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Modernizing Combined Sewers Inspections using Drones in Boston, MA

By Kleinfelder in partnership with
Boston Water and Sewer Commission

NEW ENGLAND WATER ENVIRONMENT ASSOCIATION
NEWEA
WORKING FOR WATER QUALITY

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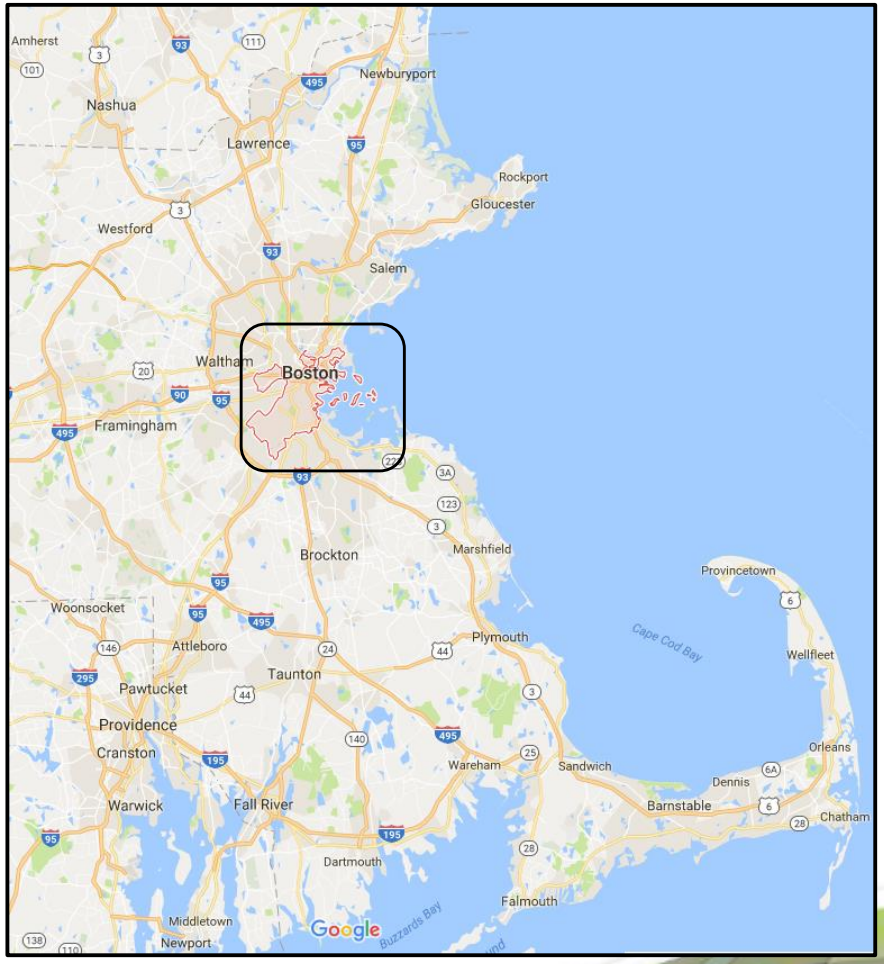
Presentation Outline

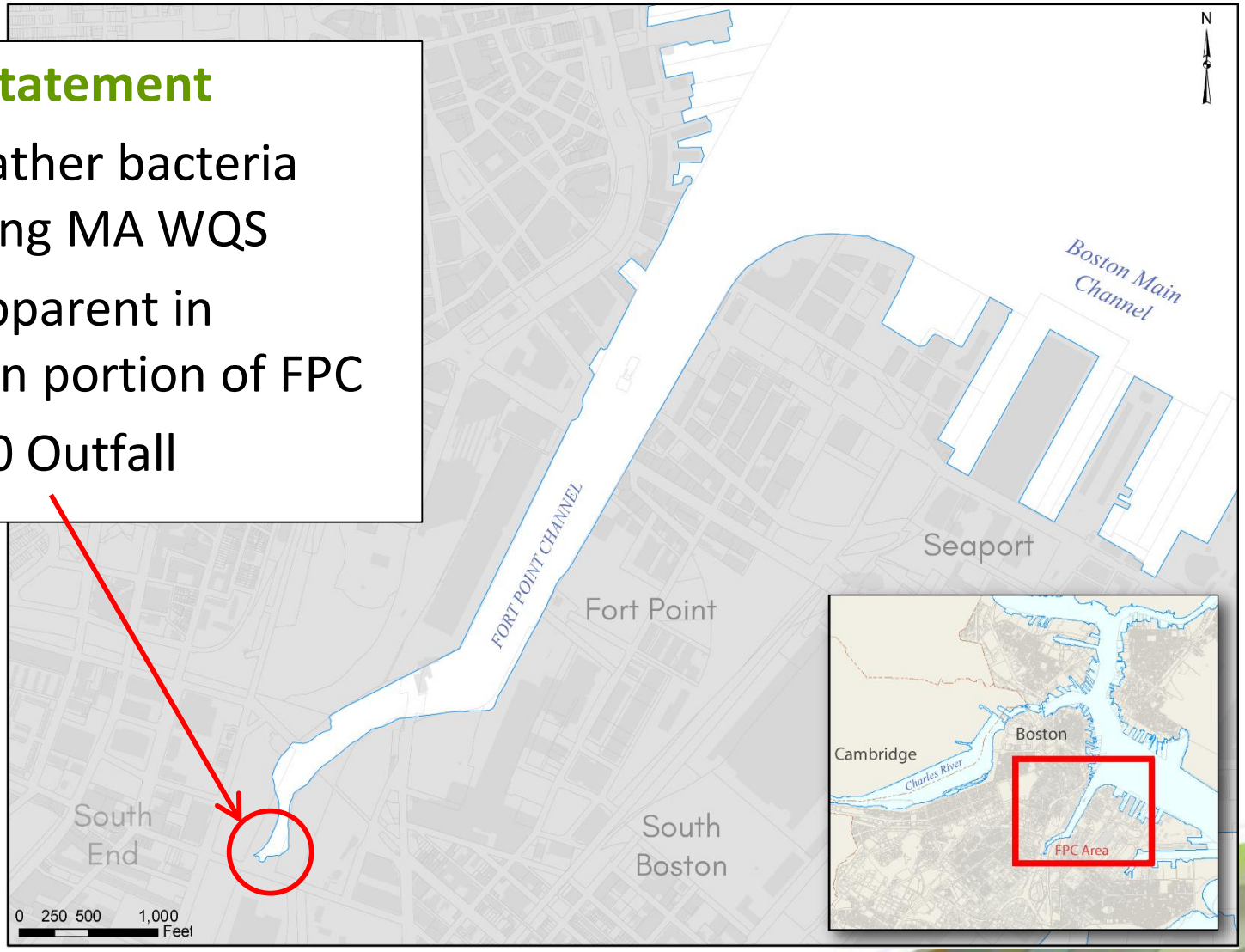
- Fort Point Channel (FPC) Project Background
- FPC Project Drone Field Investigations
- Results and Recommendations
- Future of Drone Inspections
- Summary and Questions



