Challenges of Rehabilitation in Large Interceptors: Cambridge Street Area Sewer Rehabilitation Project

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Background

Worcester Sewer Interceptor

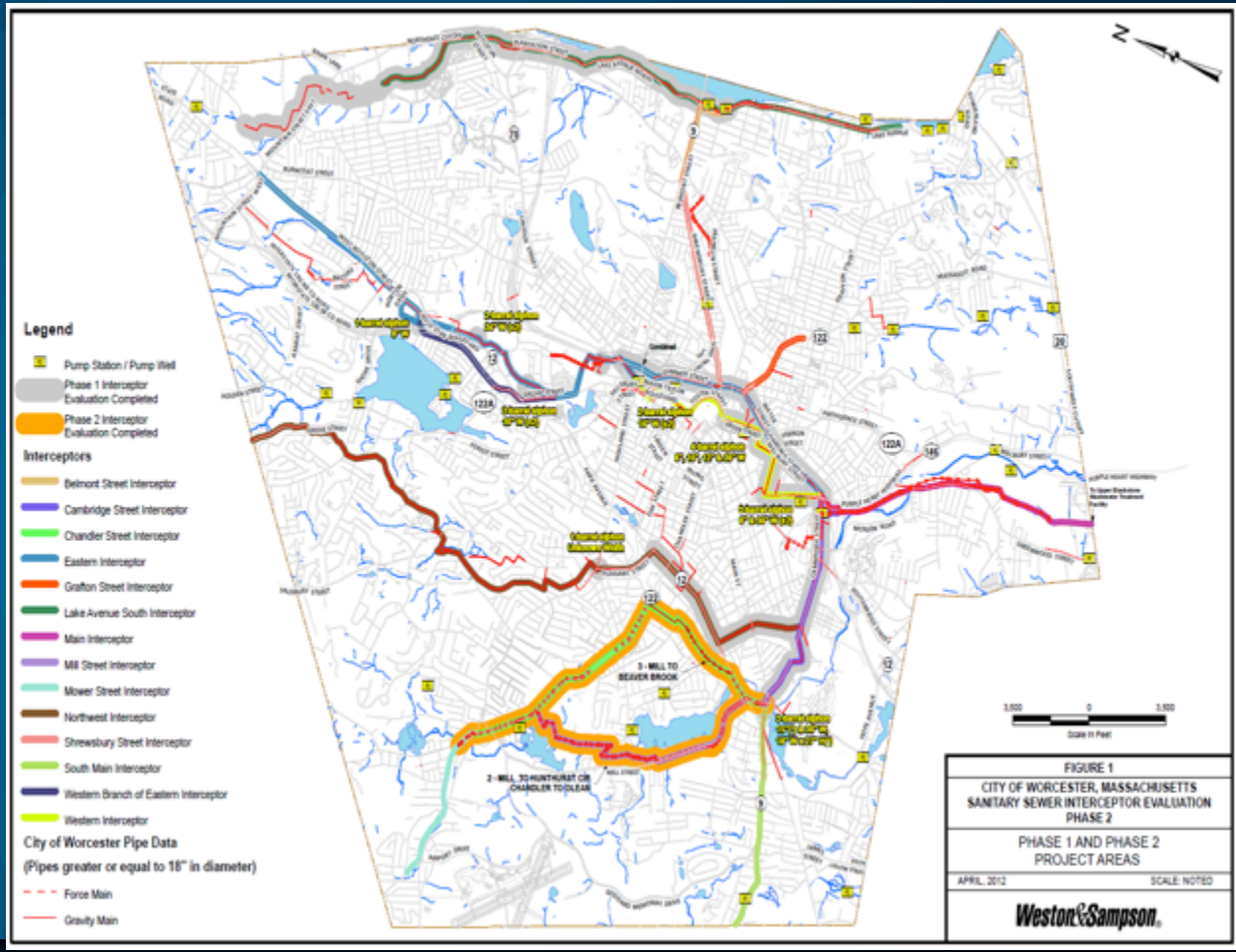
Large Sewer Interceptors consist of approximately 40 miles of pipeline

Phase I - 2008

- ≈ 68,000 lf
- ≈ 350 MH

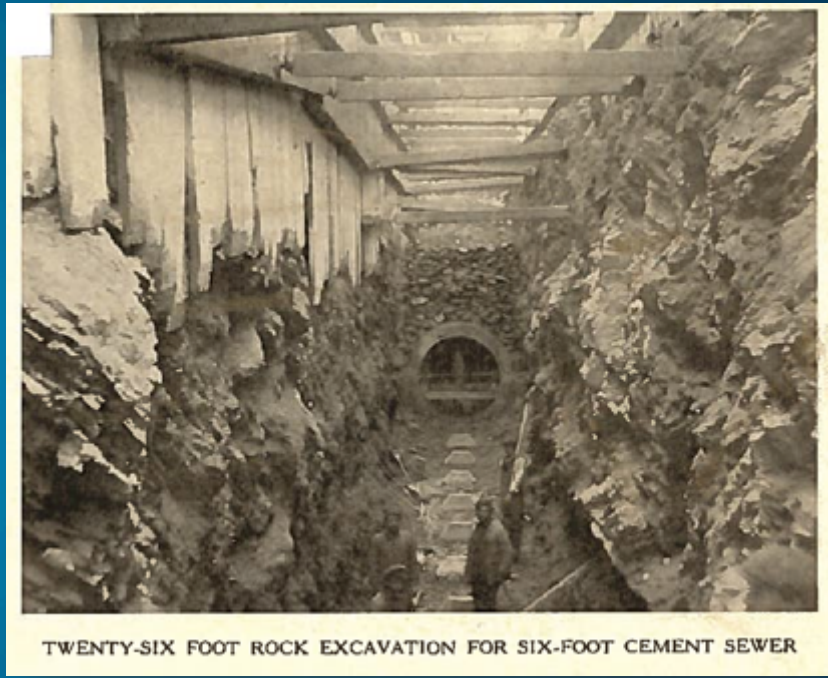
Phase II - 2011

- ≈ 30,000 lf
- ≈ 150 MH



Large Sewer Definition

- **Capability to inspect pipes that are less than 18-inch diameter**
- **Sanitary Sewer Interceptors ranging from 18-inch to 108-inch in diameter**
- **Sewer interceptor includes approximately 40 miles of pipeline**



TWENTY-SIX FOOT ROCK EXCAVATION FOR SIX-FOOT CEMENT SEWER

Why Bother???
Out of Site – Out of Mind

- **Health & Safety**
- **Cost (Maintenance vs. Emergency Repair)**
- **Potential Penalties**

Deep under the streets of Worcester, a newly constructed sewer is inspected by the Worcester Committee on Sewers in 1915. Increased development put pressure on many municipal departments as the demand for services increased; the sewer department was no exception. In 1915, there were still Worcester neighborhoods unconnected to the municipal sewerage system.

Priorities

- Structural Integrity
- Pipeline Capacity
- Flow Conditions
- I/I Sources
- Odor Generation
- Access and Maintenance
- Draft Contingency Plan

Phased Approach

Phase 1A – Initial Investigation/Risk Analysis

- Preliminary Field Investigation
- Prioritize based on Risk Assessment

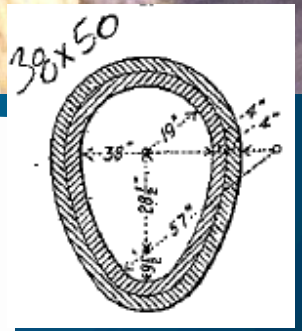
Phase 1B – Detailed Investigation & Evaluation

- CCTV, Sonar, Laser & H_2S Monitoring
- Internal Manhole Inspections
- Prioritize based on Risk Assessment

1905.

Fig. 156*a*.—Worcester, Mass., Sewer Dept., 38 × 50-in. brick, egg-shaped sewer, typical of construction used extensively in many old systems throughout the country. In recent years, however, this type has been replaced largely by sections shown in Figs. 156*c*, *d*, *e* and *f*. Many of these old sewers show but few signs of distortion due to earth pressures. Where this type was built on steep grades in combined systems the invert bricks have been worn to a considerable extent and in some cases worn through, causing backfilling and supporting earth outside of brickwork to be washed away and resulting in caving in of sewer. This trouble overcome by making invert masonry heavier and lining invert with hard-burned or vitrified brick, calculated to resist wear better.

