-inch diameter pipe consisted of a steel arch, prestressed concrete cylinder pipe (PCCP), and a concrete weir. Section 186 follows the access road to the Deer Island Treatment Plant. In 1992 and 1995, segments of the NMS in Winthrop were rehabilitated. The segments rehabilitated in Phase I (1992) were lined with shotcrete and coated with epoxy. The remainder of Sections 4, 5, and 6, which were rehabilitated in Phase II (1995), were lined with a combination of embedded plastic liner, bolted plastic liner, and plastic liner adhered with an adhesive. In 2011, pieces of the plastic liner were discovered on the inlet screens of the Winthrop Terminal Facility. This prompted Closed-Circuit Television (CCTV) inspections of Sections 4, 5, 6, and 186 and a manned pipe walk of Section 186 to locate the area of the deficient liner. In 2011, approximately 60 LF of the plastic liner was removed between Stations 5+78 and 5+14 of Section 186 based on JF White's manned inspection. The scope of this project includes evaluating the condition of, and developing a rehabilitation plan for, 15,000 linear feet of Sections 4, 5, 6 and 186 of the NMS.

This memo summarizes the pipe and manhole inspections conducted as part of this project and provides an evaluation of Sections 4, 5, 6 and 186 in fulfillment of Task 2.4.1 of Contract 7423. Hazen reviewed the CCTV footage for the pipe segments of Sections 4, 5, 6 and 186, obtained during a pipe walk performed between June 20th and 28th, 2017 by the Ted Berry Company (under subcontract to Hazen), in accordance with National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) procedures. Hazen also performed (via subcontract to Bryant Associates) as visual manhole inspections in accordance with NASSCO Manhole Assessment Certification Program (MACP) procedures. Both were performed in order to evaluate the interceptor's structural condition and the feasibility of its rehabilitation. Hazen (via subcontract to Bryant Associates) performed a survey of the manhole rims along Sections 4, 5, 6 and 186, obtaining rim elevations and horizontal locations (northing, easting) in order to create an alignment and profile of the NMS to be used during preliminary design. Additionally, Hazen reviewed the Light Detection and Ranging (LIDAR) data obtained during the Ted

CCTV Review – Liner and Surface Defects

Condition of shotcrete?

