Protecting Critical Infrastructure: Phases 1 and 2 of the Beardsley Force Main Renewal

"A Walk in the Park"

NEWEA Annual Conference

January 28, 2025

Introductions

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- *Scott Haynes, PE, Technical Expert*

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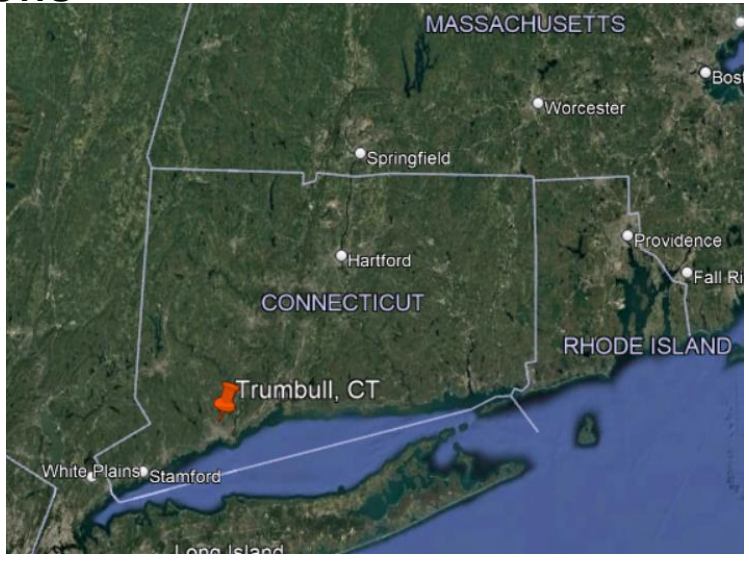
- *Julie Bjorkman, PE, Permitting Specialist*

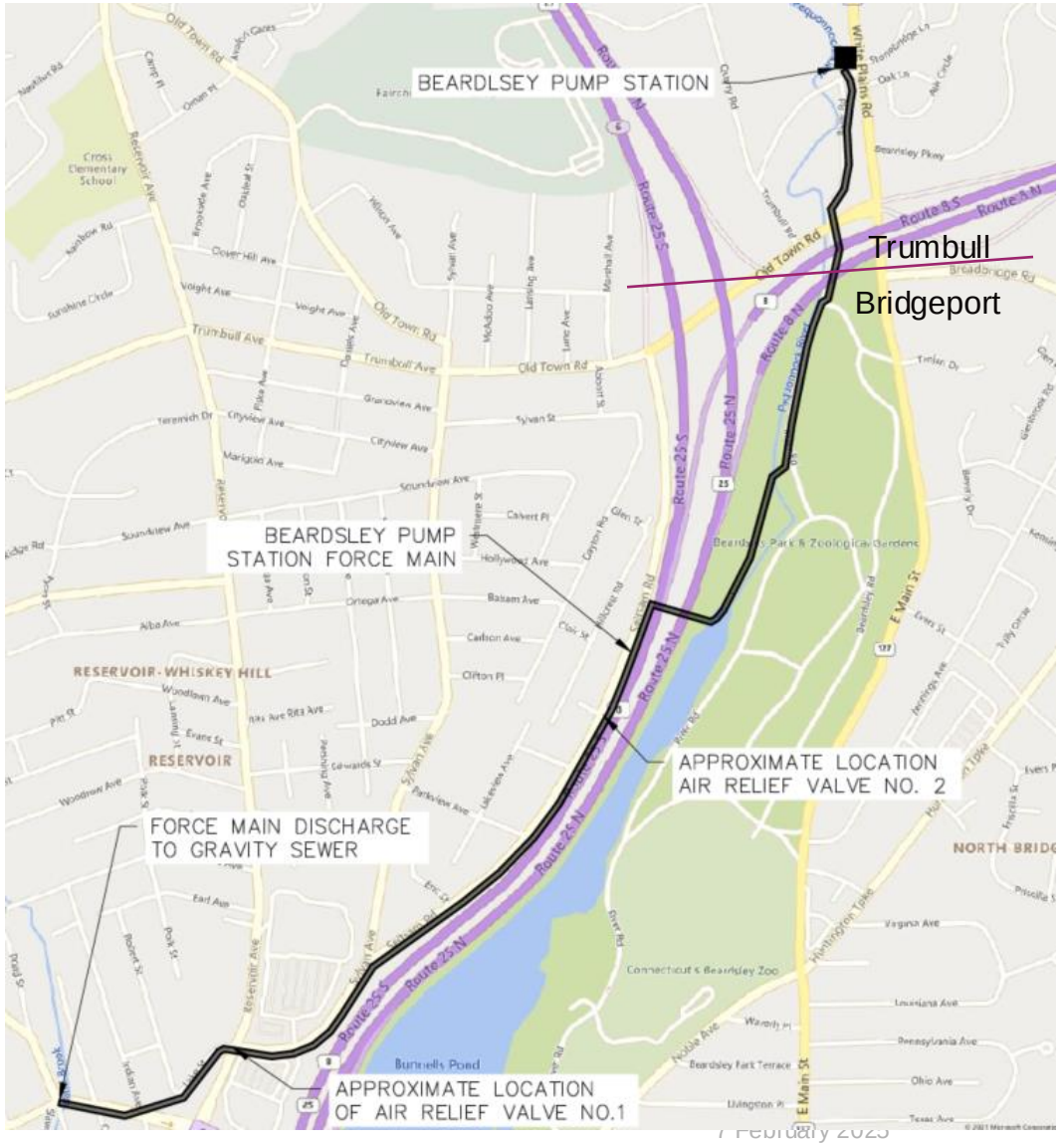
Agenda

1. Project Background
2. Phase 1 Planning and Inspections
3. Phase 1 Design and Construction
4. Phase 2 Planning and Inspections
5. Preliminary Recommendations
6. Lessons Learned

Beardsley Pump Station and Force Main

- Pump Station constructed in 1970
- Two pumps @ 3,700 gpm/pump (5.3 MGD)
- Force Main: 9,600+/- LF; 20”; DIP
- Two Air Release Valves along Force Main
- Discharges to City of Bridgeport collection system
- 2/3 of Town sewer flows
- ADF = 2.05 MGD
- PHF = 9.93 MGD





