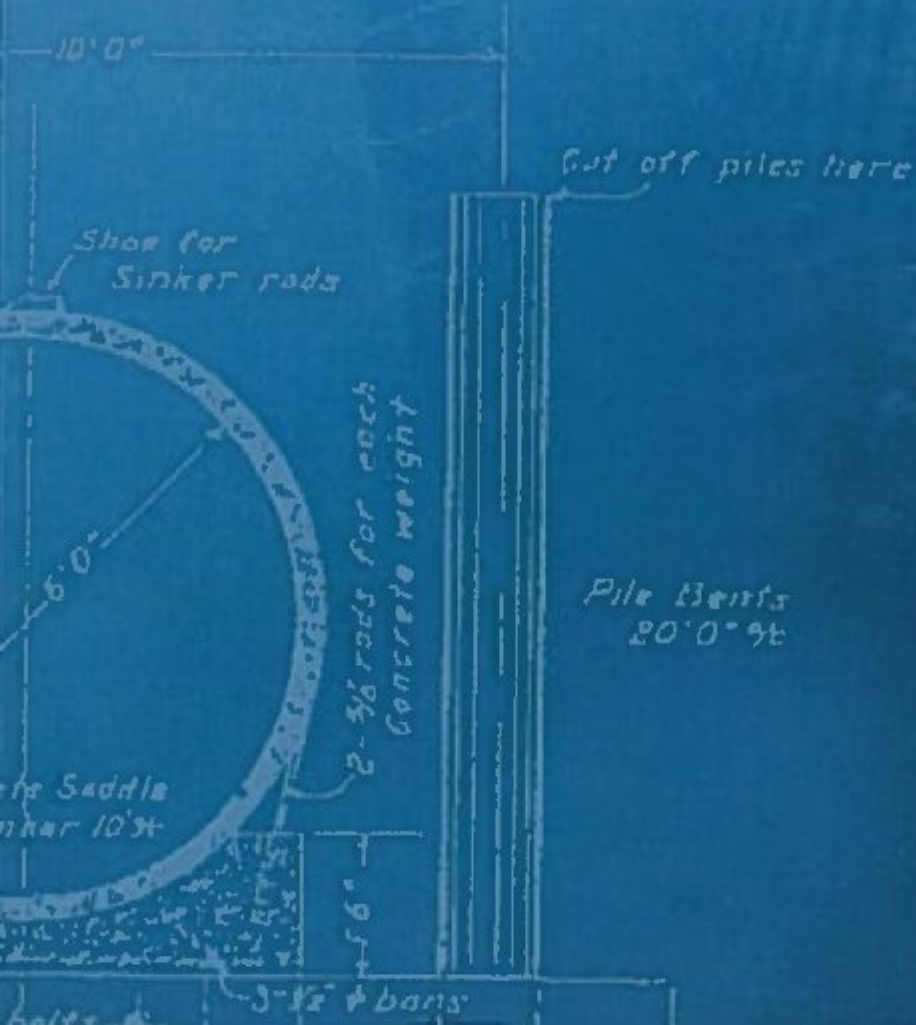


Condition Assessment: City of Bellingham Supply System

2015 PNWS-AWWA Conference



ch2m.SM

Presentation Topics

1. Background

2. Condition Assessment

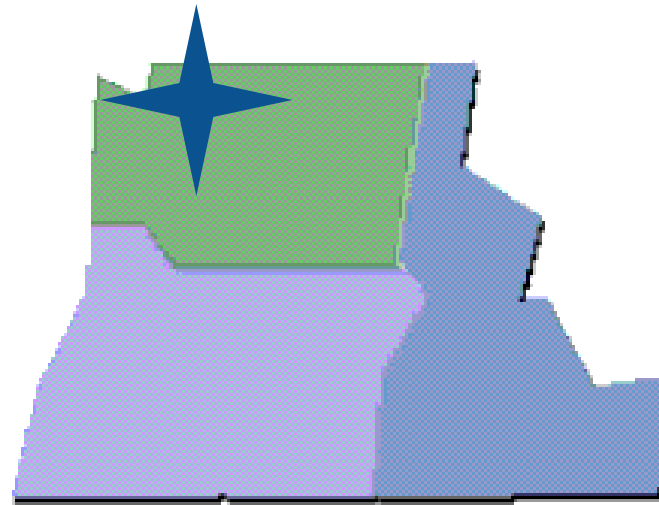
1. Wood Stave Intake
2. Tunnel
3. Screen House
4. Pipelines
 1. Industrial (48" CCP)
 2. Municipal (66" steel)