Fig. 156*b*.—Worcester, Mass., Sewer Dept., 48 × 72-in. brick, egg-shaped sewer, interesting on account of special shape used in several instances in that city.



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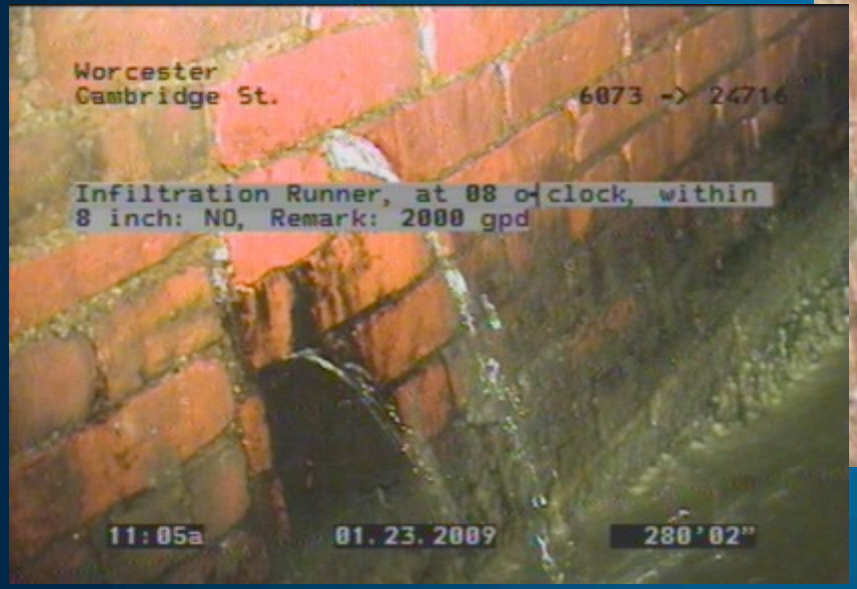
Observations