Liner delamination

Surface spalling

CCTV Review – Reinforcing Steel Exposed

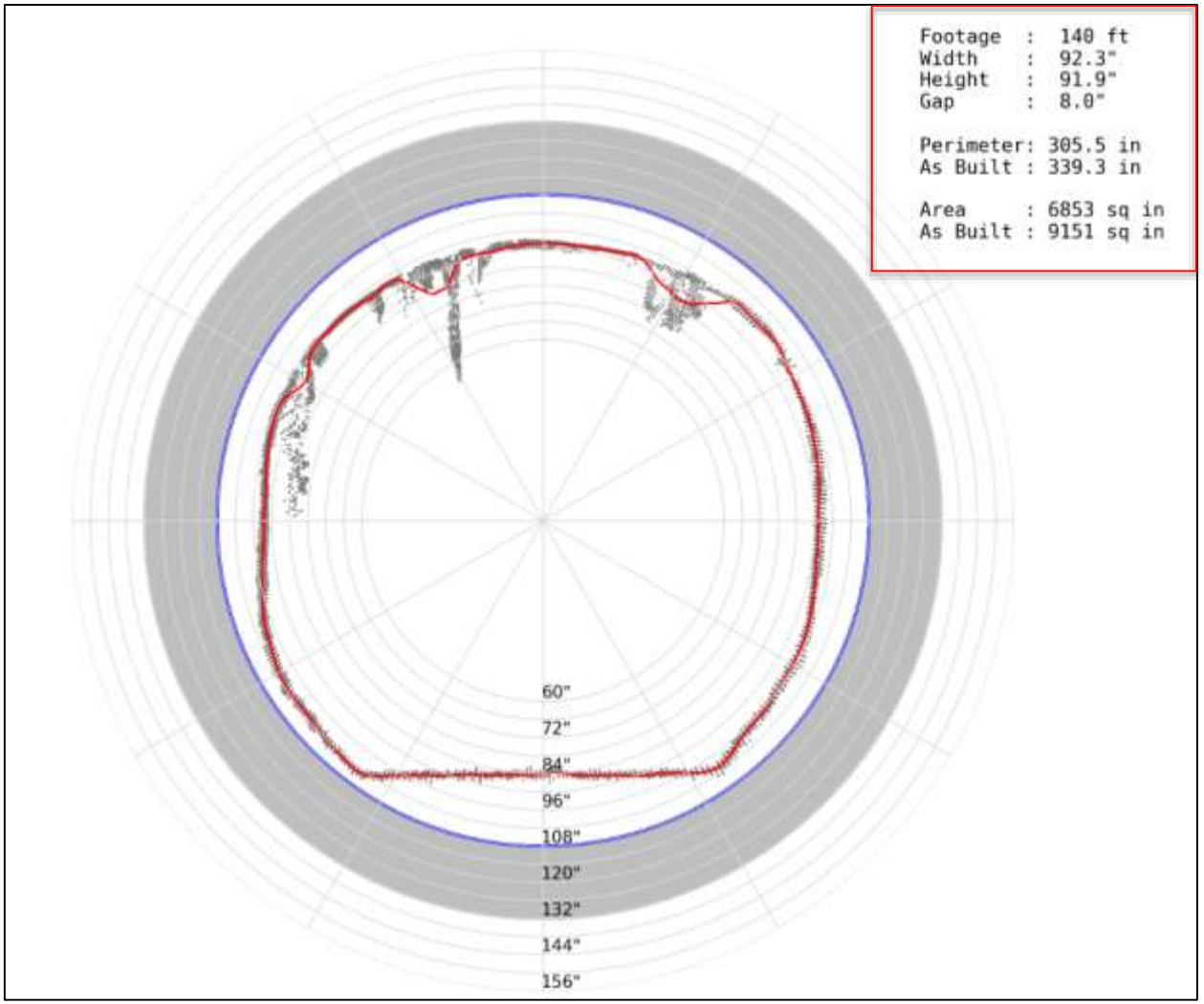
~35 LF of exposed rebar

~25 LF of exposed rebar

Pipe Walk and Soundings

LiDAR - Light Detection and Ranging

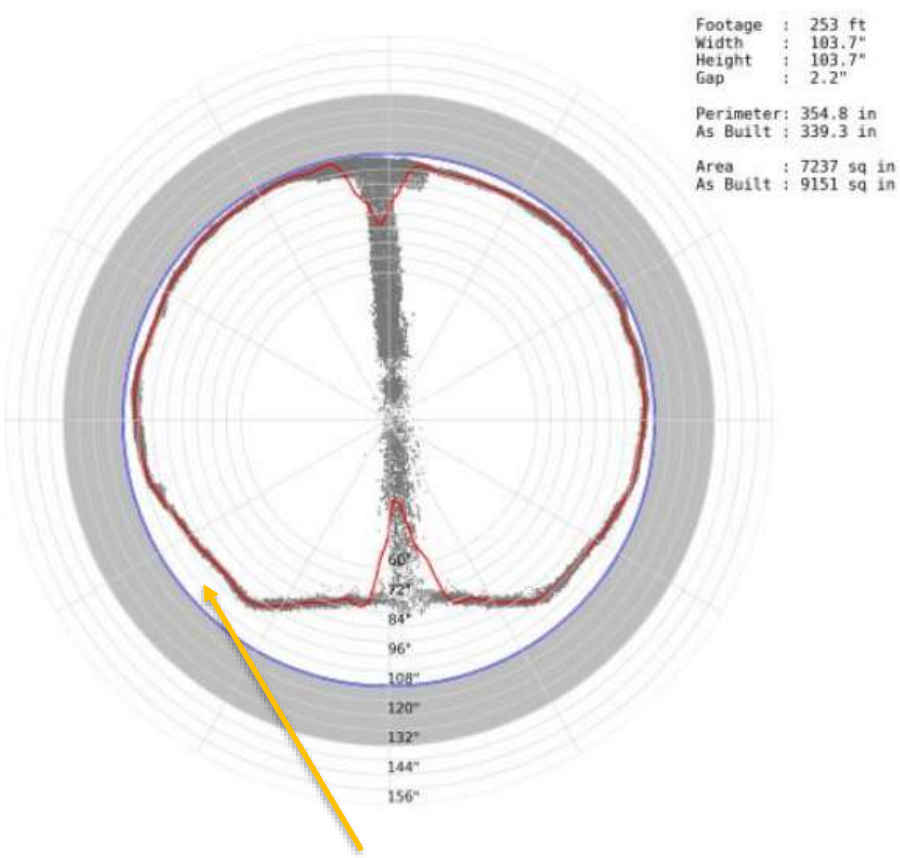
Typical LiDAR section (1 foot)