Fort Point Channel Background

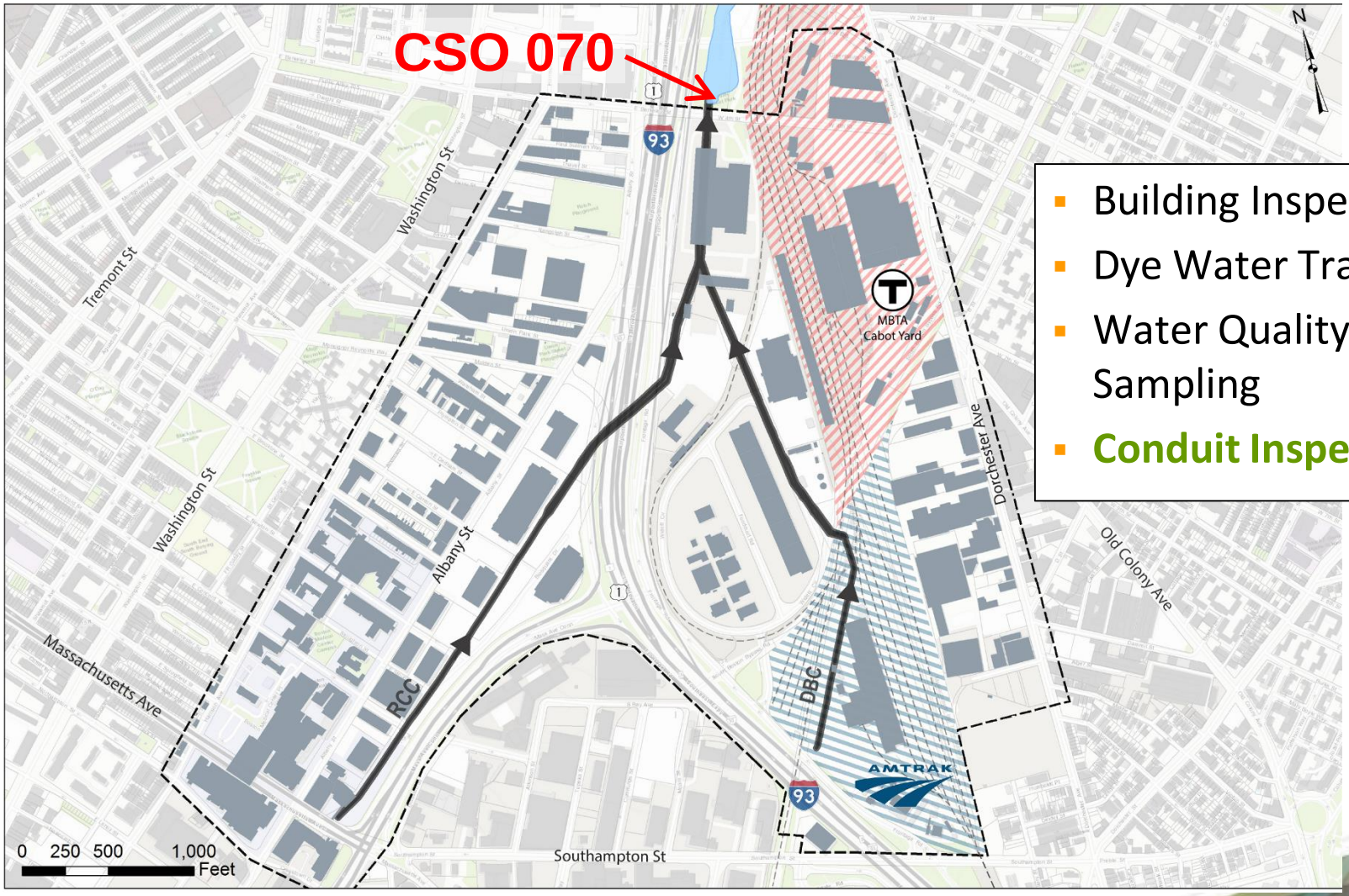
Problem Statement

- Dry weather bacteria exceeding MA WQS
- Most apparent in southern portion of FPC
- CSO 070 Outfall



CSO 070 Outfall

IDDE Project Approach



- Building Inspections
- Dye Water Tracing
- Water Quality Sampling
- **Conduit Inspection**