Infiltration

Observations

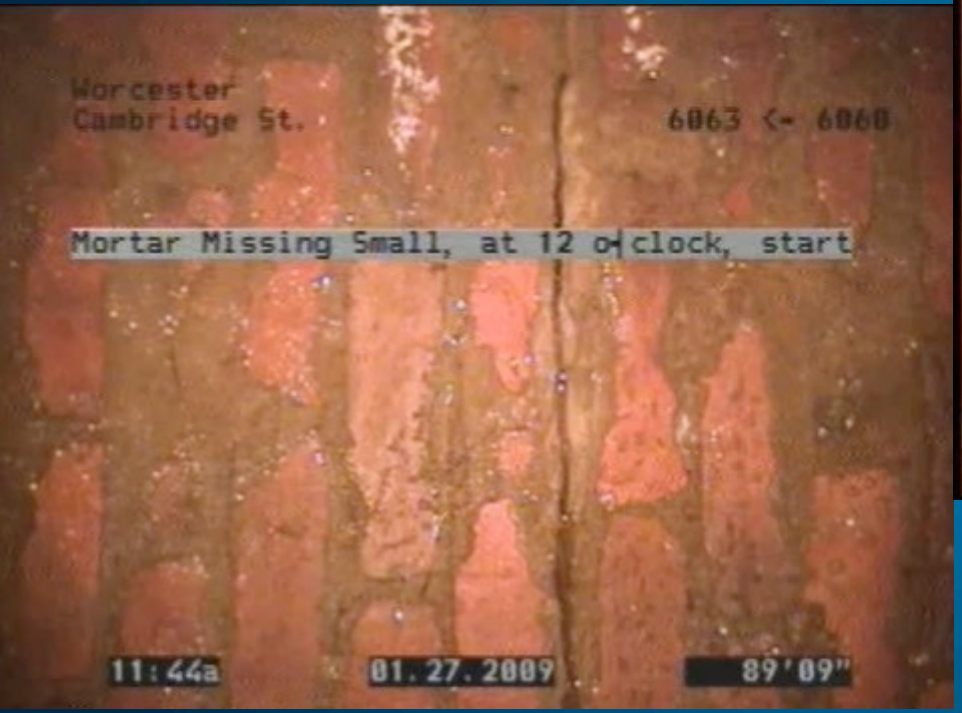
Roots

Capacity
Deficiencies

Observations

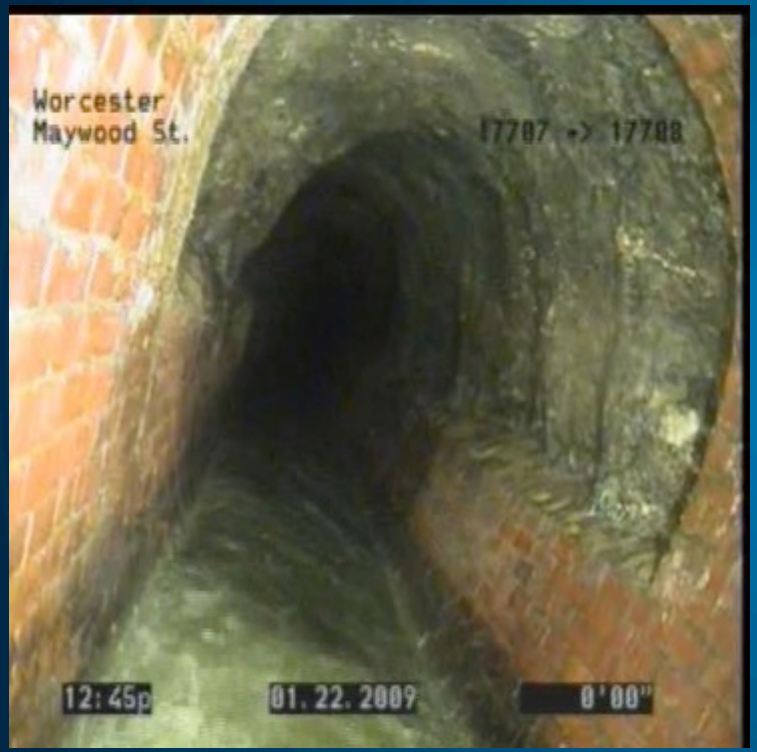
Missing Mortar

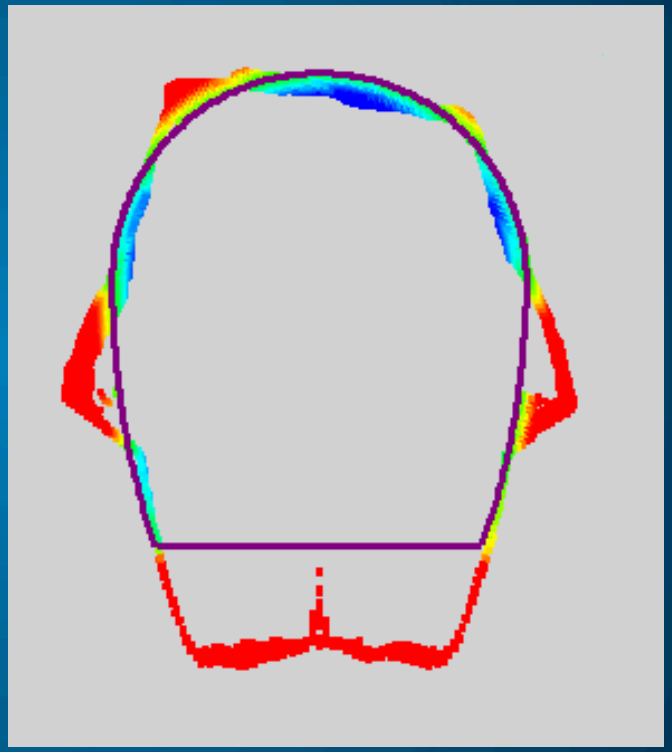
Observations



Structural Defects
Defects

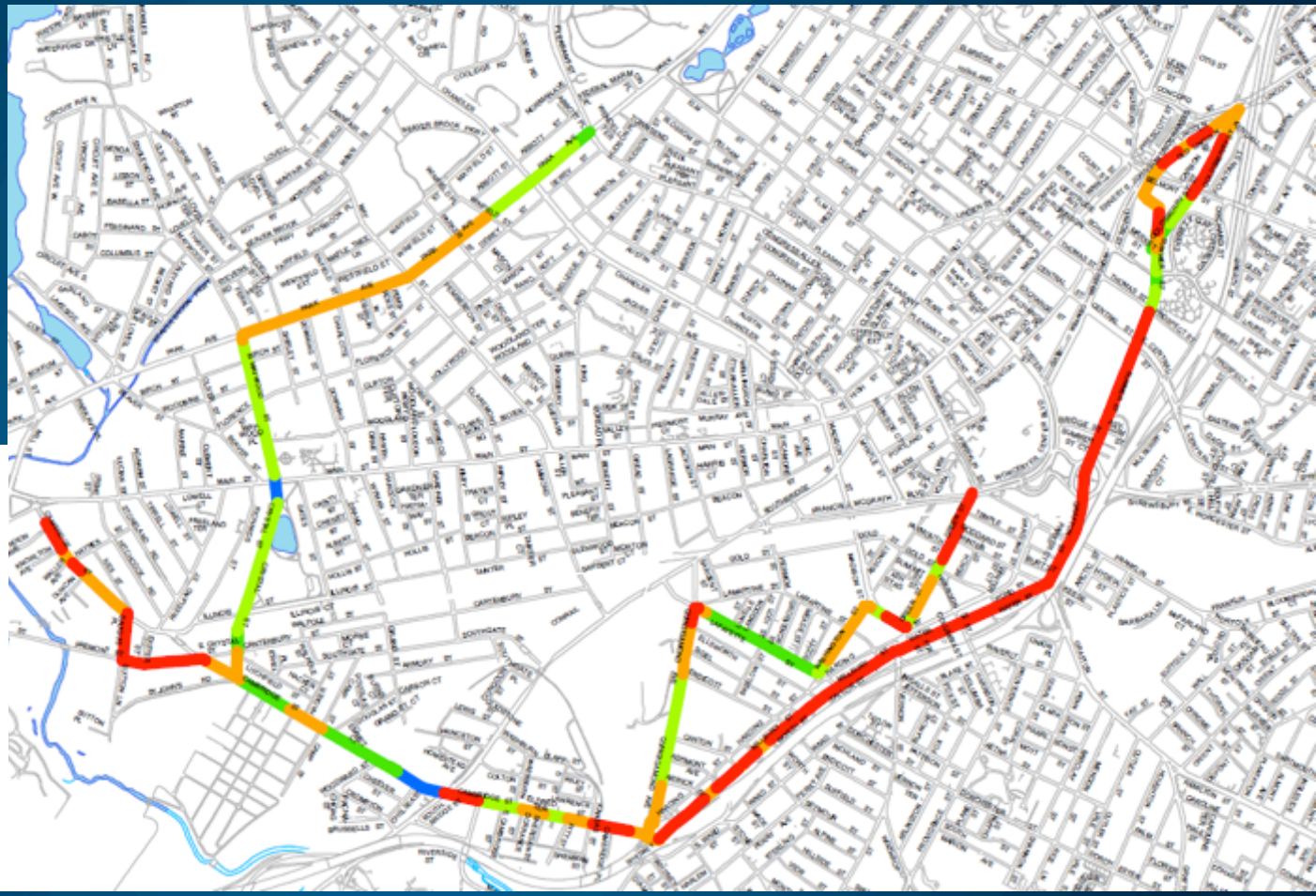
Observations - Laser Profiling





Phase 1

Criticality Results

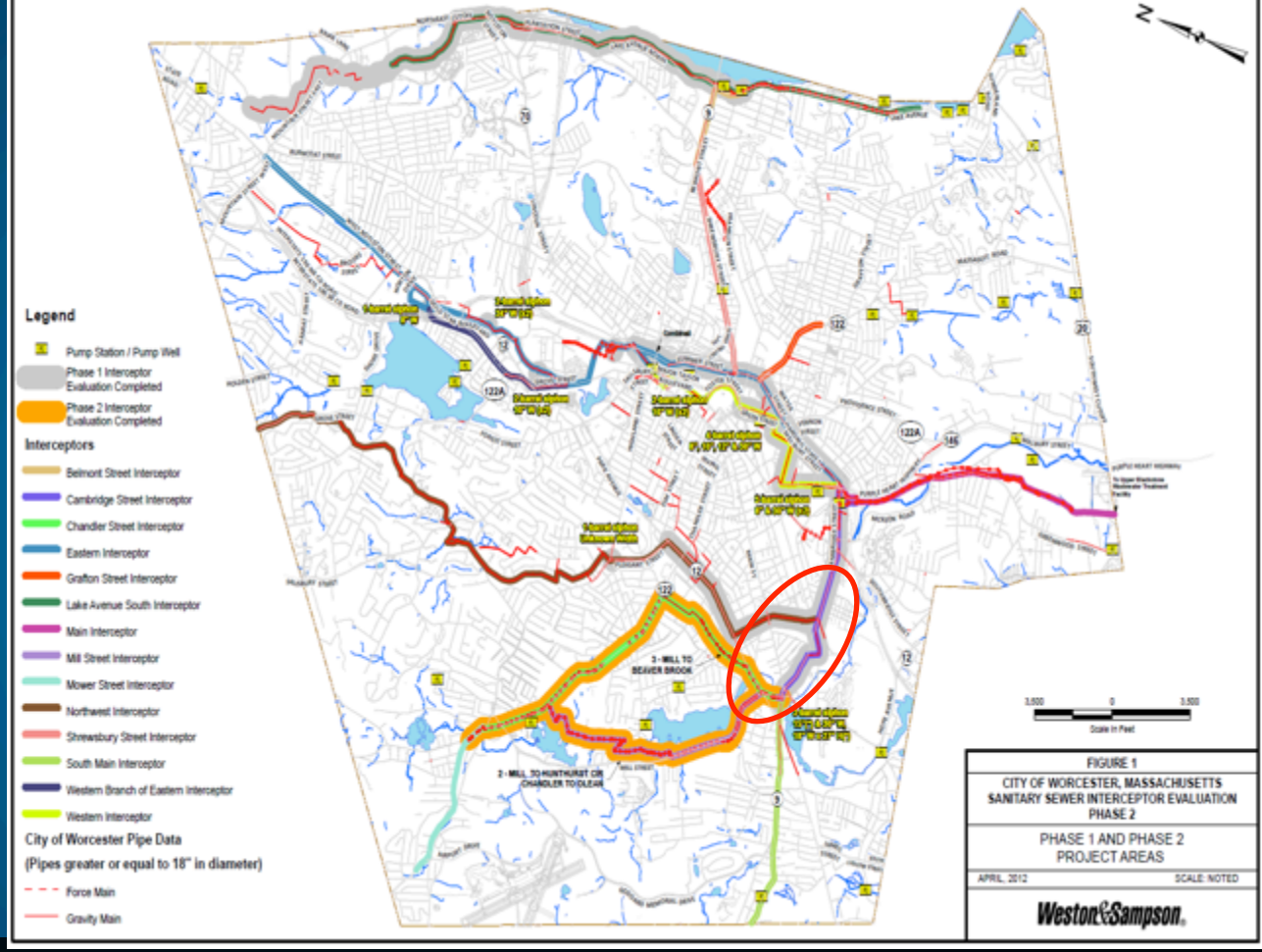


Phase 2

Phase 2 – 2011

Scope

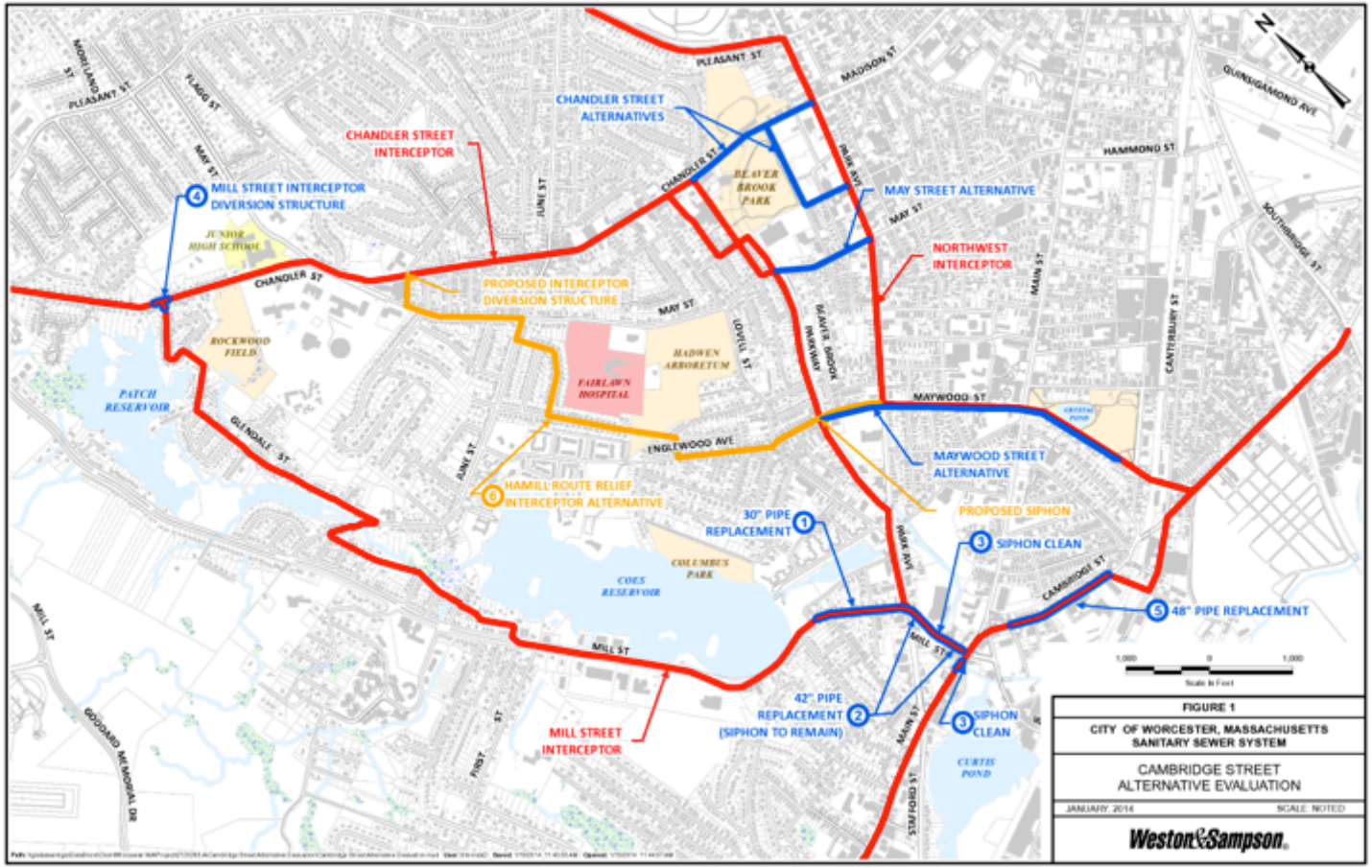
- Flow & Rainfall Monitoring
- Hydraulic Computer Modeling & Analysis (XPSWMM)
