Proper Planning & Analysis Results in a Focused, Cost Effective Pipeline Rehab Project

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WHAT TO EXPECT

- **Front End Planning & Early Stage Analysis**
  - Condition Assessment
  - Design Considerations
  - Trenchless Options

- **Project Overview**
  - Project Background
  - Project Specifics
  - Challenges

LOCATION – TOWN OF BROOKLINE

- Part of Greater Boston
- Population of ~60,000
- Close proximity to downtown Boston / Fenway Park
- MBTA Green Line Route
- Birthplace of JFK
- Very Affluent Community

PIPELINE ORIGINS

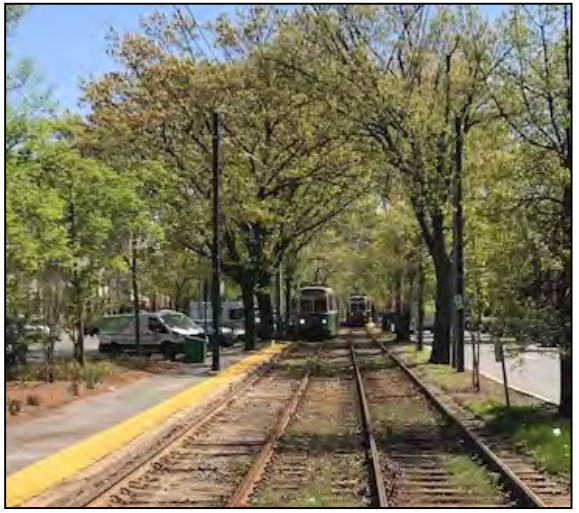
- Original line installed in 1870
- Cement mortar lined in 2000
- 2006 sinkhole under tracks from crack/leaks
- Similar issues in 2013
- Currently feeds 21,500,000 GPD of potable water to the Boston Low Service System (13%)

Original Pipe Installation

2006 Excavated Repairs

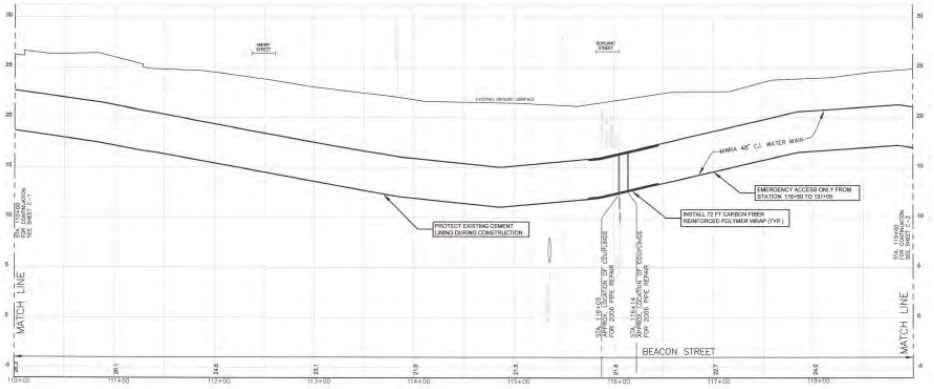
LOCATION – MBTA GREEN LINE

- “C Branch”
- 300 Trips to/from Boston daily
- Serves more than 14,500 daily passengers
- Two parallel sets of tracks directly on vertical alignment of 48” pipeline



ENGINEERING CHALLENGES

- **Minimize Disruption**
  - Previous open cut projects severely impacted area
- **Keep Greenline Open**
- **Constrained Access**
  - Alignment under railway requires distant access points
- **Horizontal & Vertical Alignment**
  - Multiple elevation changes



FEASIBILITY PLANNING

- **8 Different Rehabilitation Options:**
  - Cured-in-Place Pipe (CIPP)
  - Fusible PVC® Sliplining
  - Compressed Fit HDPE Sliplining
  - Standard HDPE Sliplining
  - High Strength HDPE Sliplining
  - Steel Sliplining
  - Segmental Steel Sliplining
  - Carbon Fiber Reinforced Polymer (CFRP)