Project Roadmap

1970

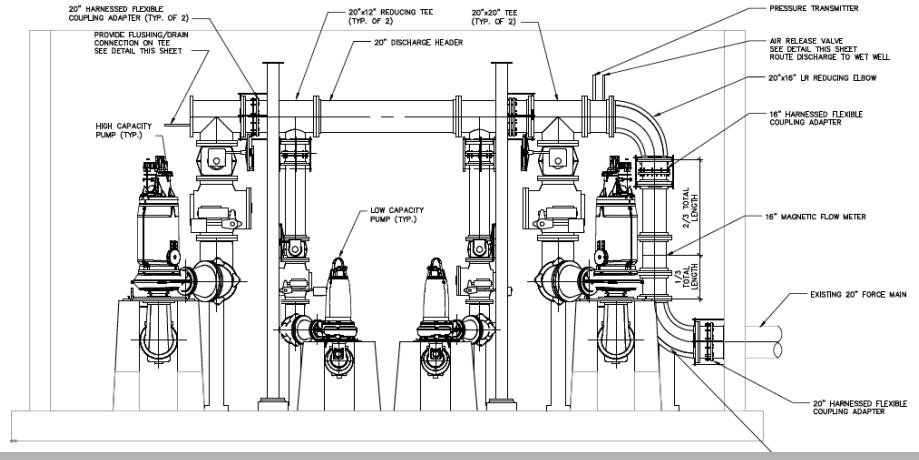
Construction of Pump Station and Force Main

Jan 2020

Force Main Break

2019

Pump Station Upgrade



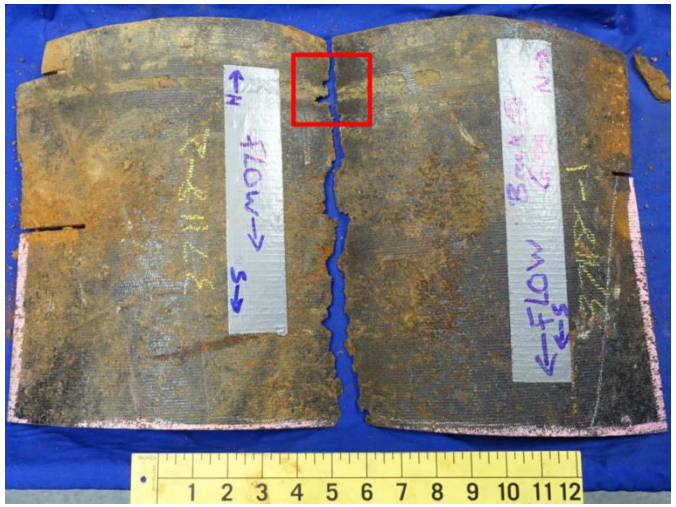
Pump Station Upgrades:

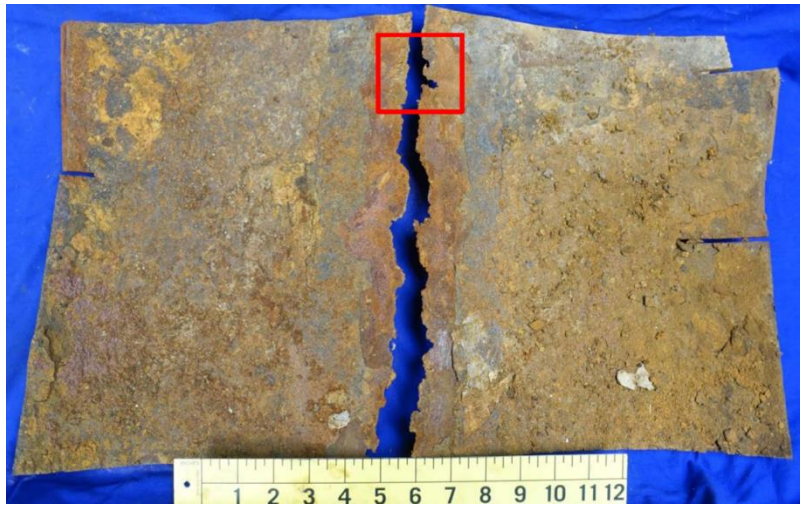
- (4) Mixed-Sized Pumps
  - (2) Low Capacity Pumps [44 HP]
  - (2) High Capacity Pumps [385 HP]

Site Figure

Force Main Break

Project Roadmap





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Construction of Pump Station and Force Main

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Jan 2020
Force Main Break

May 2020
Ultrasonic Thickness (UT) Testing

Testing Locations:

- Failure Analysis of removed pipe
  - Mode of Failure: Microbial Induced Corrosion (MIC)
- (2) Additional locations selected for UT testing

UT Testing

TABLE 3: 20" DI PIPING ULTRASONIC THICKNESS MEASUREMENTS (inches)													
LOCATION		CLOCK POSITION								MAX.	MIN.	AVE.	MIN./ AVE.
COMPONENT	AREA	12:00	1:30	3:00	4:30	6:00	7:30	9:00	10:30				
TEST PIT 1 BEARDSLEY	A	0.437	0.437	0.455	0.403	0.339		0.652	0.305	0.652	0.305	0.433	71%
	B	0.411	0.486	0.477	0.404	0.491	0.465	0.477	0.392	0.491	0.392	0.450	87%
	C	0.550	0.353	0.547	0.555			0.499	0.589	0.589	0.353	0.516	68%

TABLE 4: 20" DI PIPING ULTRASONIC THICKNESS MEASUREMENTS (inches)													
LOCATION		CLOCK POSITION								MAX.	MIN.	AVE.	MIN./ AVE.
COMPONENT	AREA	12:00	1:30	3:00	4:30	6:00	7:30	9:00	10:30				
TEST PIT 2 BEARDSLEY	A	0.651	0.745	0.737	0.595	0.673	0.674	0.688	0.703	0.745	0.595	0.683	87%
	B	0.550	0.598	0.654	0.582	0.645	0.478	0.648	0.573	0.654	0.478	0.591	81%
	C	0.492	0.492	0.536	0.482	0.329	0.451	0.457	0.448	0.536	0.329	0.461	71%