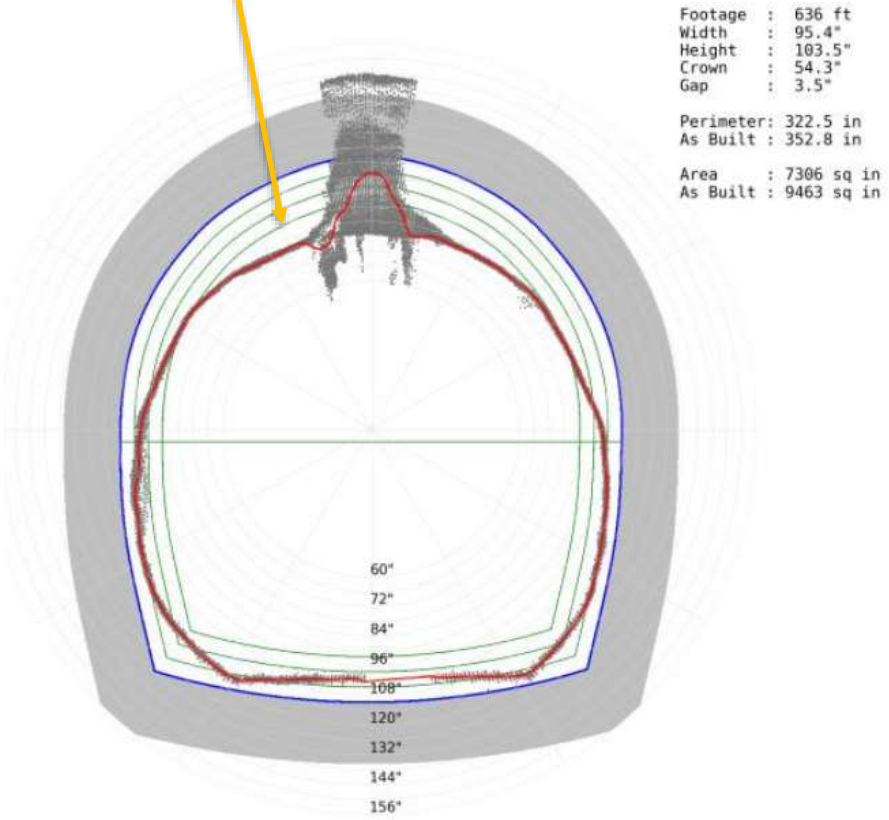


LiDAR

Careful QC is required

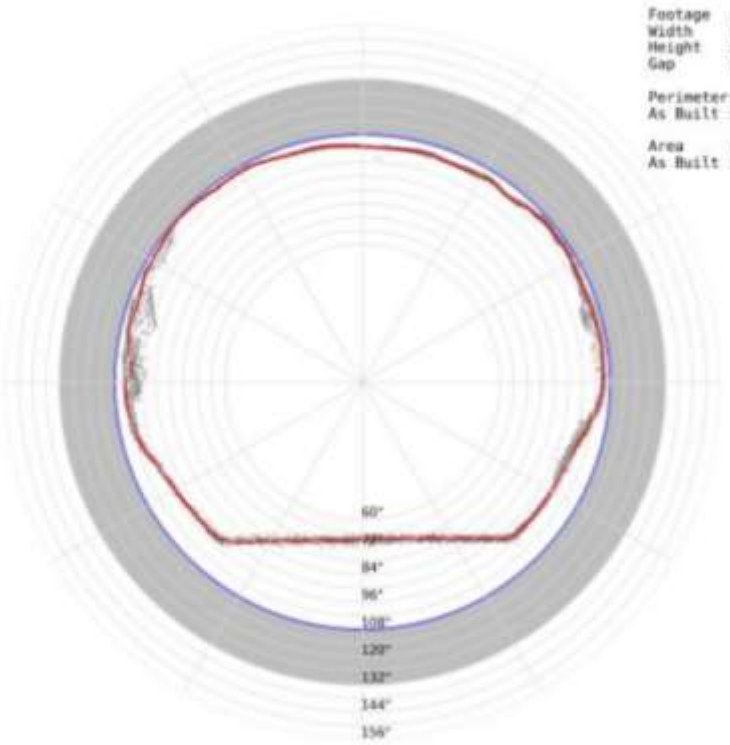
Several feet of shotcrete?