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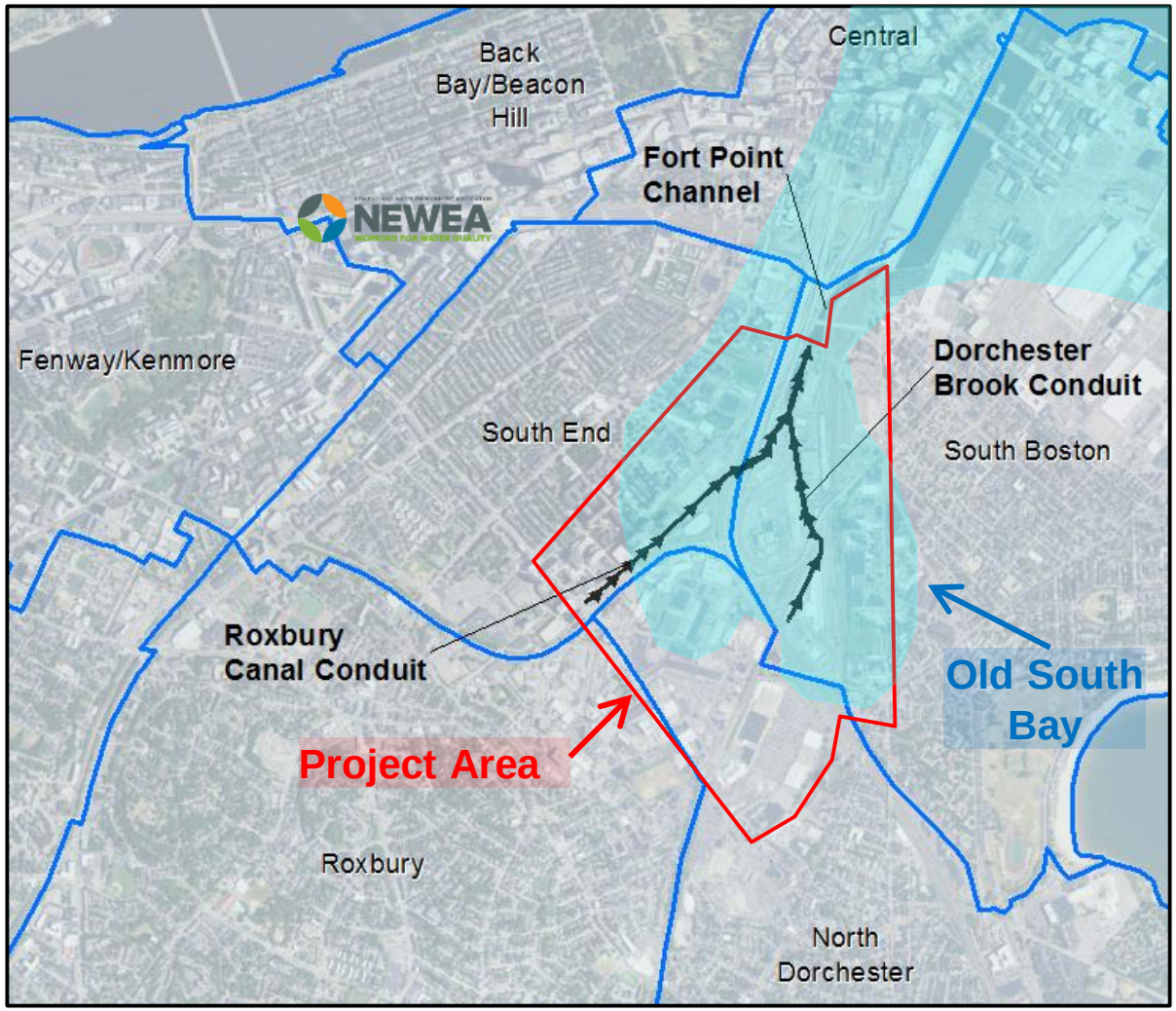
CSO 070 Conduits



FPC Tributaries

- **Roxbury Canal** & **Dorchester Brook** Conduits (RCC/DBC)
- 2 miles RC culverts
- Built in the 1960s
- Stormwater Outfall w/ CSO Activity
- Originally existed as the South Bay (1920s)

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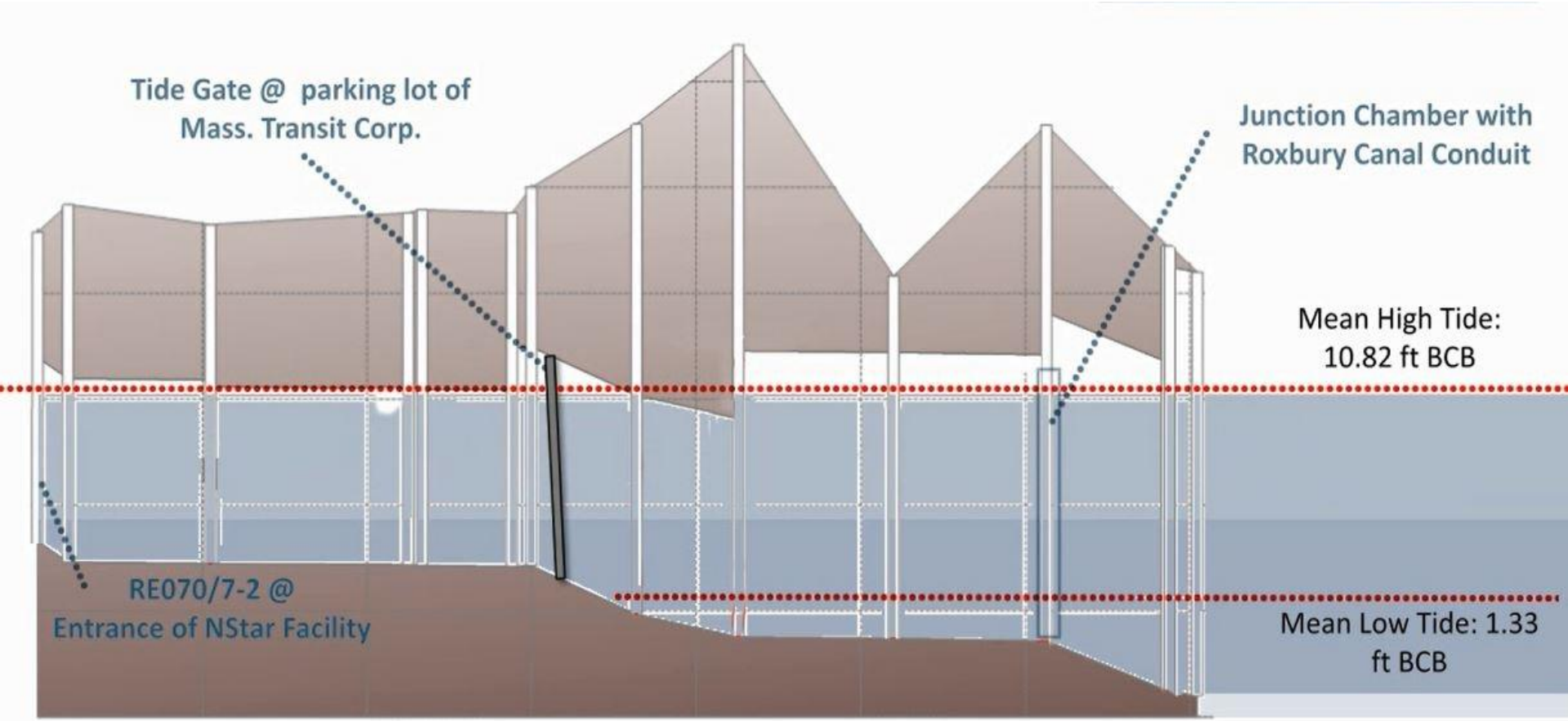
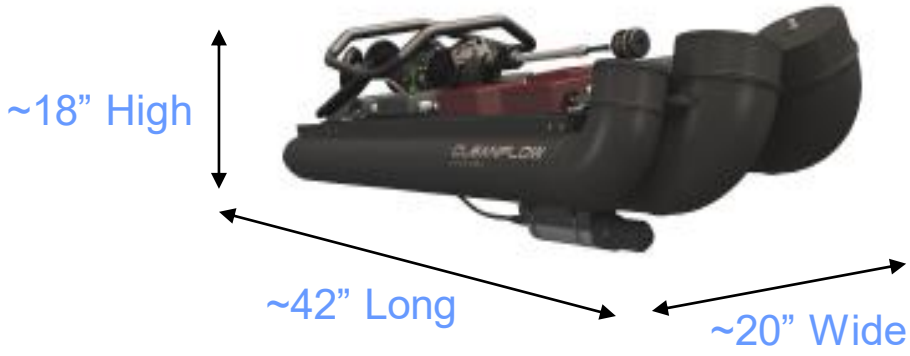
Conduit Inspection Challenges