Force Main Break

UT Testing Location

Phase 1 Force Main Renewal

Alternatives Analysis:

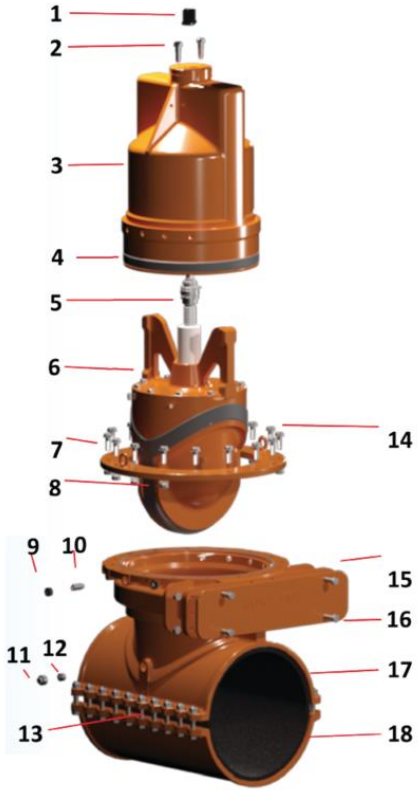
- Cured-in-Place Pipe Lining
- Sliplining
- Horizontal Directional Drilling
- **Open-Cut Excavation**

Design Challenges:

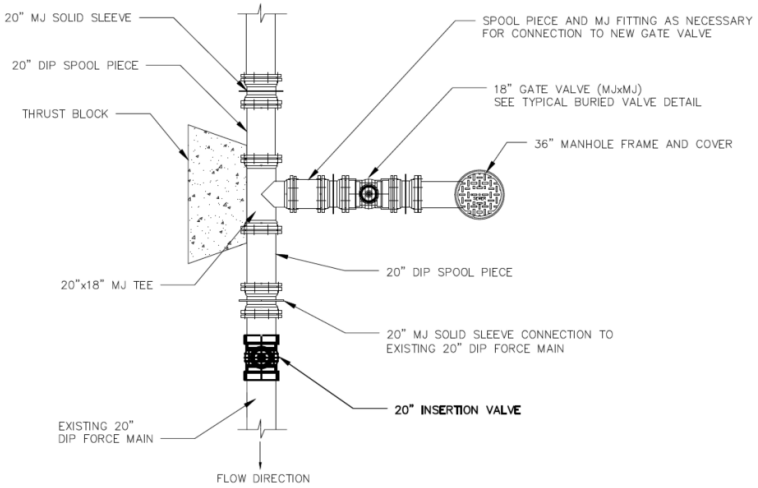
- Coordination with park activity
- Easement acquisition
- Temporary bypass

Permitting:

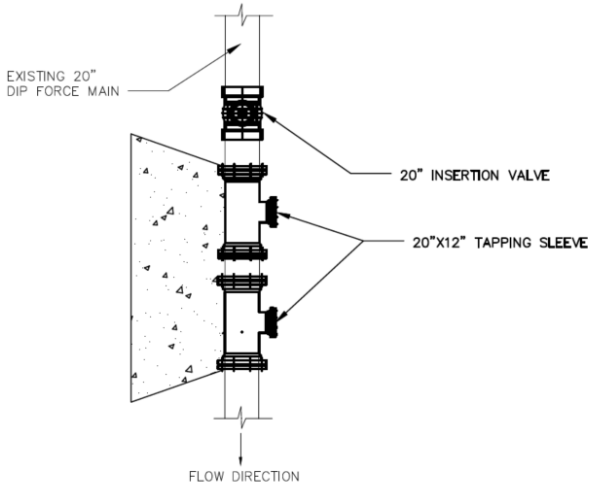
- National Diversity Data Base (NDDB) Review
- CTDEEP Flood Management Certification
- CTDEEP Land Management
- State Historic Preservation Office (SHPO)