- CCTV & Sonar
- Manhole Inspections



Cambridge Street Alternative Evaluation

Address:

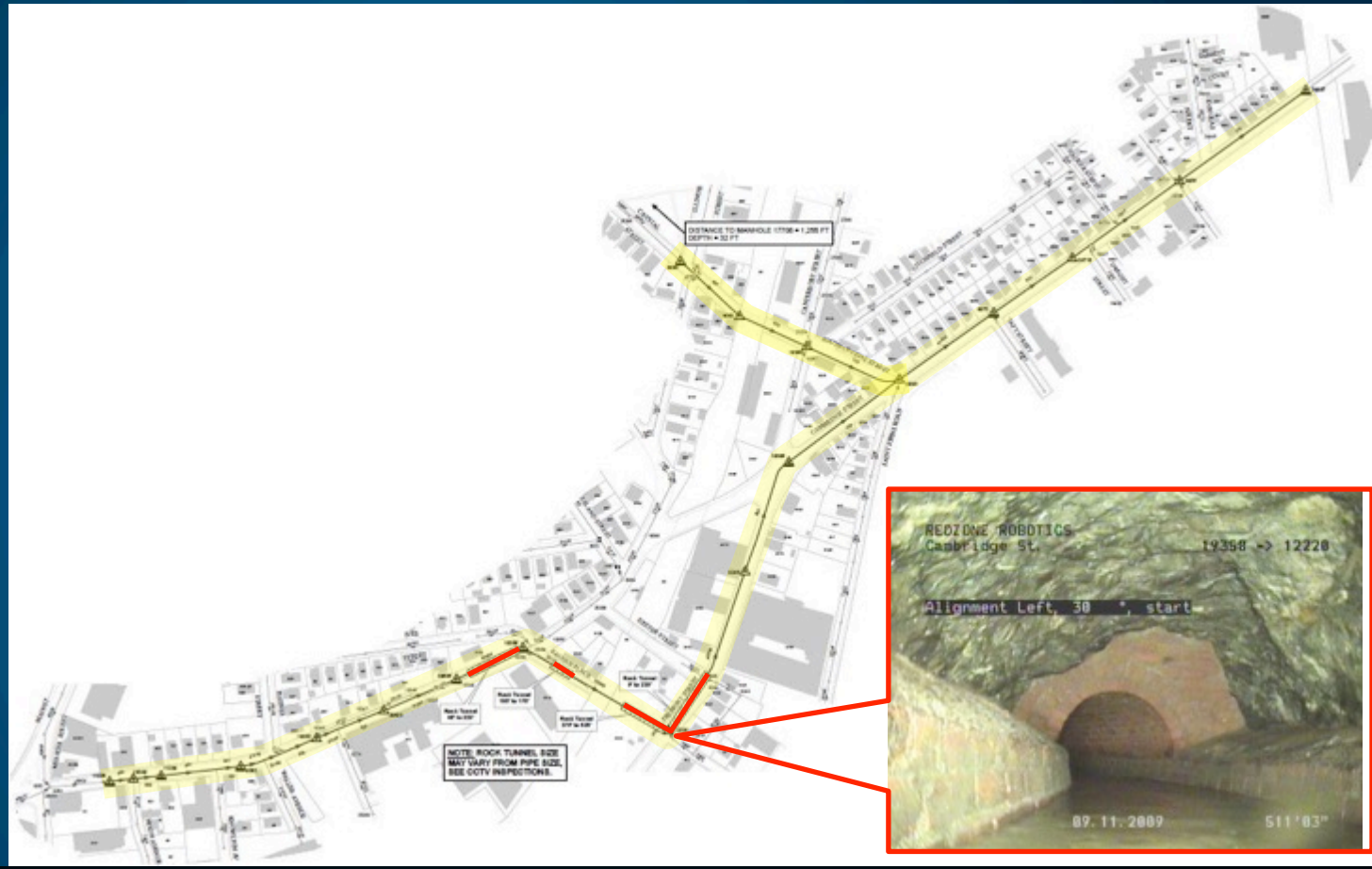
- Structural (Phase 1)
- Hydraulic (Phase 2)



Cambridge Street Rehabilitation

Includes:

- 5,638 lf of Structural CIPP
- 354 vf of Manhole Epoxy Lining
- Epoxy Grouting of 200 Laterals



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Preconstruction Planning

- Electronic Message Boards
- Distribute Flyers
- Meeting with Business Owners
- Senior Resident Representative
- Monthly Progress Meetings