- Intermittent Access
- Confined Space
- Tidally Influenced
- Sediment

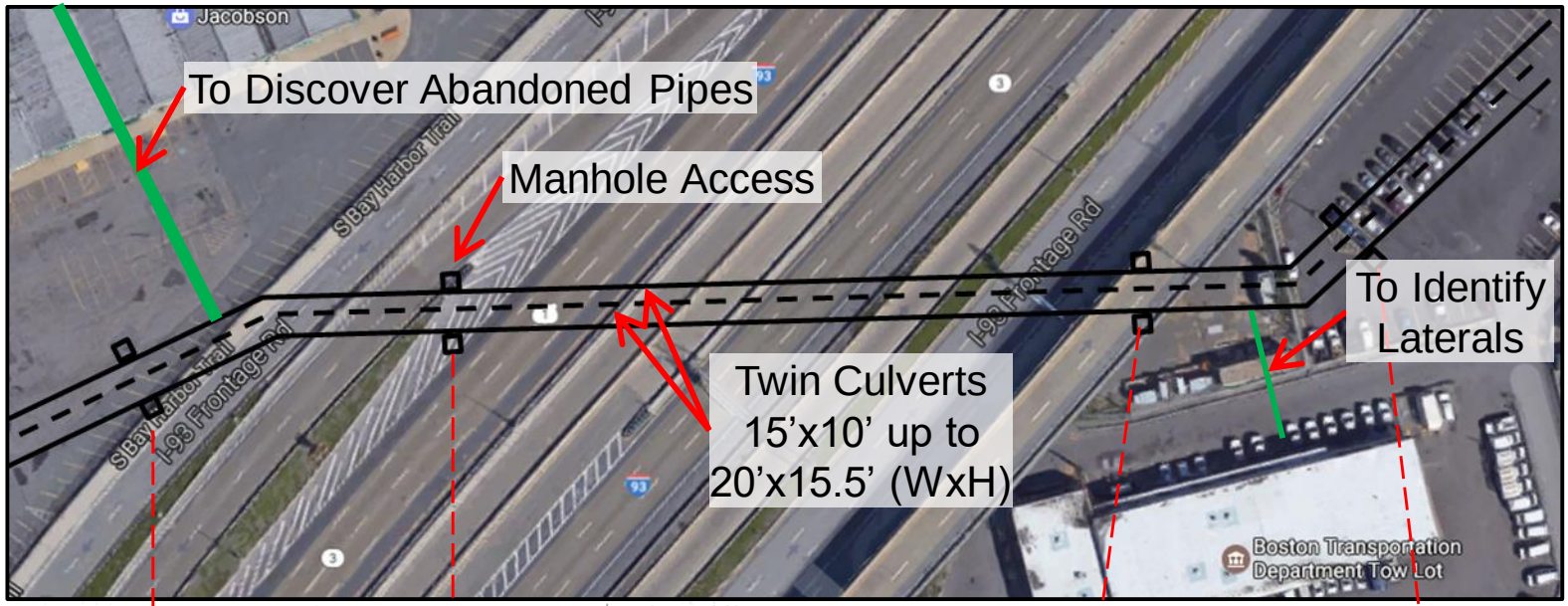


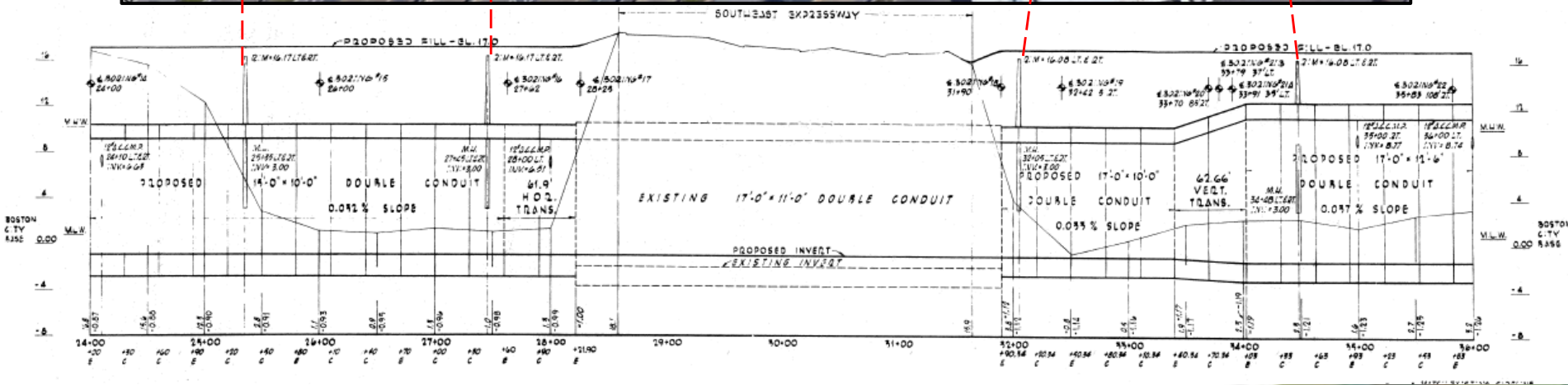
Conduit Inspection Approaches

1. CCTV on Pontoon
2. Manned Entry
3. Drone (UAV)
4. Radio Controlled Boat



Records Research/GIS Review





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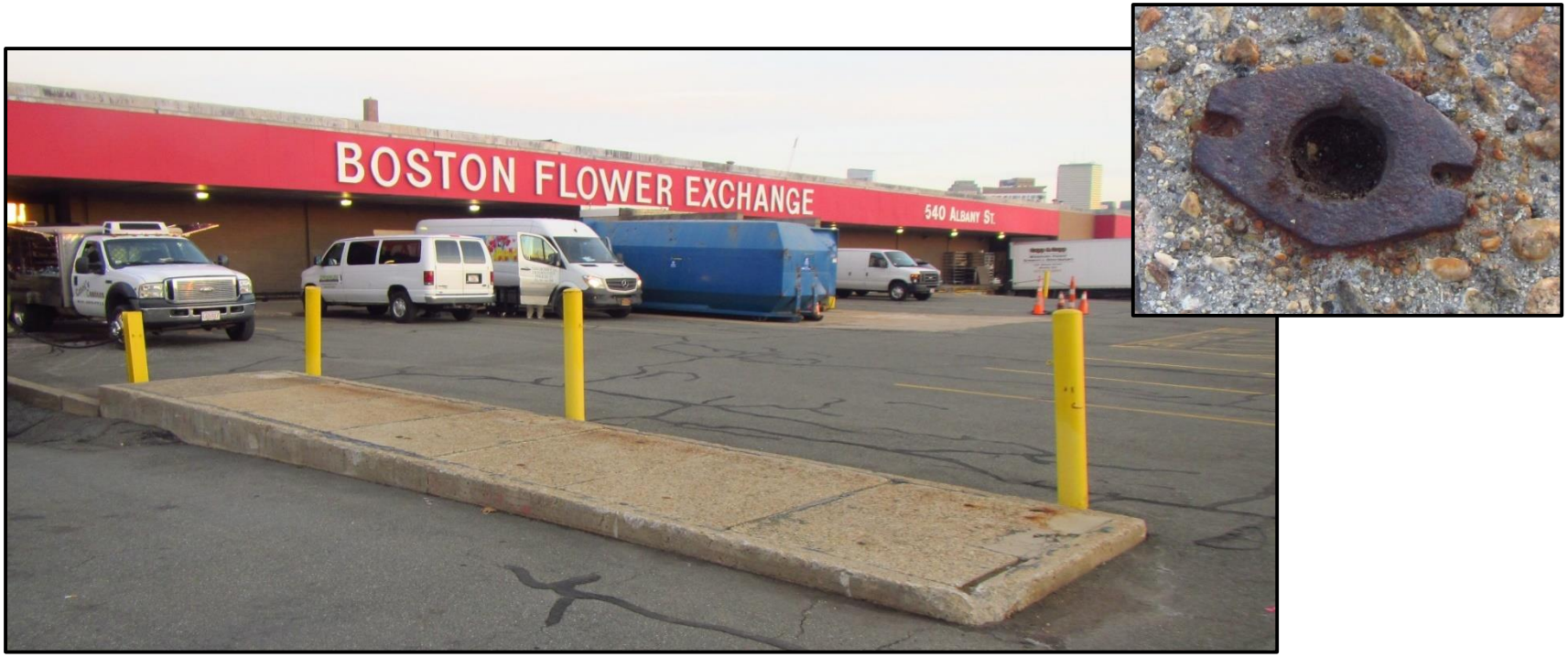