- **Options Short-listed (4)**

REHABILITATION OPTIONS - FEASIBILITY

Standard HDPE Sliplining

High Strength HDPE Sliplining

Segmental Steel Sliplining

Fiber Reinforced Polymer (FRP)

REHABILITATION OPTIONS - COST

Standard HDPE Sliplining

$2.5M / 37.8” ID

High Strength HDPE Sliplining

$2.4M / 34.3” ID

Segmental Steel Sliplining

$2.7M / 40.5” ID

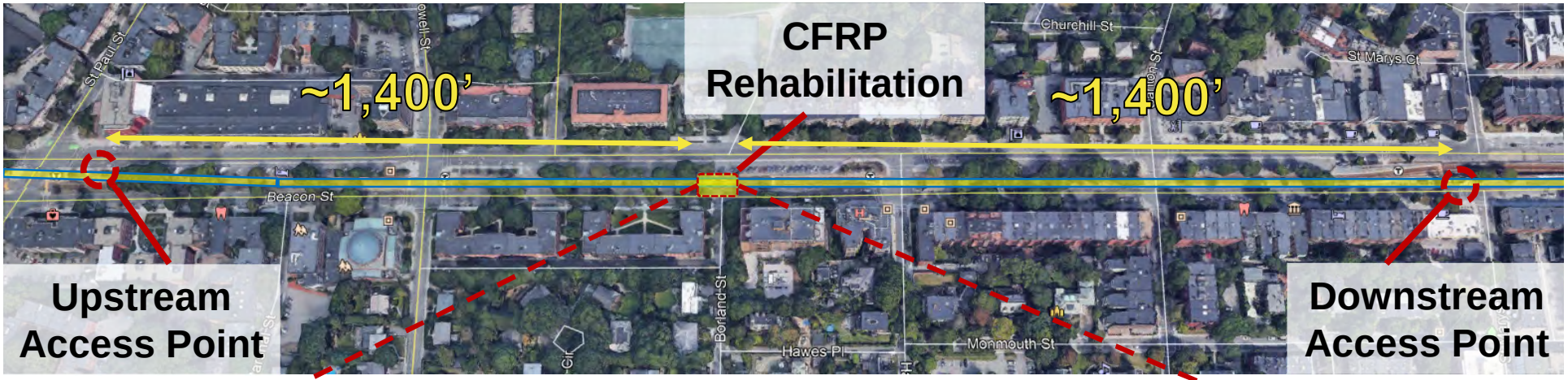
Fiber Reinforced Polymer (FRP)

$800K / 47.5” ID

PROJECT OVERVIEW

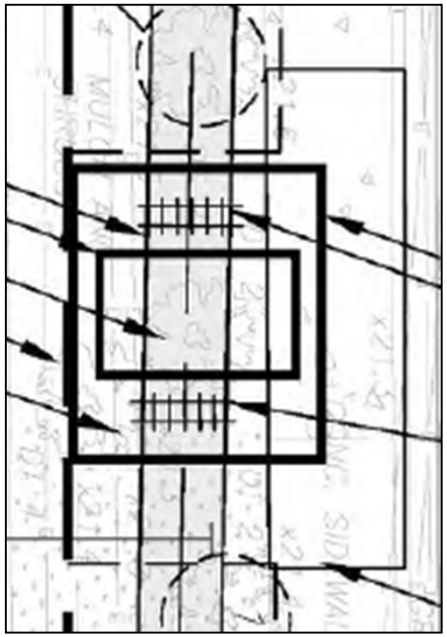
- Trenchless Rehab – 72 LF of 48” Cast Iron Water Main (8’ of DIP)
- Underneath Railway
- Heavy Traffic Area
- 90 psi Operating / 135 psi Transient Pressures
- Hand Applied CFRP / GFRP
  - Finished Thickness ~1/4”
- AWWA M28 Class IV – Fully Structural

CONSTRUCTION OVERVIEW



72’ Repair Scope

PROJECT OVERVIEW



PROJECT OVERVIEW

Downstream Access Point

WHY FIBERGLASS REINFORCED POLYMER?