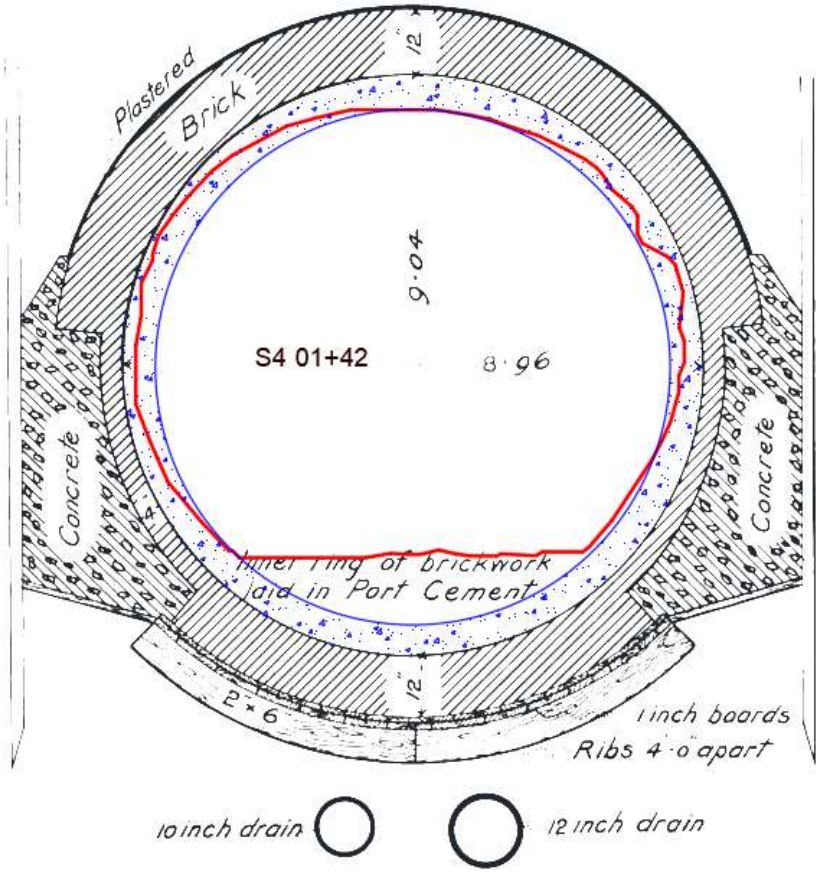




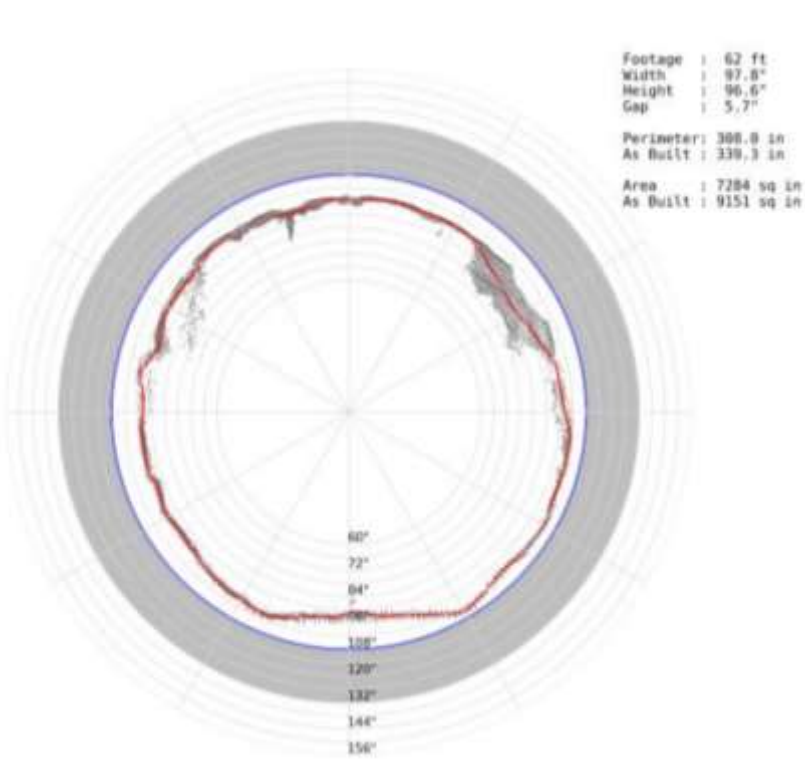
LiDAR Overlay of NMS

Adjustment of results

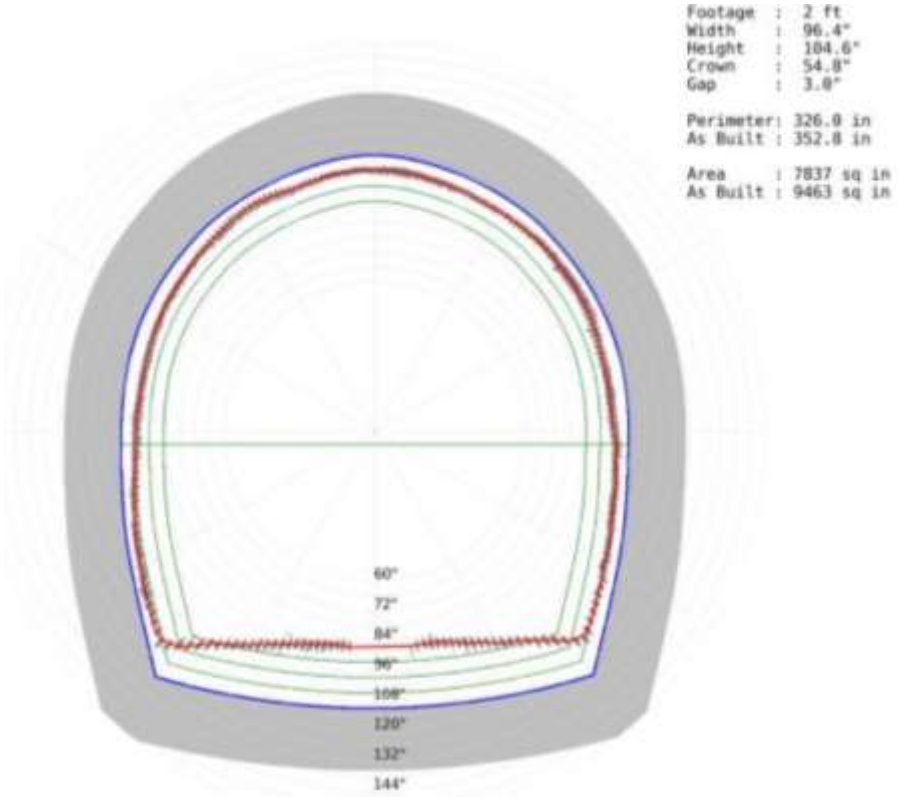




LiDAR



Phase I Rehabilitation

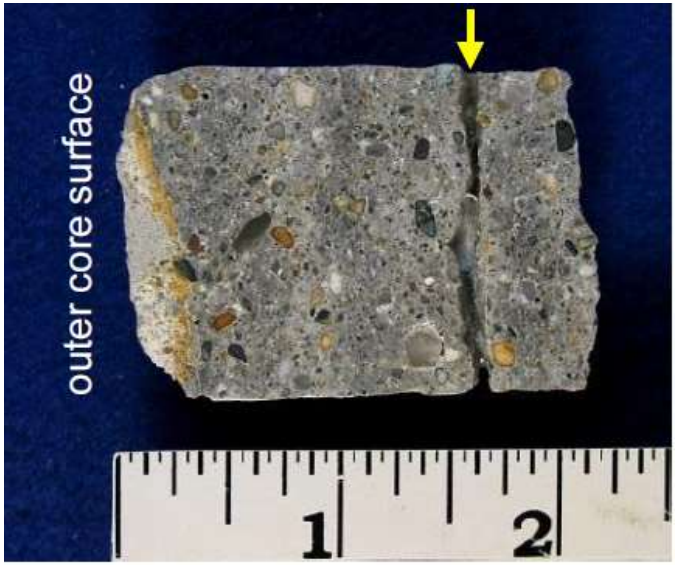


Phase II Rehabilitation

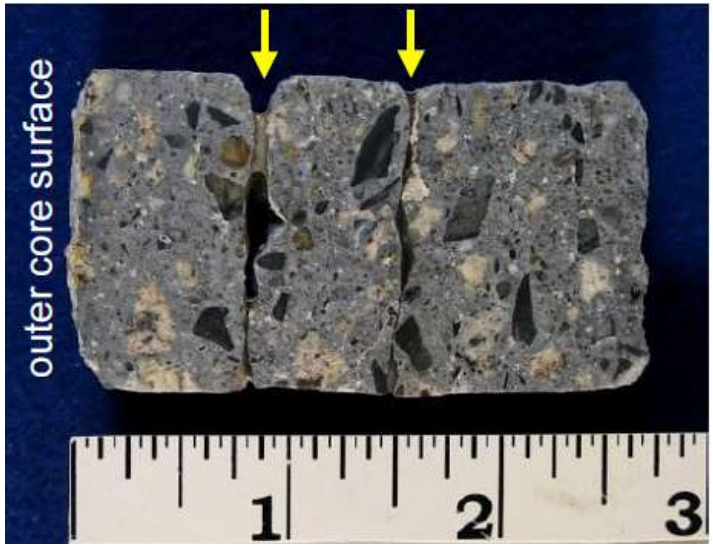
Core Samples and Petrographic Analysis

17 core samples subjected to petrographic analysis