Field Reconnaissance



- Identify access constraints at various sites
- Locate manholes and access panels
- Performed two confined-space entry investigations
- GPS infrastructure and confirm alignment

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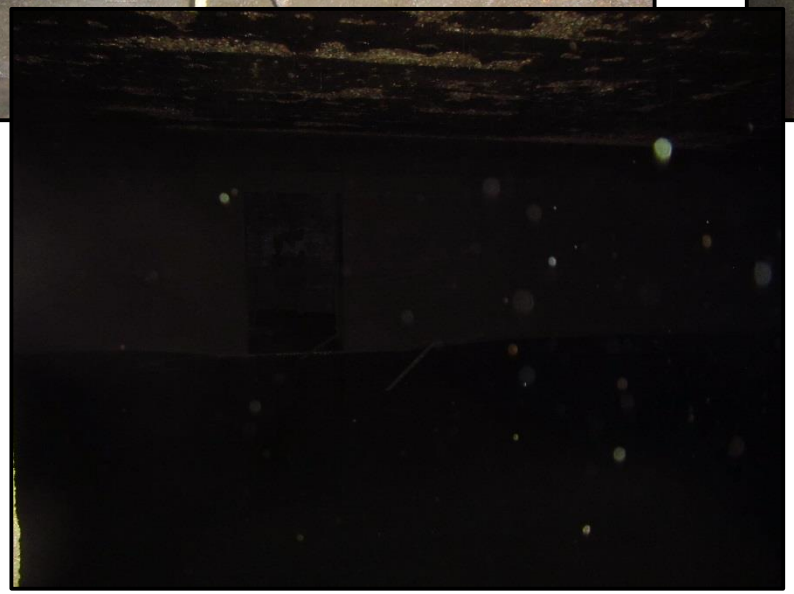
Field Reconnaissance