Insertion Valve

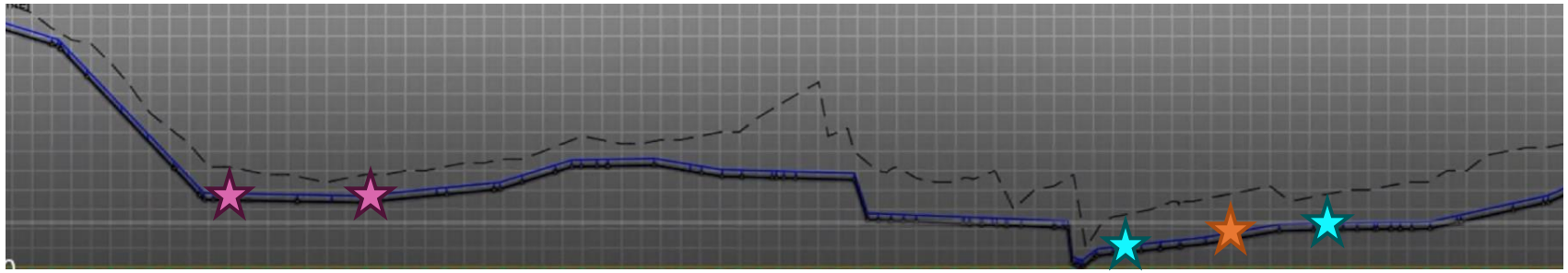


Upstream Bypass Connection



Downstream Bypass Connection

Project Roadmap



Force Main Break

UT Testing Location

BEM Inspection and UT Testing

1970

Construction of Pump Station and Force Main

2019

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Force Main Break

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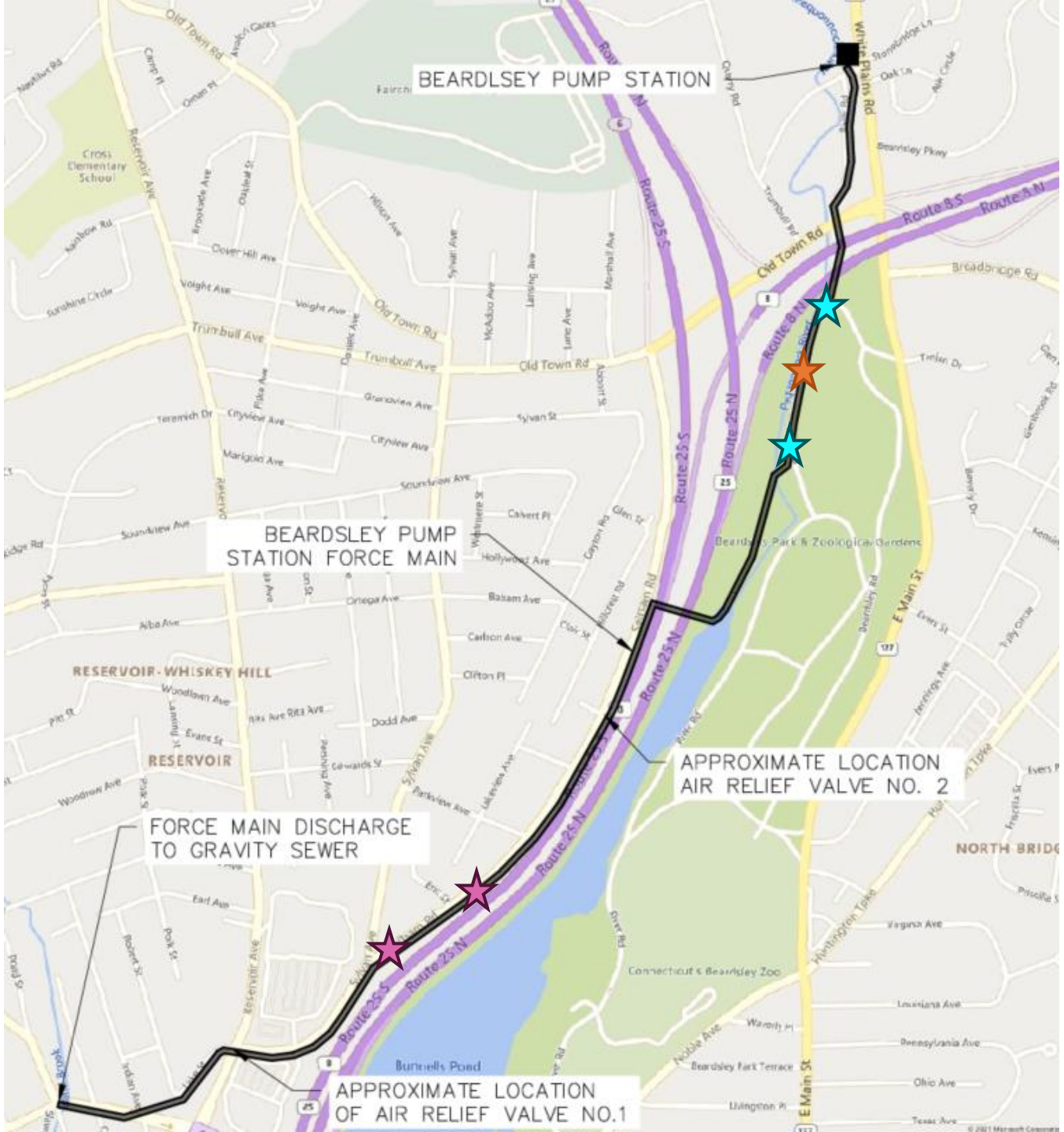
Ultrasonic Thickness (UT) Testing

June 2021

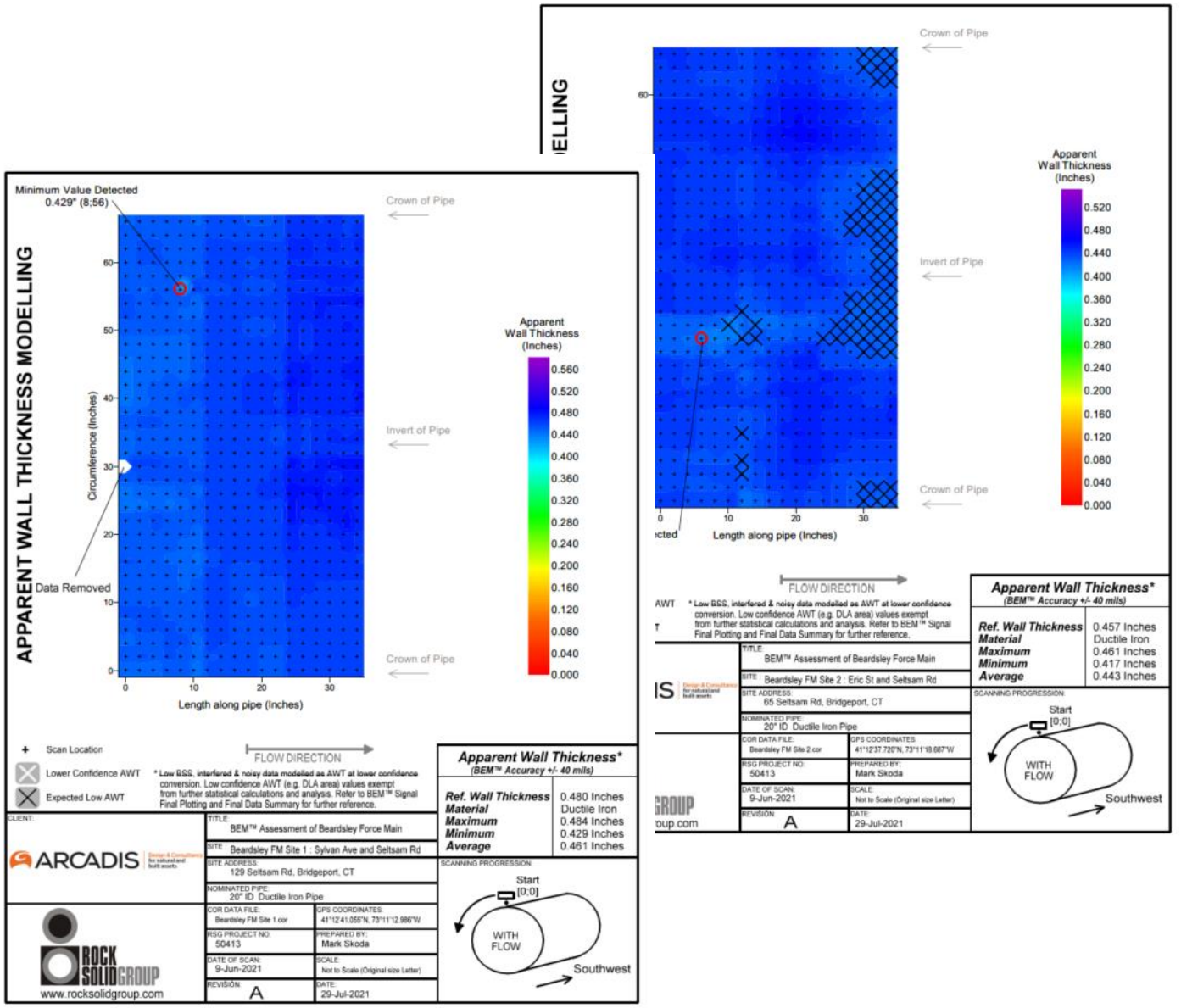
Broadband Electromagnetic (BEM) Inspections and UT Testing