Rapid Mobilization / Fast Material Procurement

- Amendable to emergency or quick-turnaround work
- Materials stocked and ready for immediate mobilization
- Crews onsite/working a few days after contract

WHY FIBERGLASS REINFORCED POLYMER?

- **General Access**
  - Small footprint
  - Access point limitations
  - Can utilize existing manways
  - Installation is all manned entry

- **Site Specific**
  - Limited staging area
  - Two distant access points 1,400 feet away
  - Fast Installation
  - Minimal impact to residents, business owners, public transportation, etc.

PROJECT CHALLENGES

- **Distance Between Entry Points**
  - Production Impact
  - Safety
- **Small Footprint**
  - Access vs. Install
- **High Profile / Social Impact**

DESIGN SUMMARY

Design Parameter	Input
Pipe Internal Diameter	48”
Pipe Type	Cast Iron / Ductile Iron
Design Standard	AWWA C305 Design Standard
Operating Pressure	90 psi
Traffic Loading	Two MBTA Green Line Trains at Fully Capacity (AW3)
Soil/Water Height	7 feet

Longitudinal

Hoop

Notes on FRP Design:

1. Carbon FRP layers utilized for strength
2. Glass FRP layers utilized as dielectric and watertightness barriers (non-structural)
3. Customized for pipe diameter

FRP PROCESS – APPLICATION

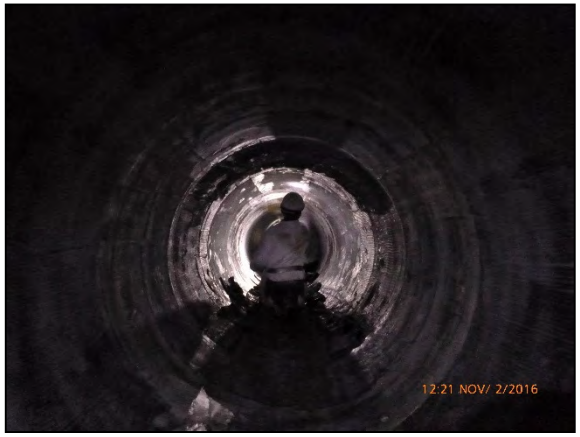
1. GFRP for steel
2. Hoop CFRP
3. Long CFRP
4. GFRP for watertightness
5. Hoop CFRP

Nominal Thickness of 0.26”

~½” Cross-sectional ID Loss

FINAL PROJECT SUMMARY

- 72 LF of FRP Rehabilitation
- 2 Access Points
  - ~3,000 LF apart
- Small Install Footprint
- Massive savings:
  - Disruption
  - Time
  - $$ Cost / Social Cost
- AWWA Class IV Fully Structural Remediation
  - ~1/2” Cross-sectional ID Loss



ANALYSIS SUMMARY

Front End Analysis and Evaluation Resulted In:

- **Minimized Access Points / Impact**
  - ~3,000 LF apart
- **Identified Need & Vehicle for Localized Repair vs. Total Length Repair**
  - 72 LF of FRP Rehab vs. 3,000 LF
- **Maximized Flow**
  - Approx ½” ID loss vs. 8”-15” ID loss
- **Costs Savings**
  - $800k vs. ~$2.5m

QUESTIONS?

THANK YOU!