3. Acknowledgements/ Questions

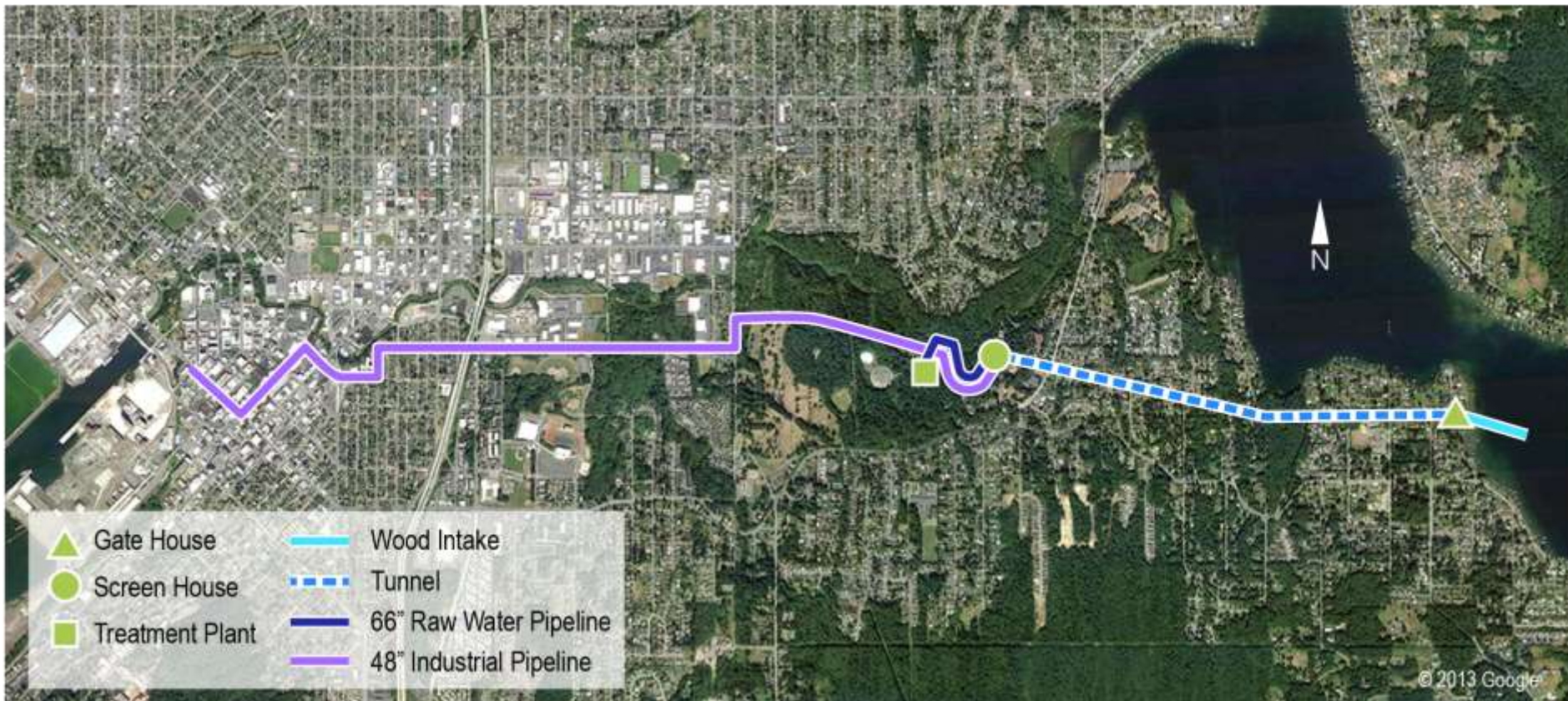


City of Bellingham

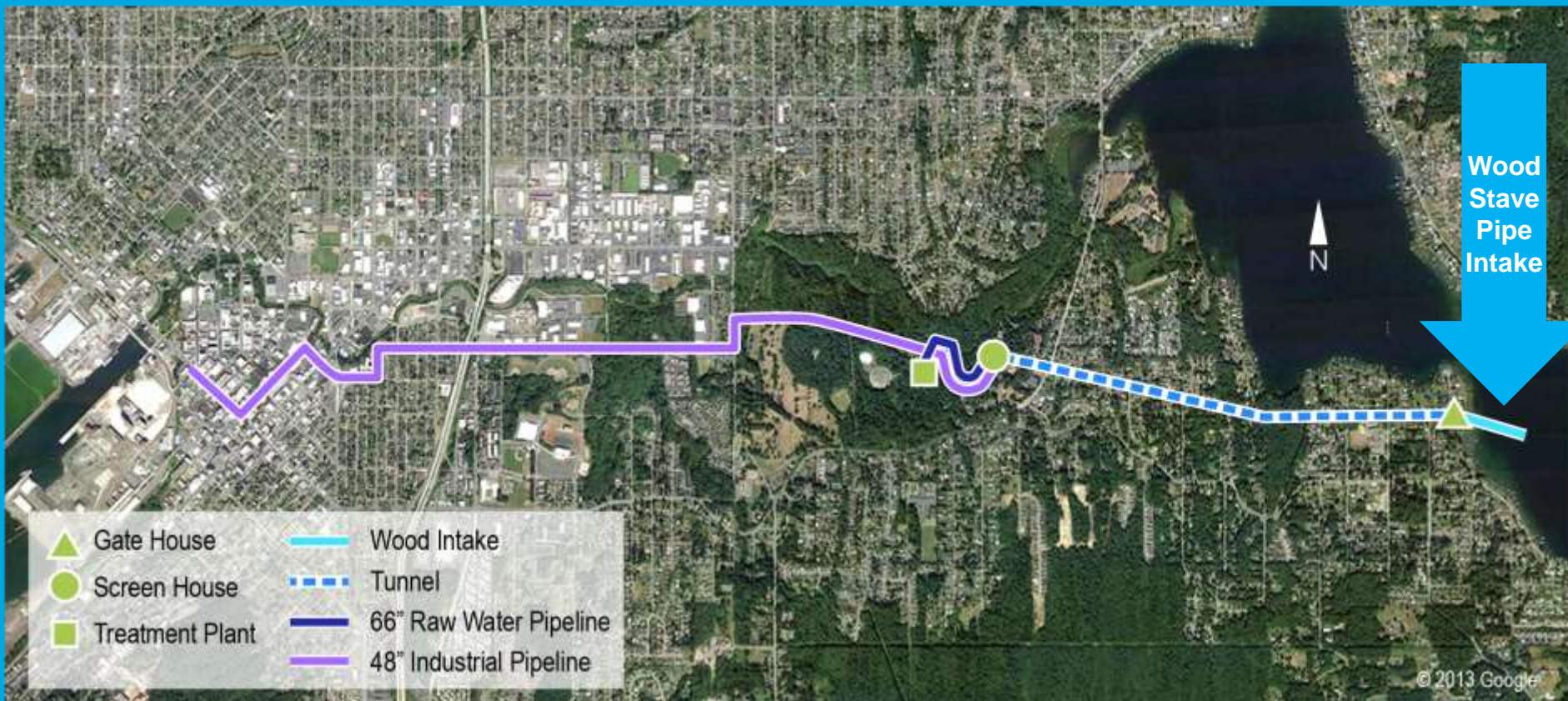
- Population = 83,000
- 13 pump stations
- 13 storage tanks
- 400 miles of pipelines
- One supply system
 - Lake Whatcom
 - Wood stave intake pipeline
 - Tunnel
 - Screen House
 - Industrial supply pipeline
 - Municipal supply pipeline