BEM Inspections

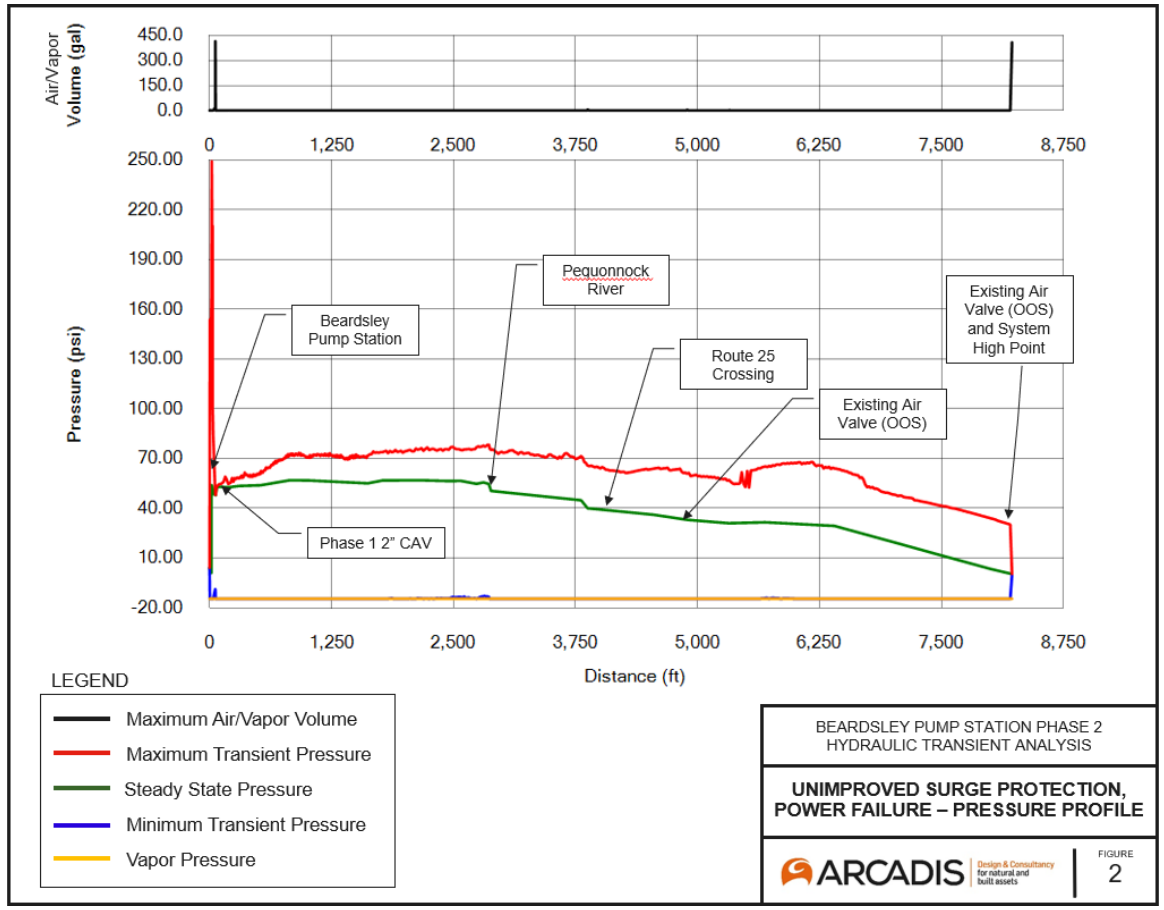


- Force Main Break
- UT Testing Location
- BEM Inspection and UT Testing

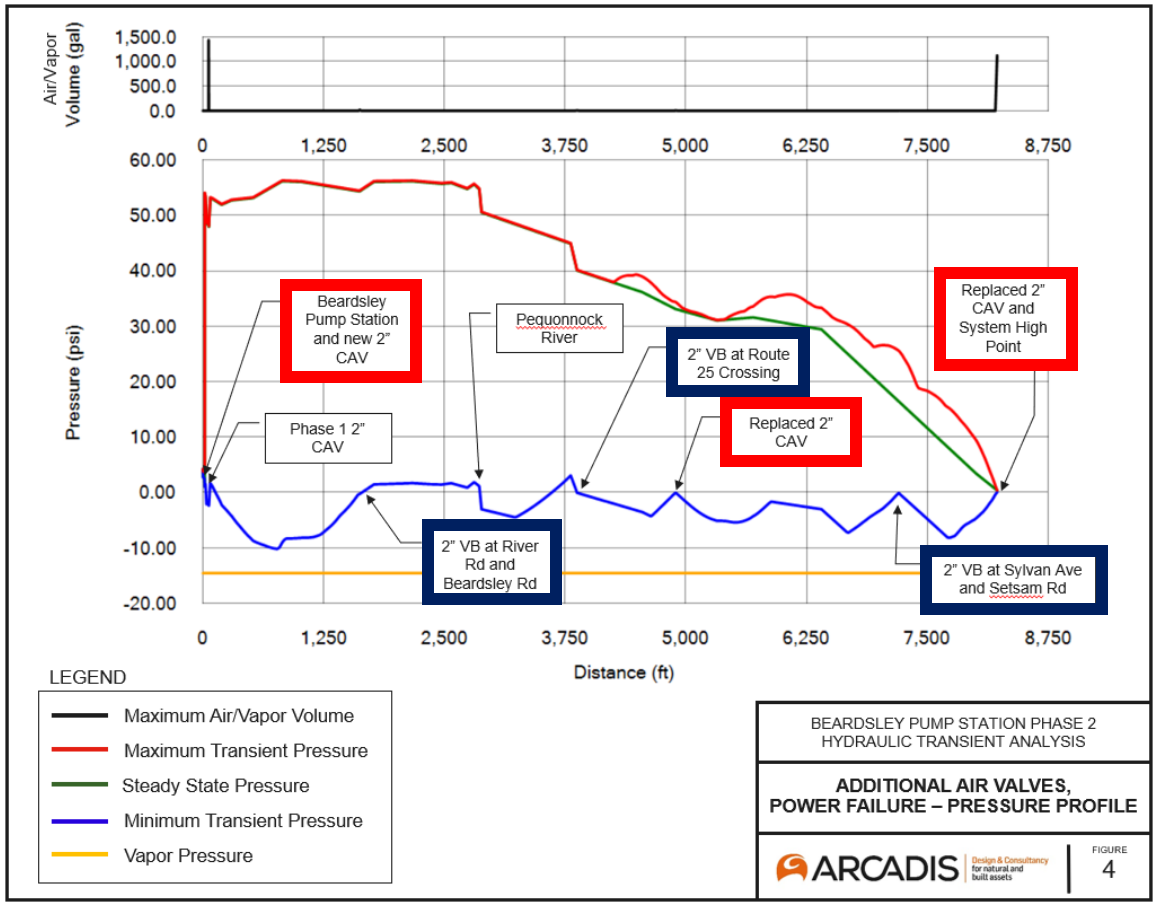
BEM Inspection Results



Transient Analysis



Existing Condition



Proposed Improvements

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Ultrasonic Thickness Testing

June 2021
Broadband Electromagnetic (BEM) Inspections