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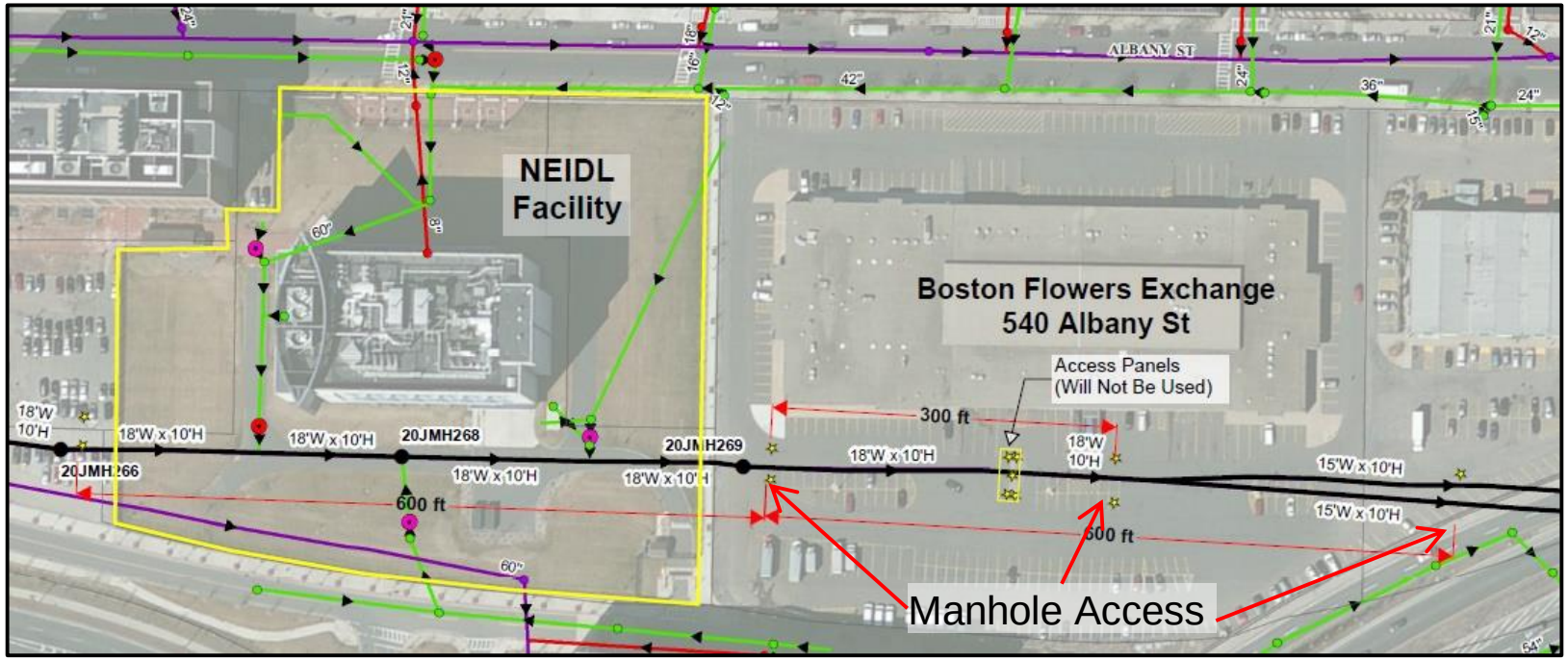
Field Reconnaissance

Drone Inspection Planning



- Coordinate property access
- Identify staging points for additional lighting
- Develop several scenarios for drone to capture data
- Review NOAA Tide Predications (target low tide)

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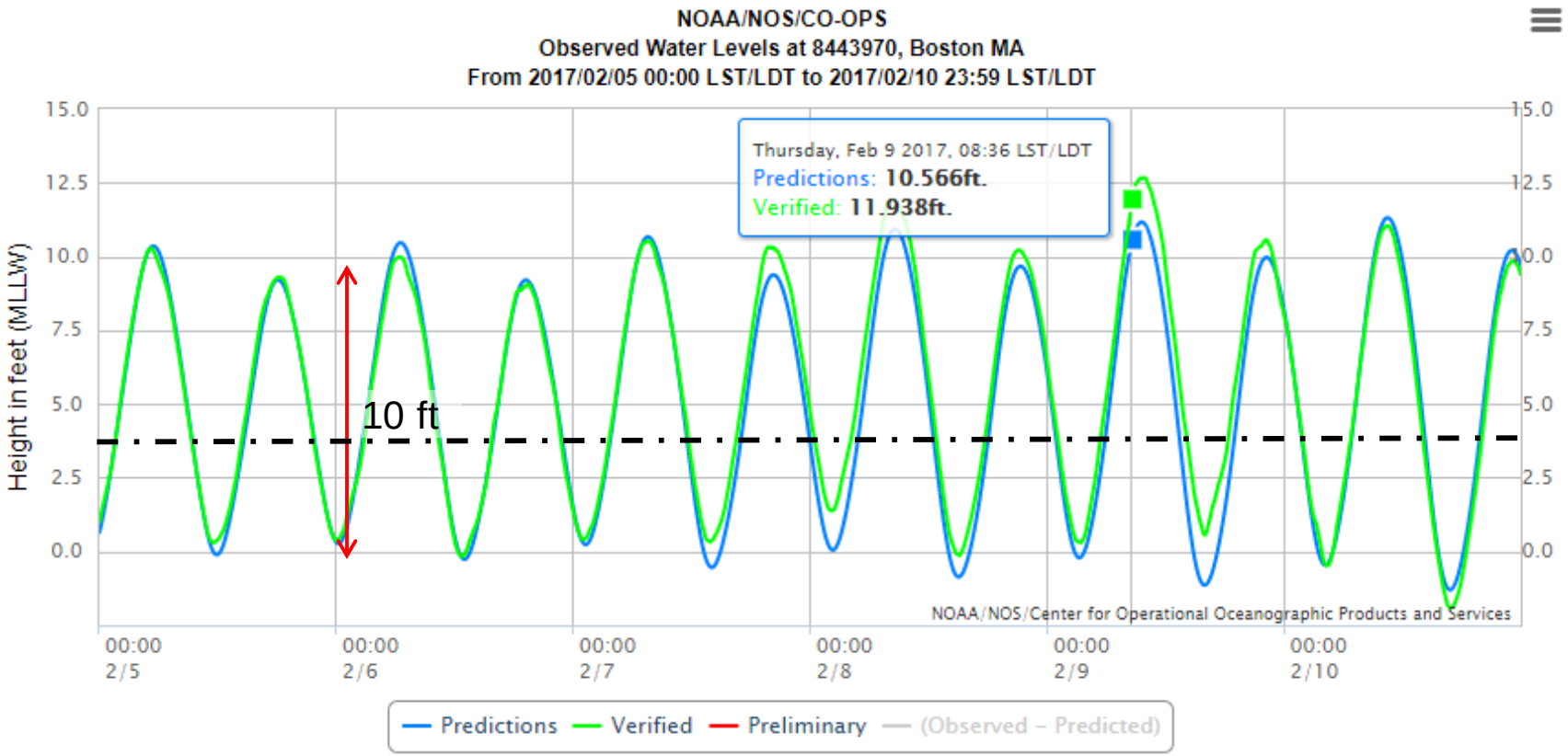
Drone Inspection Planning