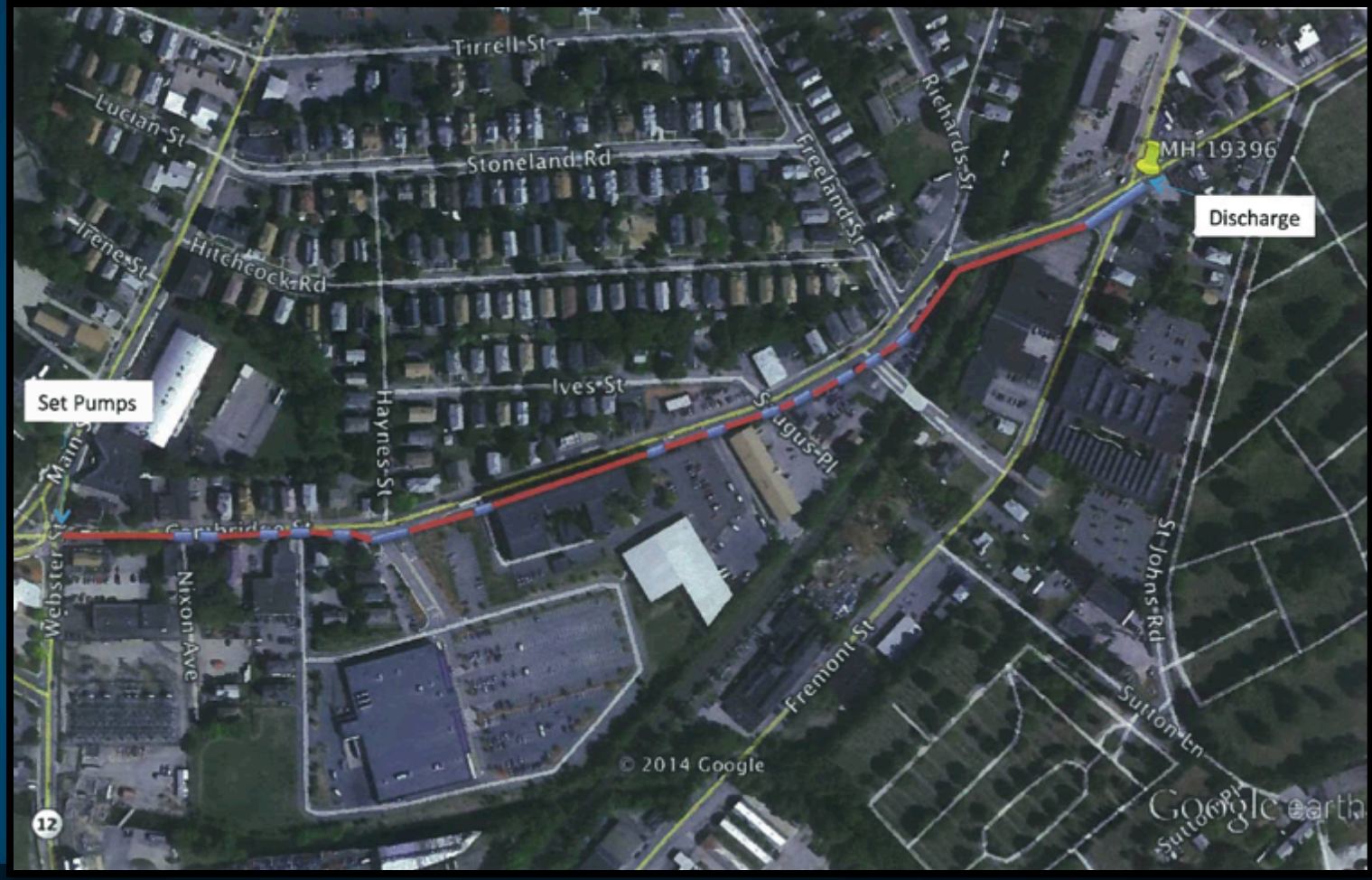
Construction Challenges

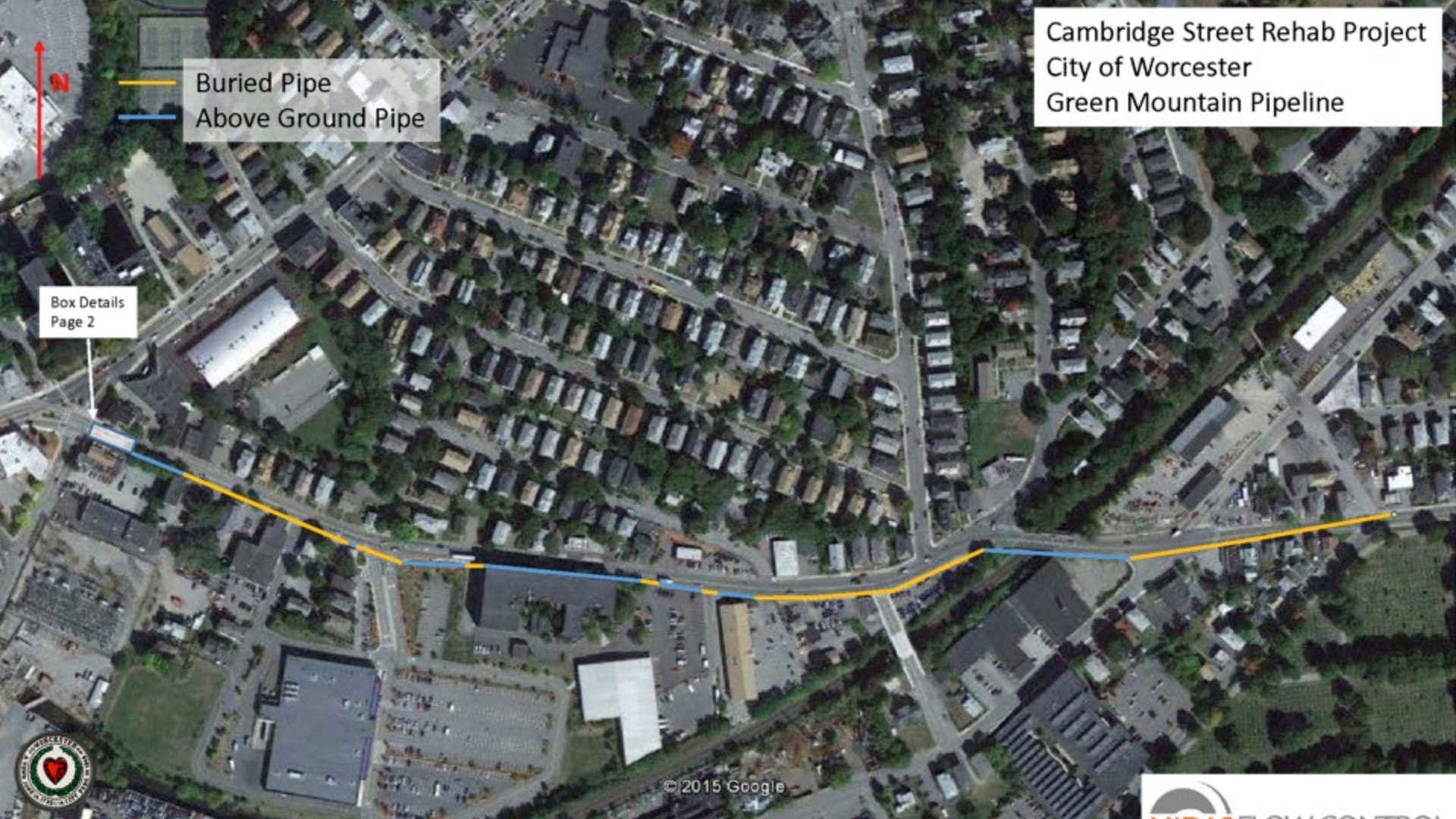
- Handling Existing Flows/Bypass Pumping
  - Flow
  - Utility Conflicts
  - Size and Depth
  - Topography
  - Railroad easement
- Lining Partial Rock Tunnel
- Winter 2015
- Bedrock
- Grouting Laterals
- Sealing Manholes in below freezing temperatures

Bypass #1 Upper Cambridge Street

Bypass:

- Flow = 15.71 MGD
- 7,000 LF of 18 inch in two lines




Cambridge Street Rehab Project
City of Worcester
Green Mountain Pipeline
N
Buried Pipe
Above Ground Pipe
Box Details
Page 2
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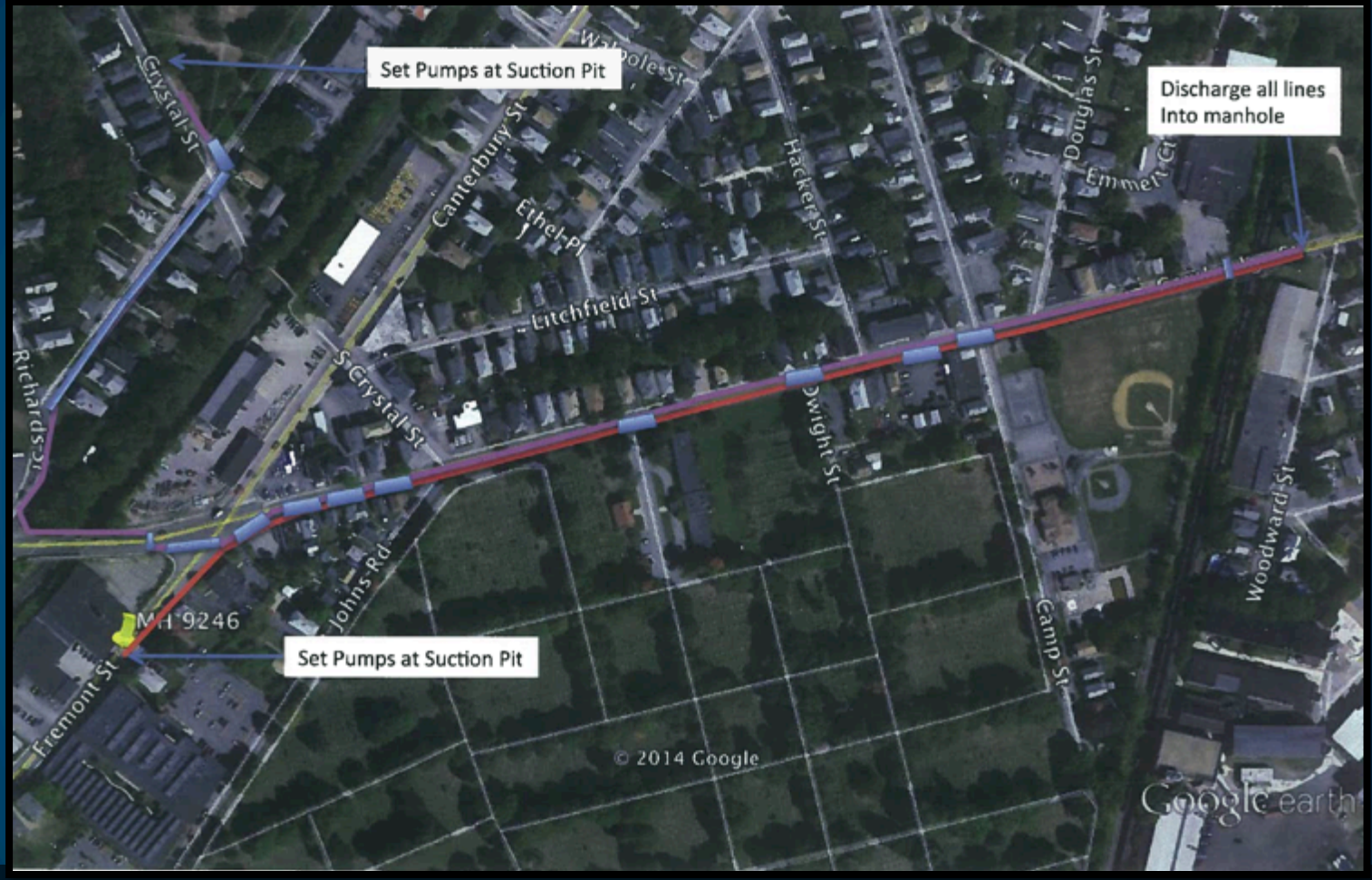
Bypass # 2 Lower Cambridge Street

Bypass from Fremont Street:

- Flow = 15.71 MGD
- 8,000 LF of 18 inch in two lines

Bypass from Crystal Street:

- Flow = 12.37 MGD
- 3,000 LF of 18 inch in two lines



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Rock Tunnel


REDZONE ROBOTICS
Cambridge St.
19358 -> 12220
09.11.2009
512'02"