June 2022
Phase 1 Construction Contract Award

July 2022
Force Main Break

Nov 2022
Construction Commencement

Construction – Bypassing the Force Main

Upstream connection for temporary bypass

Downstream connection for temporary bypass

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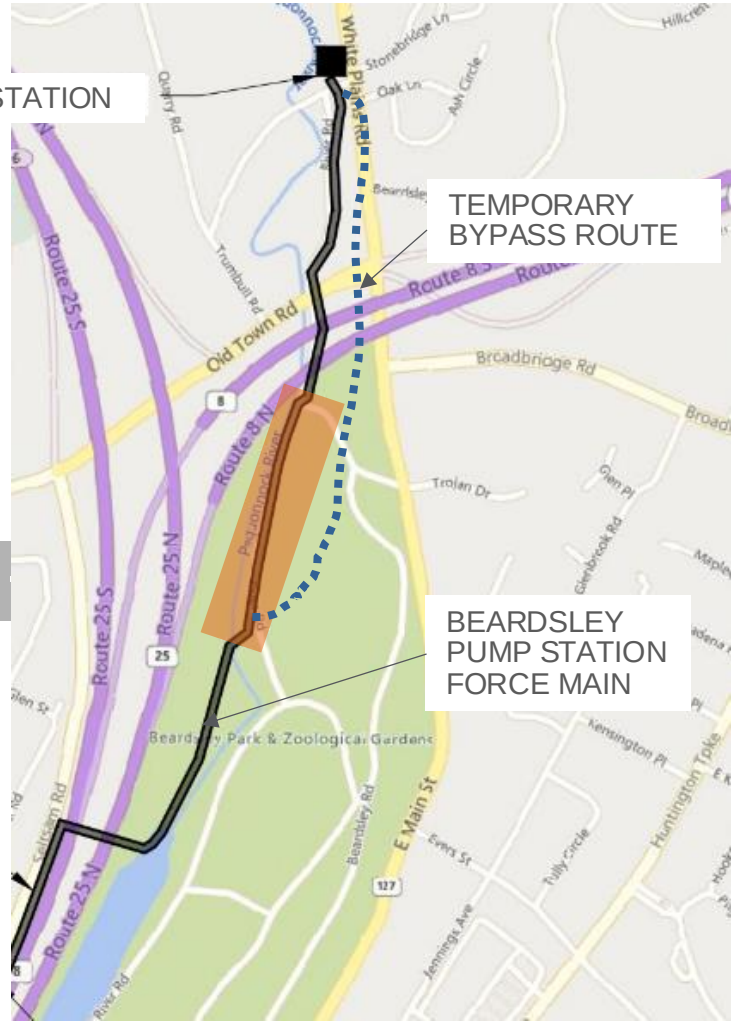
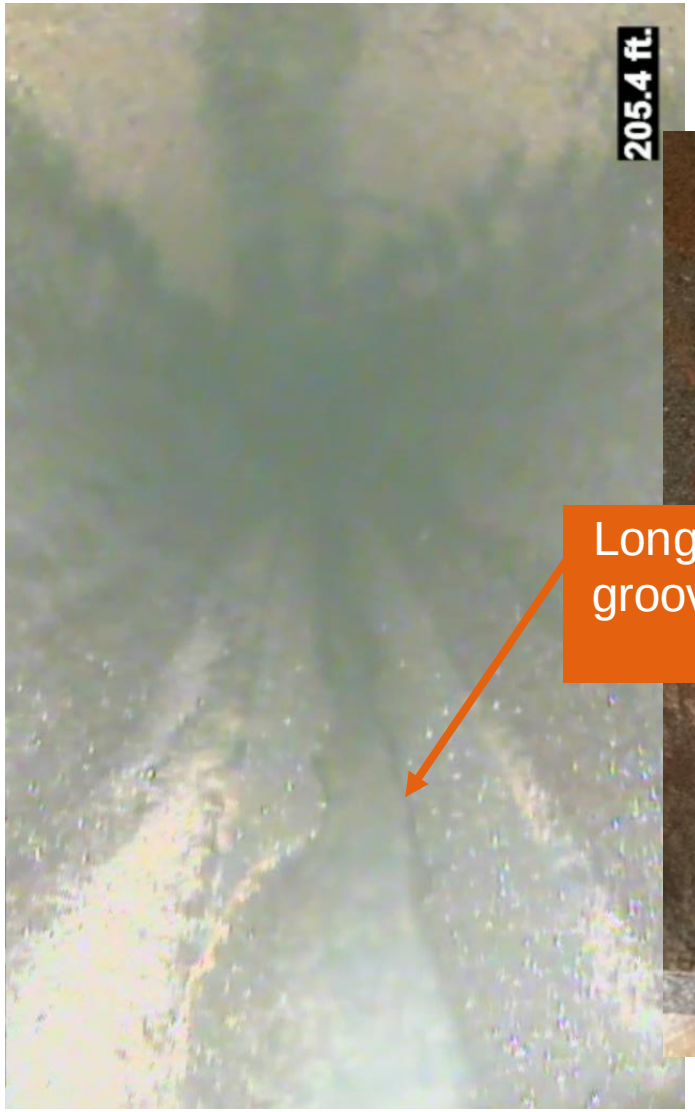
Jan 2023
CCTV Inspection