- 4 in Phase I shotcrete (spec'd at 5" to 6")
- 13 in Phase II shotcrete (spec'd at 3" to 4")



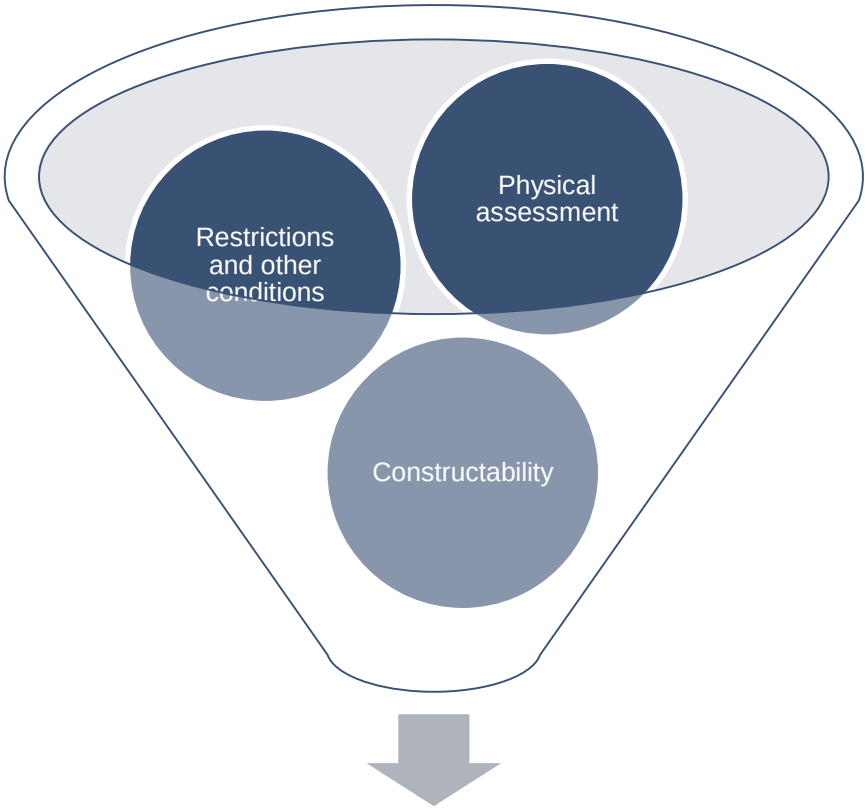
Core at STA S004 0002+62 (spec'd at 6")



Core at STA S004 0048+32 (spec'd at 3")

Other Evaluations

- Hydraulic capacity evaluation
- Bypass pumping
- Corrosivity
- Traffic assessment
- Permitting
- Project coordination



Pipe Rehabilitation - Considerations

- Proven fully structural solution with 50-year design life
- Bypass pumping requirements
- Pipe surface preparation requirements
- Construction impacts on Winthrop residents and businesses
- Corrosion resistance

Rehabilitation Options

- Cured-In-Place Pipe (CIPP) lining
- Slip-lining / Segmental lining
- Spiral-wound lining
- Spot repairs:
  - Fiber Wrap
  - Chemical grouting
  - Joint seals
- Spray-on linings:
  - Epoxy and Polyurethane
  - Cementitious
  - Geopolymer