- Greater highs/lows around full and new moons
- Also impacted by weather pattern (storm surge)

Drone Inspection Planning

Objectives

1. Gain access and make a safe entry into RCC manholes
2. Develop an understanding of the tidal influence on the RCC
3. Photograph the inside of the RCC, including piped connections
4. Test multiple approaches to lighting the interior of the RCC
5. Demonstrate use of quadcopter drone to fly within the conduit
6. Determine whether a 3D model of the conduit is possible

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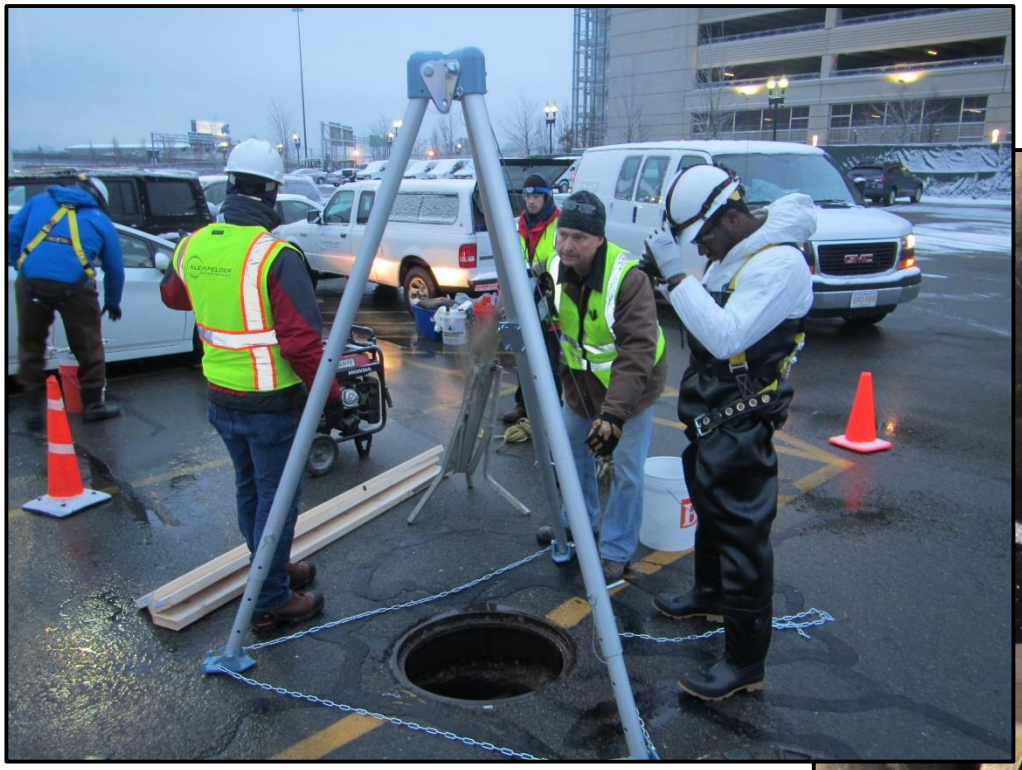
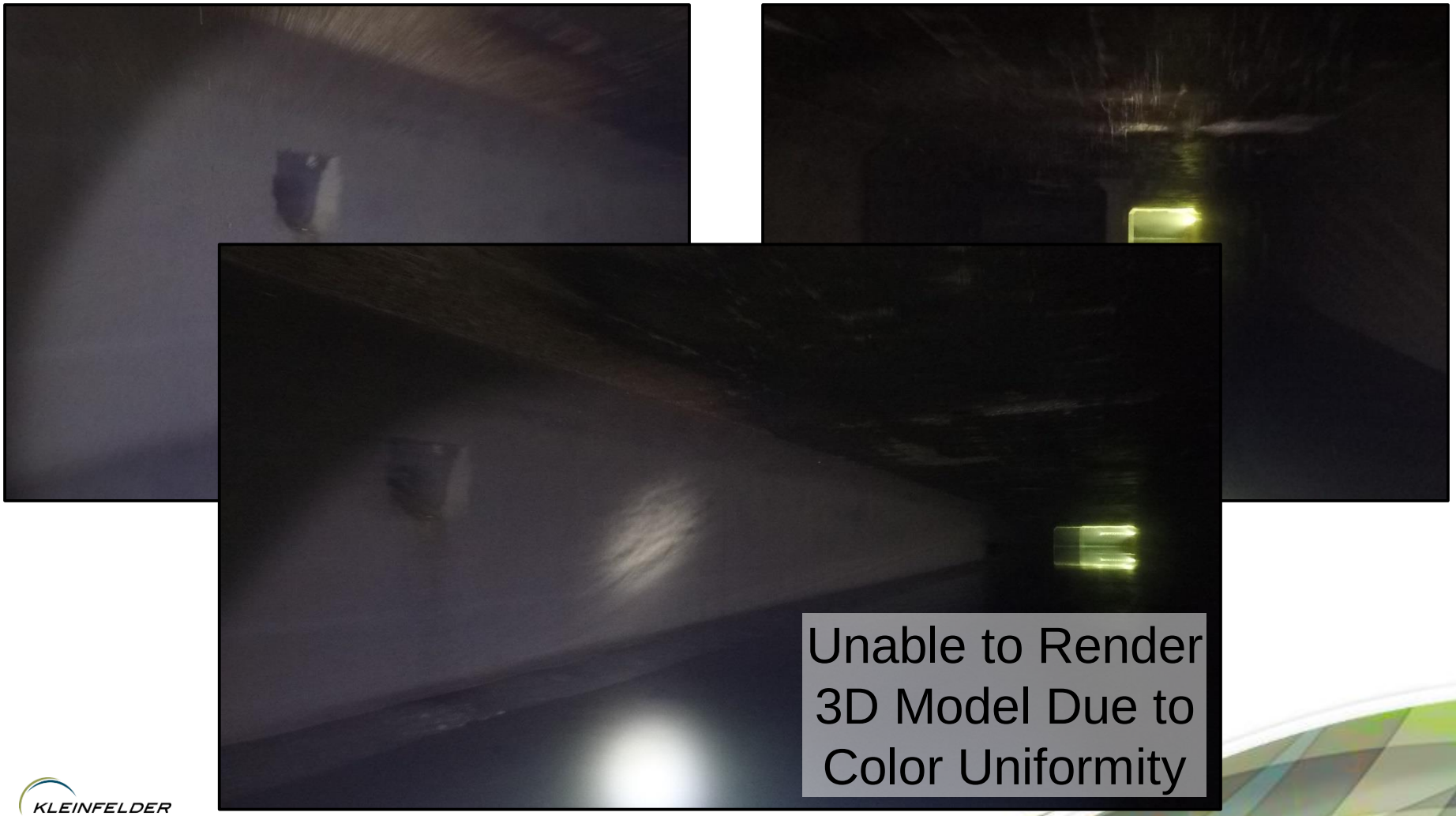
Drone Demonstration