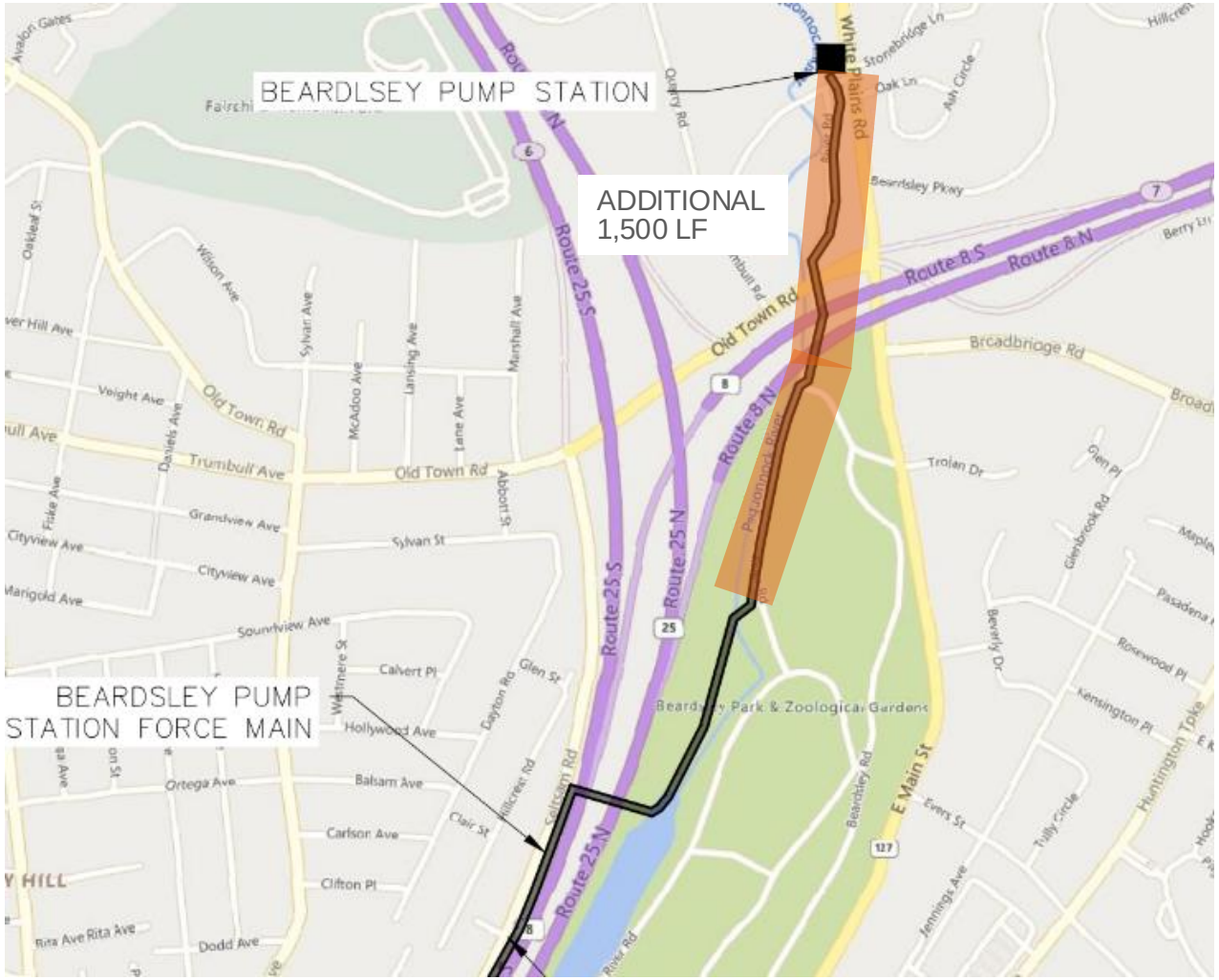
CCTV Inspection

CCTV inspection completed while FM was under bypass during replacement period



Long, continuous groove located at 6 OC

Phase 1 Expanded Scope



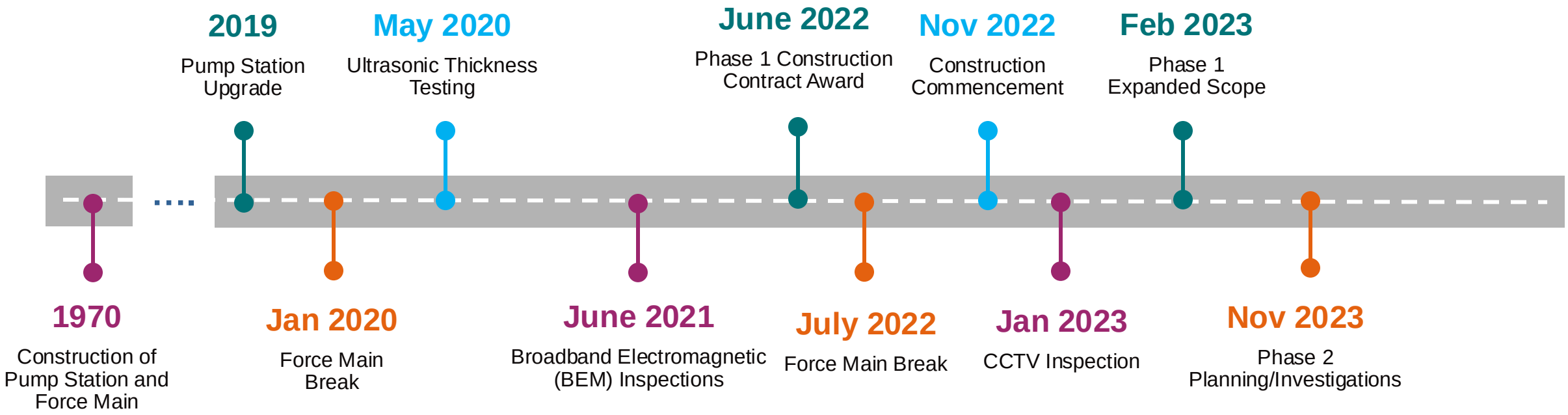
Construction – Installation of New Force Main Pipe

Ductile Iron Pipe Installation within Beardsley Park

HDPE – DIP coupling

HDPE Pipe Installation – navigating existing infrastructure

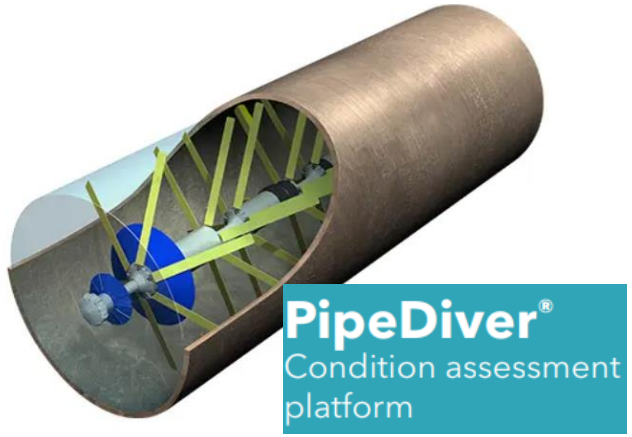
Project Roadmap



Phase 2 Inspection – Technologies Considered

Smart Ball

- acoustic detection of leaks and pockets of gas



PipeDiver

- electromagnetic sensors for metallic pipe

Scope:

Full-length condition assessment of 7,000 LF 20-inch DIP, based on knowledge of prior pipe breaks

ACQUARIUS
In-line Inspection Tool

Acquarius

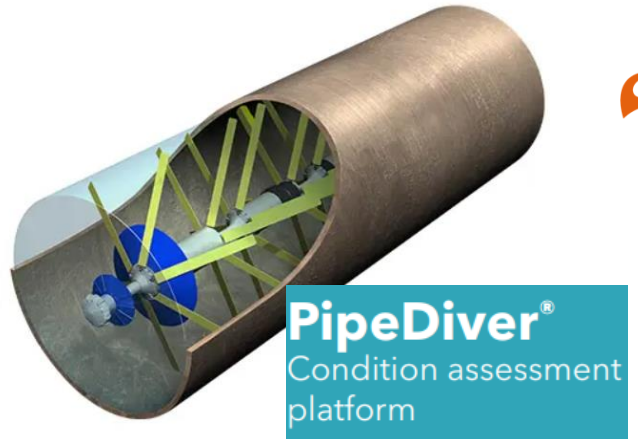
- ultrasonic testing

PICA's SeeSnake

- wall thickness, surface area, magnetic variation
- requires complete bypass of force main

Project Roadmap

Best option for our scenario – reputable, used in US, suitable for our pipe material, pipeline remained in service



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CCTV Inspection

Feb 2023
Phase 1 Expanded Scope

Nov 2023
Phase 2 Planning/Investigations

May 2024
Electromagnetic Inspections

Phase 2 PipeDiver Inspection Planning

Much planning was involved ahead of the PipeDiver inspection:

- Delays due to weather – needed 3 weeks of dry weather for I&I to subside following rain
- Nighttime low flow
- Shutdown of pumps for tool insertion
- Manually operate pumps to maintain constant velocity (1 ft/sec)
  - 3-hour inspection (3 AM - 6 AM)
- Inspection performed on two consecutive nights

Phase 2 PipeDiver Inspection Results