REDZONE ROBOTICS
Cambridge St.
19358-2 -> 19358
09.11.2009

Rock Tunnel Lining Bid as Alternate

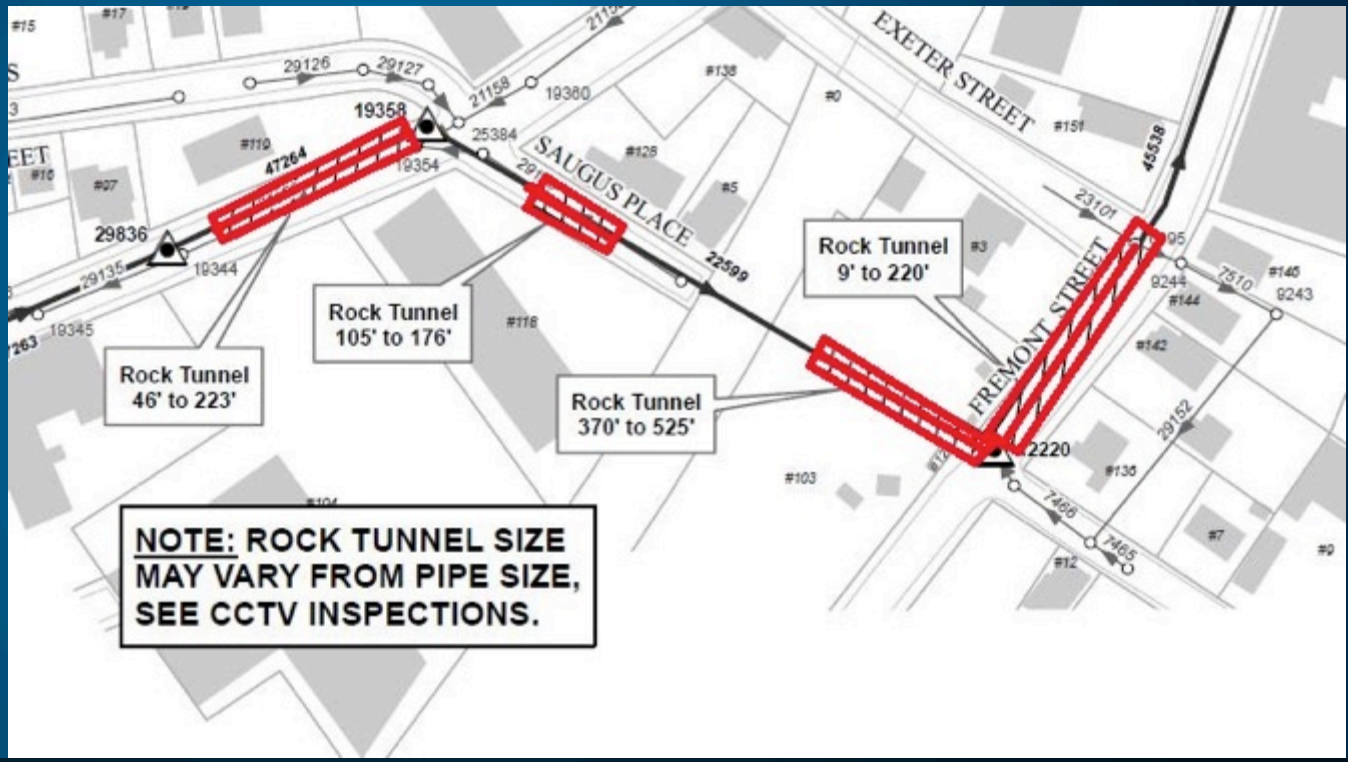
Alternate 1

- Epoxy Lining
- $2,242,790

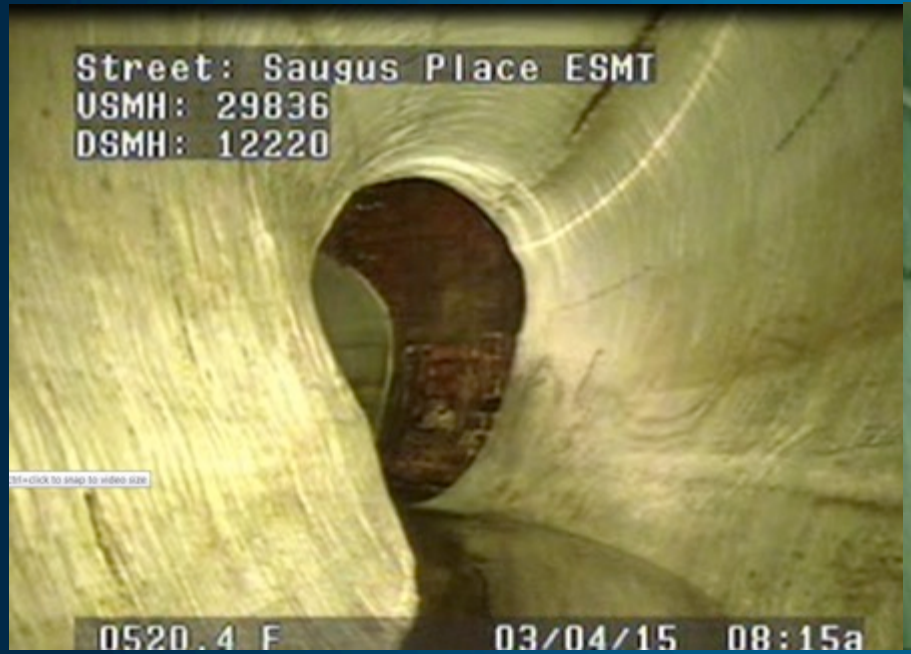
Alternate 2

- CIPP
- $1,369,770

Cost differential = $873,020



Post CIPP in Rock Tunnel



Worcester's Winter 2014-2015 = SNOW

3rd snowiest winter – 119.7 inches

February 2015 - 53.4 inches (snowiest month on record)

January 2015 – 46.5 inches (5th snowiest month on record)

- **34.5 inches fell between Jan 26-28**

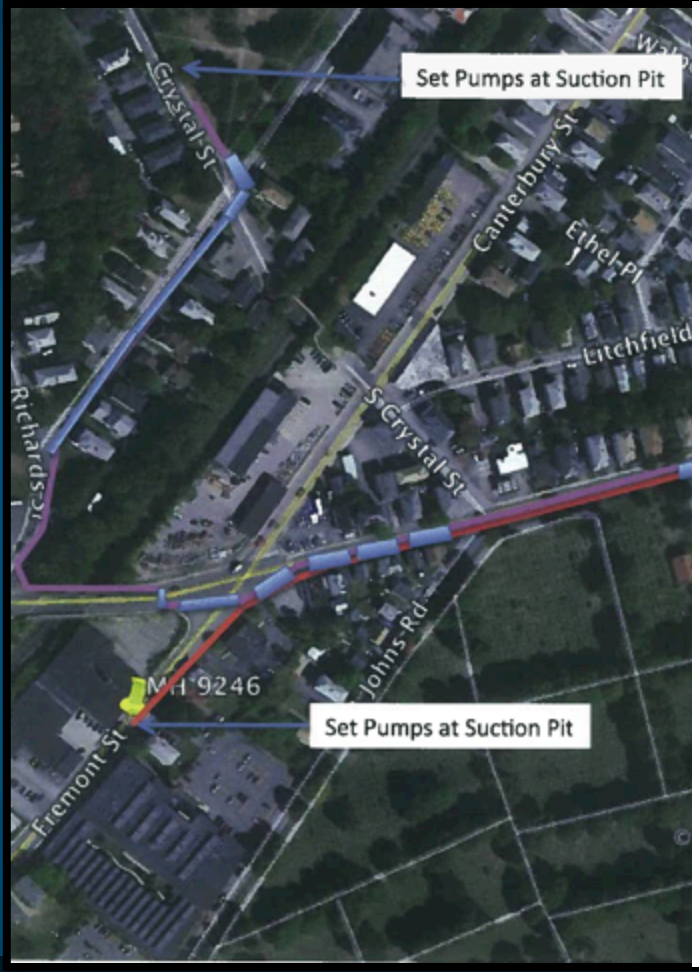


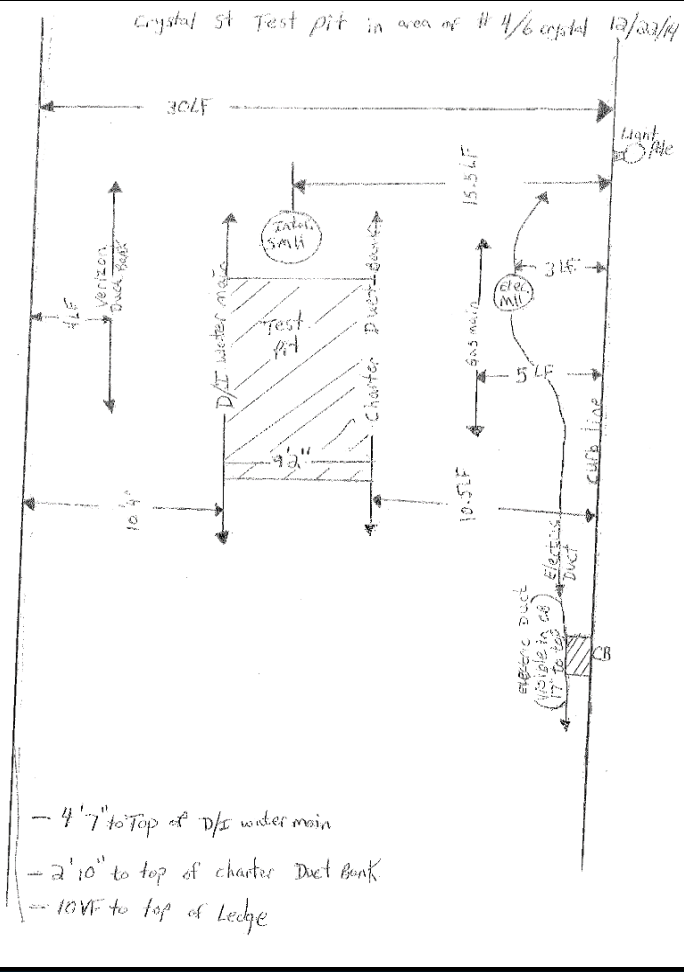



Rock

Issues

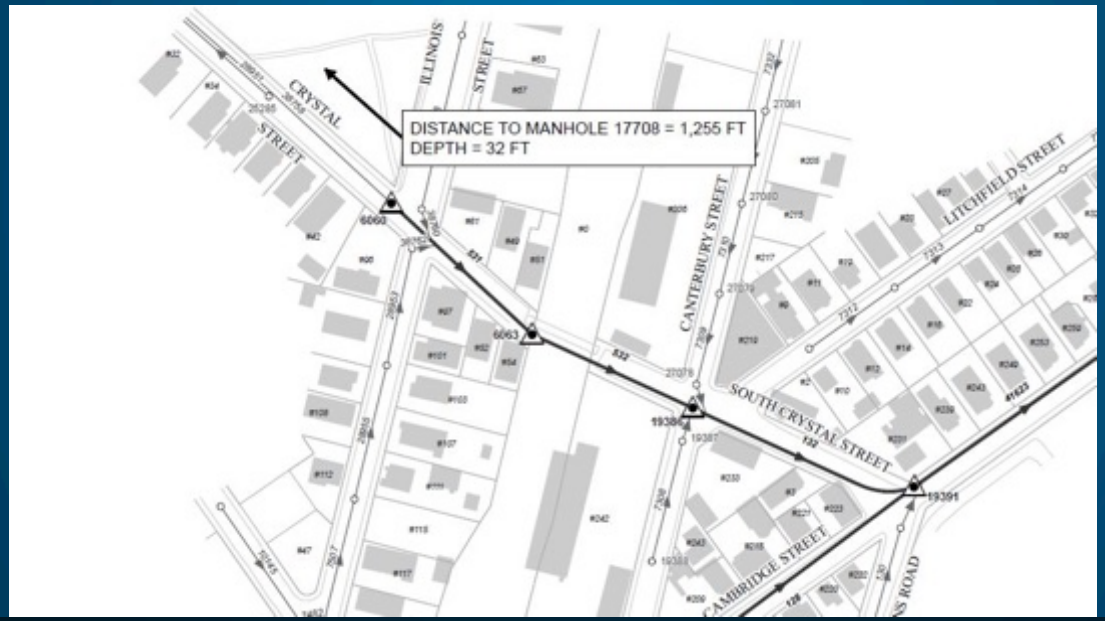
1. Sewer is 32 feet deep
2. Pumps need to be set 15 feet below street level
3. Required pump pit dimension is approximately 9 feet by 60 feet
4. Rock found at 10 feet