Drone Demonstration

RC Boat Approach

Processing/Review of Collected Data



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Result of Drone Demonstrations

- Successfully captured photo and video with proper illumination
- Inspection speeds >30 ft per minute
- Sediment and debris build-up (over 3ft) throughout conduit
- Tidal work window was determined to be about 5 hours

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Comparative Cost

Inspection Type	Crew Size	Total Daily Cost	Inspection Length	Unit Cost	Required Production	New Unit Cost
Drone	9	$8,760	300 ft	$29.20/ft	>1,850 ft	<$4.73/ft
Drone	4	$5,100	250 ft	$20.40/ft	>1,100 ft	<$4.63/ft
Pontoon*	2	$4,750	1,000 ft	$ 4.75/ft	n/a	n/a

*Vendor quoted price and production

Achievable with optimizations to inspections

- Schedule can also benefit from speed of drone/boat inspections

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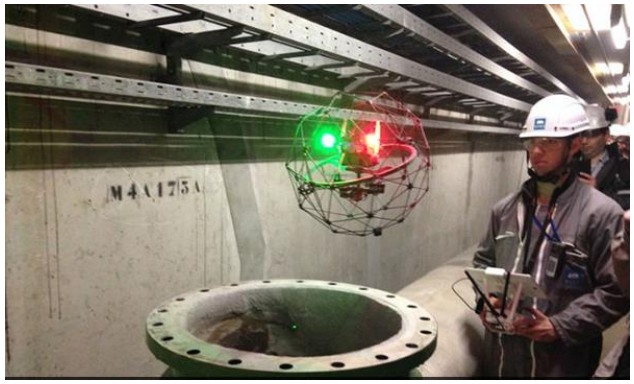
Recommendations

- Confirm existing conditions (sediment, flow speed, lighting, etc.)
- Check water depths especially for tidally-influenced pipelines
- Come prepared with necessary accessories (raft, planks, etc.)
- Outfit your drone with the appropriate equipment (camera and add-on lights should be compatible)
  - High resolution 4K camera
  - Provide heavy duty lights for illumination (1000+ lumens)

The Drone Inspection Industry

Building Architecture

- Building Envelope Evaluation
- Perspective Aerial Photography
- Roof/Facade Inspection



Oil & Gas Pipeline

- Leakage and Spill Inspection
- Thermal Imaging
- Pipeline Survey

Water and Sewer

- Water Pipeline Leak Detection
- Not Many Internal Sewer Inspections

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General Drone Guidelines

FAA Regulations Part 107 - Guidelines for Commercial Drone Use

- Keep the unmanned aircraft within visual line-of-sight*
- Fly in Class G airspace* (Keep 5 miles away from airports)
- Fly during daylight or civil twilight*
- Fly at or below 400 feet*
- Fly at or under 100 mph*
- ** Rules subject to a waiver*

- FAA does not have jurisdiction over indoor or underground buildings and structures

Municipal Applications

"As the capability and flexibility of UAVs increases and the costs fall, expect to see UAV become a standard part of the toolkit!" – Frank Courtney, Melbourne Water (Australia)

Internal Pipeline Inspections

- CSO Storage Tunnels
- Stormwater Outfalls
- Water Transmission Aqueducts
- Pipes 60" and larger
  - Stagnant or no flow
  - Tidal influences
  - Sediment build up
  - Odd cross-sections
  - Difficult to bypass flows

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Summary

- Planning and preparation is key and increases in magnitude with larger conduit inspections
- Drone inspections can be cost competitive with conventional pipeline inspection technologies
- Drones used for inspections should be outfitted accordingly

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Thank You!

Acknowledgements

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QUESTIONS???

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