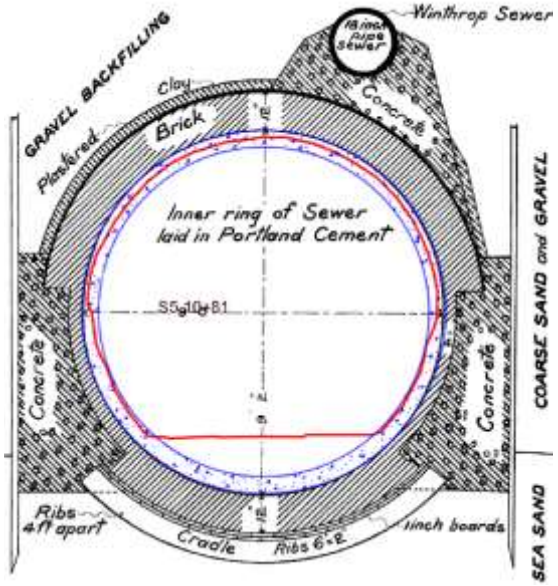
Methods not recommended

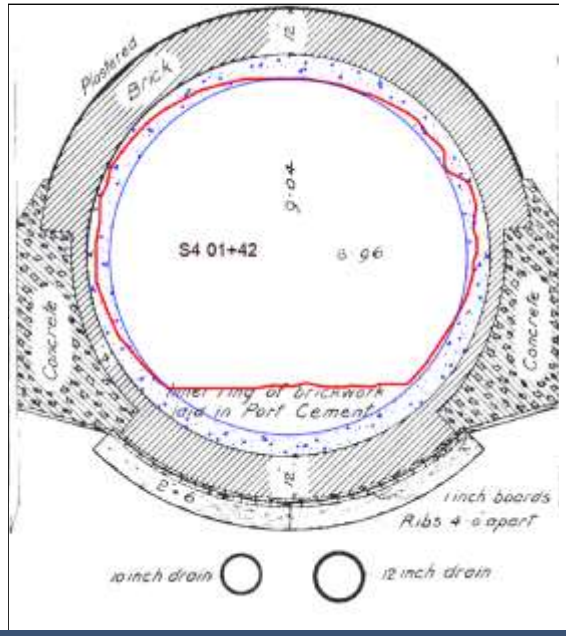
Technology	Reasons			
CIPP	*Full Bypass*	*Styrene cure water*	*Wet-out facilities*	*Excessive cure time*
Spray-on (over degraded shotcrete)	*Surface preparation would be impractical and unsafe*	*Not fully structural*	*Internal bypass*	*QA/QC inspection in NMS*
Spiral wound	*Radii smaller than can be navigated*	*Wet weather flows would make nearly infeasible*	*Varying amounts of bypass*	
Point Repair (Fiberwrap)	*Full Bypass*	*Surface preparation would be impractical*	*Not proven*	

Recommended Methods

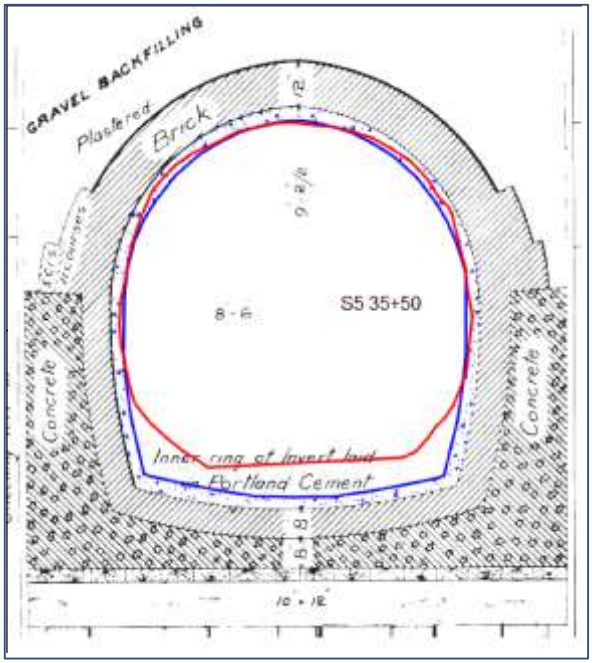
Technology	Reasons			
Slip-lining	*Bypass pumping not needed*	*Fully structural*	*Corrosion resistant pipe*	*Many straight runs lends itself to slip-lining*
Segmental lining (25' of exposed rebar)	*Structural repair (wire mesh is likely already compromised)*	*Prevent further corrosion*		
Spray-on (over exposed steel)	*Prevent corrosion / rust of exposed steel*	*Shotcrete with MS has been proven within the NMS*	*Potentially improve flow hydraulics*	
Chemical grout	*Infiltration should be stopped to prevent sinkholes*		*Infiltration must be stopped before spray-on lining of steel pipe*	
Internal Joint Seal	Infiltration in sand catcher chamber might be too heavy for chemical grouting			