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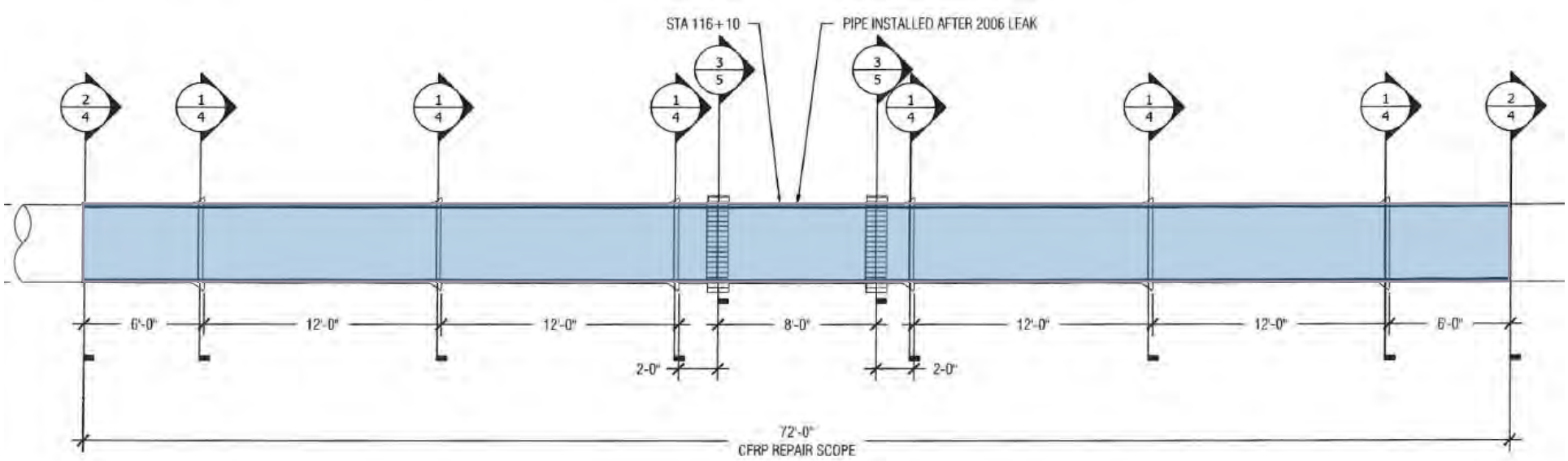
QUESTIONS?

SUPPLEMENTAL SLIDES

FRP DESIGN



48” Dia. Steel Pipe

FRP Design:

- Glass FRP: 2 layers to act as a dielectric & watertightness barrier
- Hoop Layers: 2 layers of Carbon FRP System
- Longitudinal Layers: 1 layer of Carbon FRP System

FRP INSTALLATION OVERVIEW

- ACCESS (MANWAY OR EXCAVATION)
- BYPASS / FLOW DIVERSION
  - HOT TAP / LINE STOP
- CLEANING / SURFACE PREP
- INSTALLATION
  - SATURATION / HAND LAYUP
- QA/QC TESTING
- RESTORATION
  - (IF NEEDED)

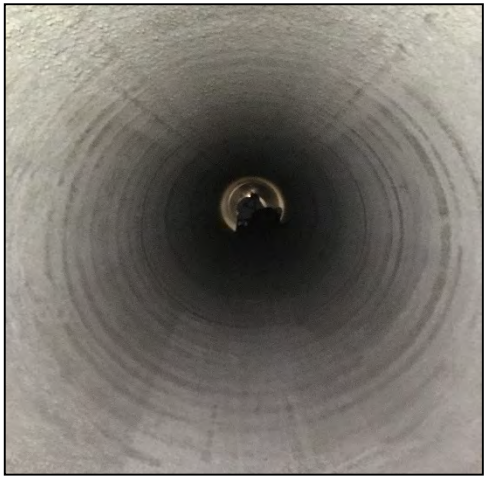
FRP PROCESS – SURFACE PREP

Ventilation Plan

High Pressure Water or Sand Blast

- Media capture

Steel: SSPC SP-10 profile (Near white metal)



QA/QC TESTING

- Minimum (3) 2 ft. x 2 ft. panels on adjacent non-repair pipes
- Prepared and tested by Installer (ASTM D4541)
- >200 psi required for at least 3 tests per panel
- Witnessed by Inspector