Options

1. Excavate rock at planned suction pit location at MH 17708 (1,255 lf upstream of MH 6060 and on roof of rock tunnel) - $120,800
2. Install a dog house manhole adjacent to MH 6060 - $66,800



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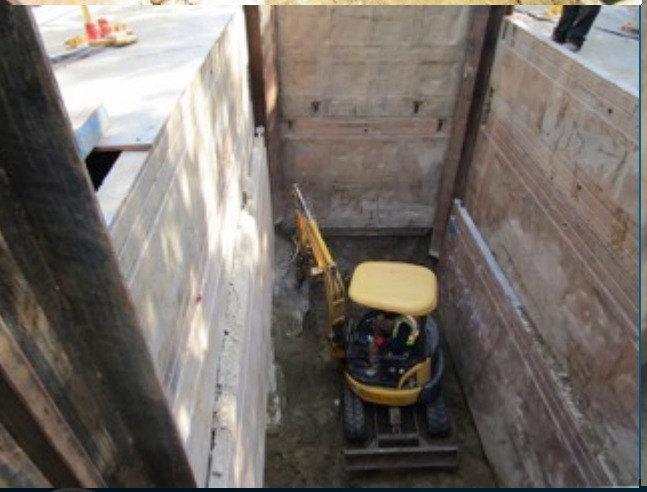
Dog House Manhole Excavation and Trench Support



Rock

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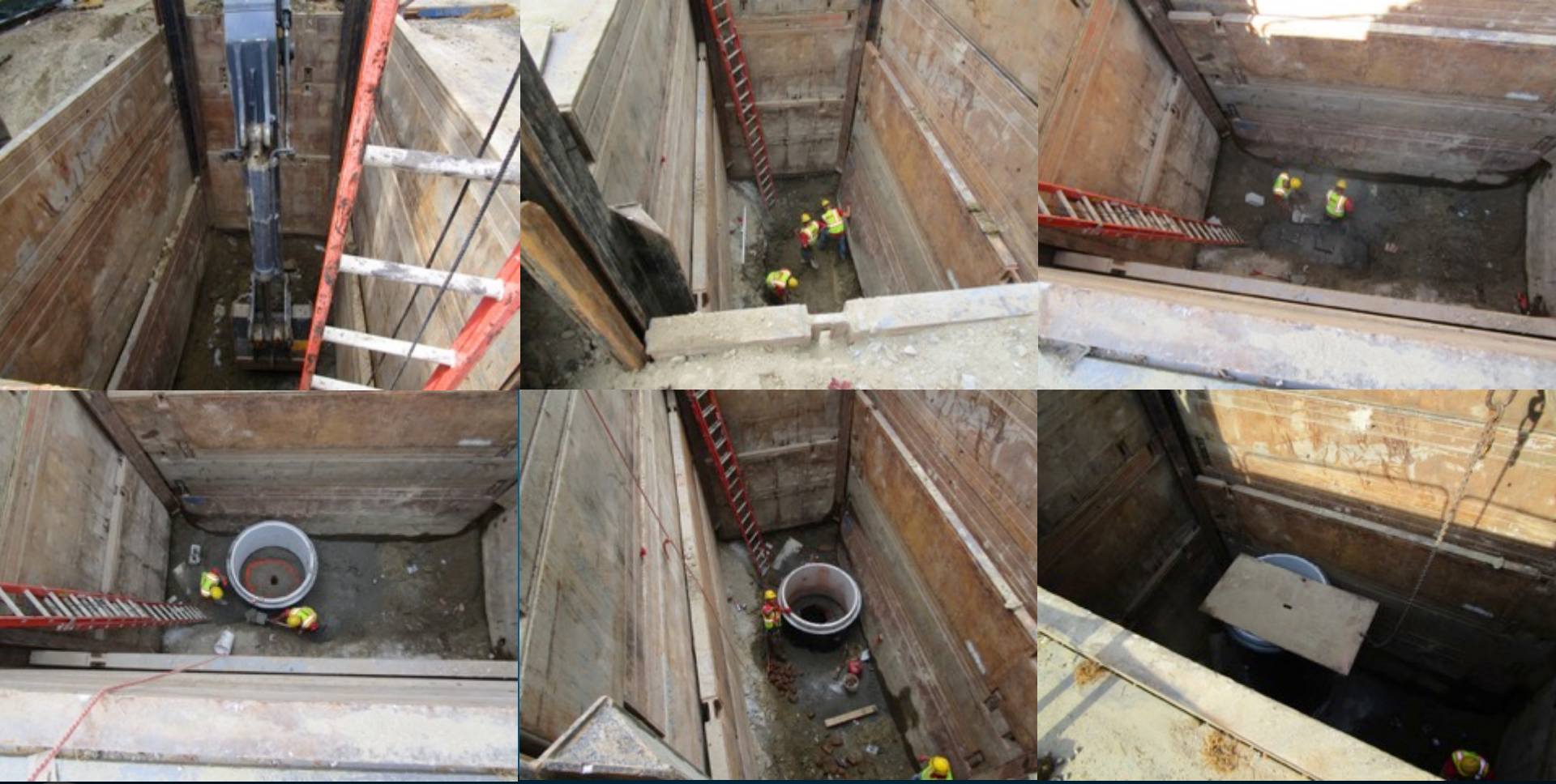

Installing Dog House Manhole

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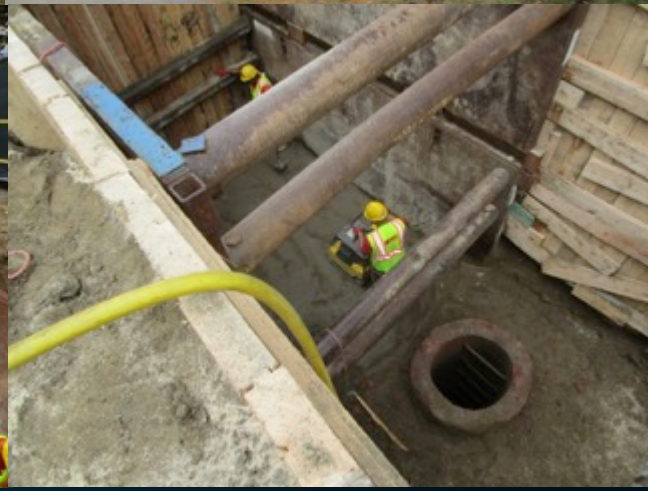

Installing Bypass Pumps at MH 6060

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Sewer Manhole – Epoxy Lining

- Sealing Manholes in below freezing temperatures
- Epoxy applied from the invert to above the flow line

Grouting Laterals

Conventional lateral grouting methods cannot be used in non-circular pipe

- Sewers range in size from 28-inch by 42-inch to 48-inch by 72-inch
- Hand applied epoxy was completed

Budget:

As Bid ($7,606,690)

- 2,292 lf of sewer line chemical root treatment
- 4,324 lf of structural CIPP in brick sewer
- 1,314 lf of structural CIPP in rock tunnel/brick sewer
- Epoxy Grouting of 200 service and lateral connections
- 354 vf of manhole epoxy lining

Change Orders ($219,113)

- Borings, probes and rock coring ($20,371)
- Dog House Manhole Installation ($66,800)
- Rock removal for dog house manhole ($33,411)
- CIPP lining of chimneys and cleanout ($87,500)
- Hazardous waste disposal and transportation ($7,428)
- Manhole frames and covers ($3,600)

Total Construction Cost =	$7,825,800
Engineering Fee =	$440,450
Total Project Cost =	$8,266,250

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Lessons Learned

- Keep Public Informed
  - Use Electronic Message Boards
  - Social Media and Flyers
  - Experienced Resident Engineer
- Bypass Pumping Costs
- Consider Alternative Bid Items
- Establish a Good Working Relationship with Project Team

Project Team

Owner - City of Worcester Department of Public Works & Parks

- Sewer Engineering Division
- Sewer Operations Division
- Water
- Residents and Business Owners

Engineer - Weston & Sampson

General Contractor - Green Mountain Pipeline Services

- GVC – Excavation subcontractor
- Midas Flow Control – Bypass subcontractor
- Dukes – Root treatment subcontractor

Questions?

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