- Zero (0) electromagnetic anomalies characteristic of wall loss were detected.
- One (1) pipe was identified with an anomaly that was detected circumferentially – bypass connection

Validating the results

- Requested additional analyses of PipeDiver data
- Additional analyses found 52 areas of signal variation at pipe invert were identified across a total of 49 pipes.
  - Possible causes
- Comparison with prior BEM

Some locations of signal variation

- Widespread wall loss (not supported by overall inspection)
- Debris
- Pipe property variations
- Tool movement

Preliminary Recommendations

Recommendations Based on PipeDiver Inspection

1. Continue operating pump station under operational parameters that limit extended periods of low flow velocity, which was the cause of the microbial induced corrosion.
2. Additional external inspections at locations of signal variation
3. Re-inspect in 10 years

Recommendations Based on Transient Analysis

1. Replace 3 existing air release valves with combination valves
2. Install 3 additional vacuum breaker and air release valves

PipeDiver tool at the insertion point.

Lessons Learned

- Research your specific failure mechanism.
  - Find the right tool and use multiple inspection and analysis techniques to get a better picture.
- Be selective with tools used for inspecting FMs.
- Scrutinize the findings and results, regardless of technology/tool.
- Take advantage of running tests on broken pipe pieces and surrounding soil.
- The search for emerging technologies continues:
  - Microbial-induced corrosion (long, continuous grooves)

Acknowledgements

- Town of Trumbull DPW
- Burns Construction
- Xylem (Pure Technologies)
- National Water Main Cleaning Company
- Corrosion Probe

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