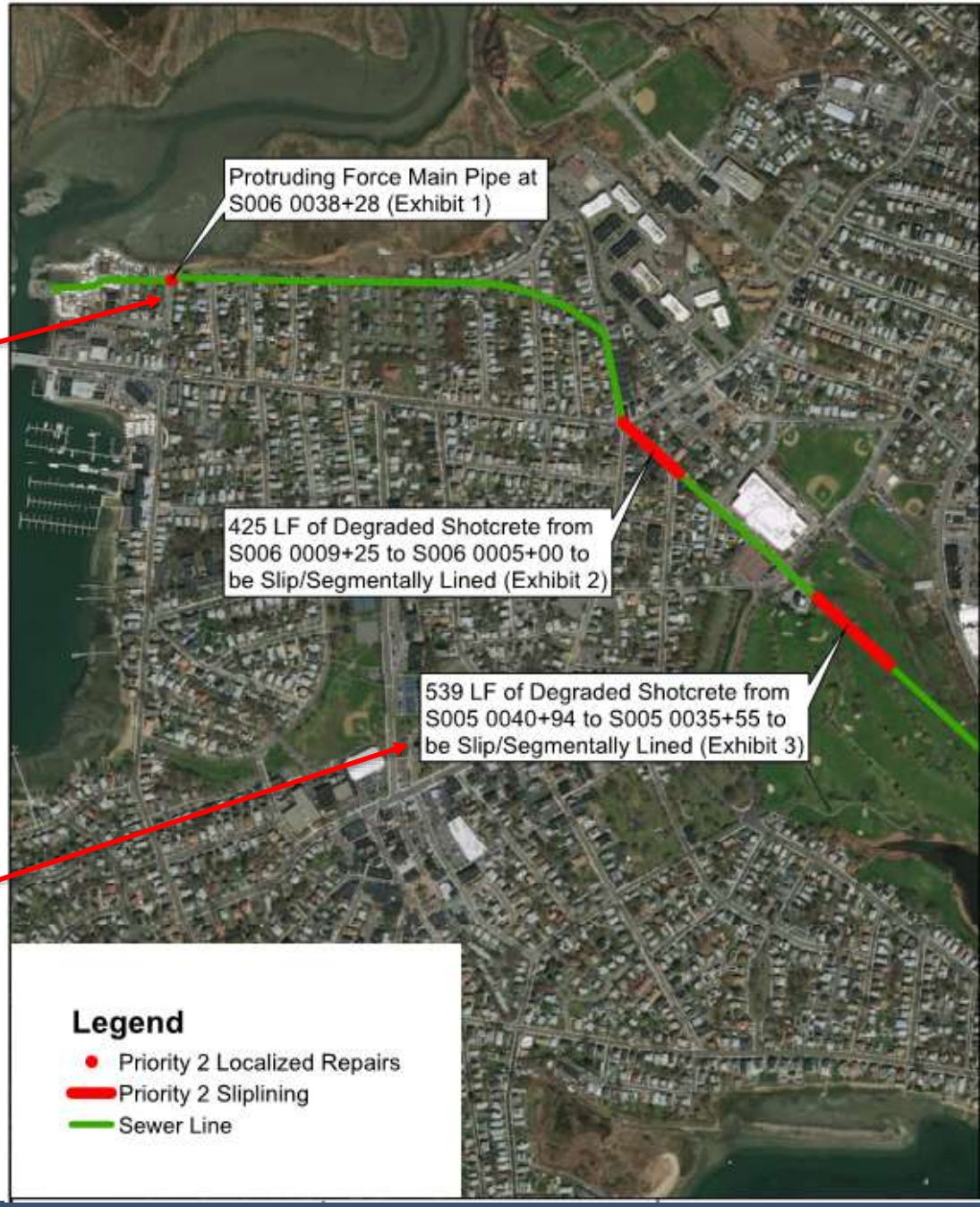
Recommendations





Recommendations





Conclusion

- Use of advanced condition assessment tools: effective, but requires careful QC and understanding
- Fully utilize institutional knowledge
- Complete understanding of project environment results in better planning
- Full market analysis of rehabilitation technologies required