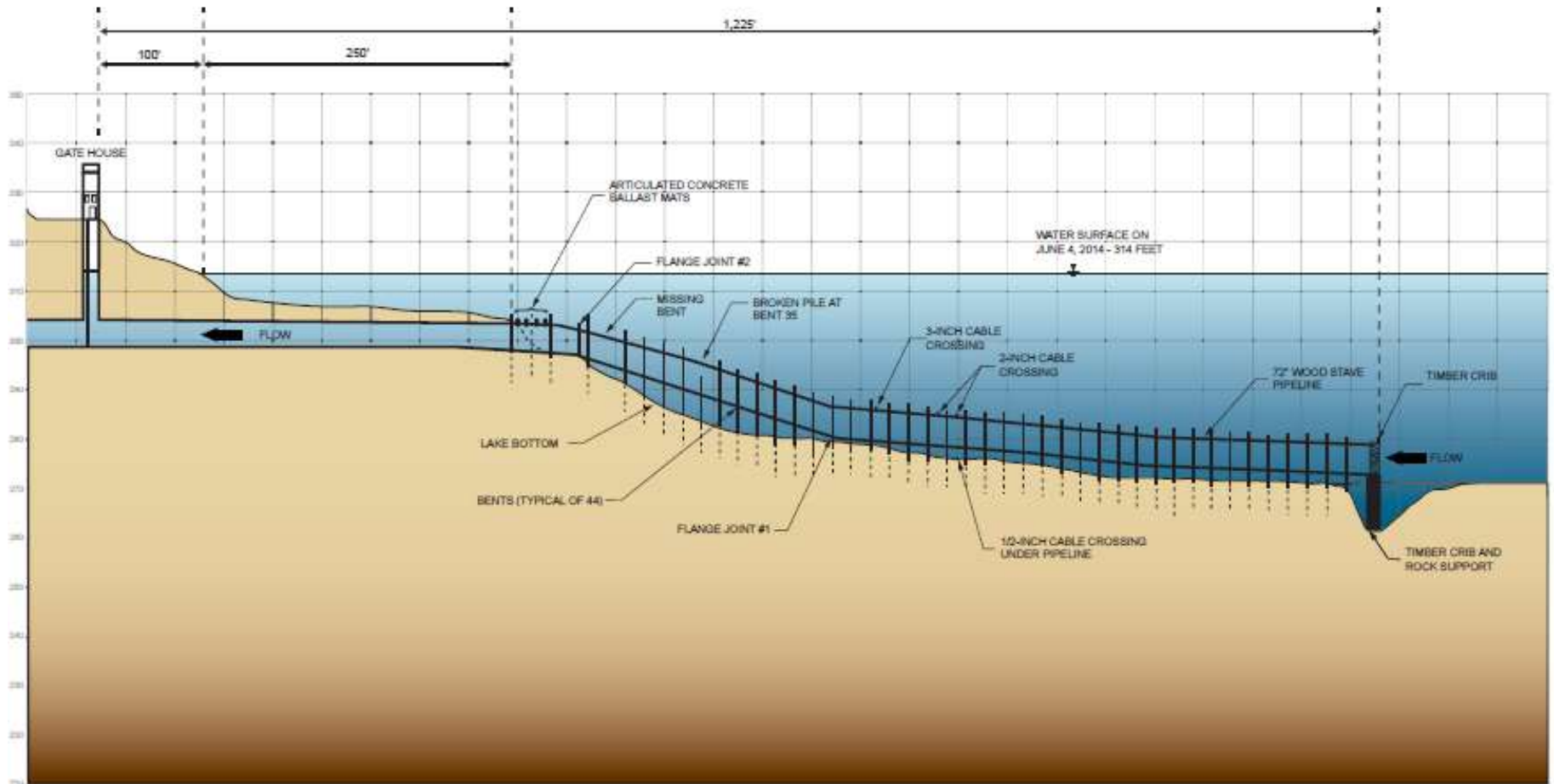
Water Supply System



Wood Stake Pipe Intake



Wood Stave Intake



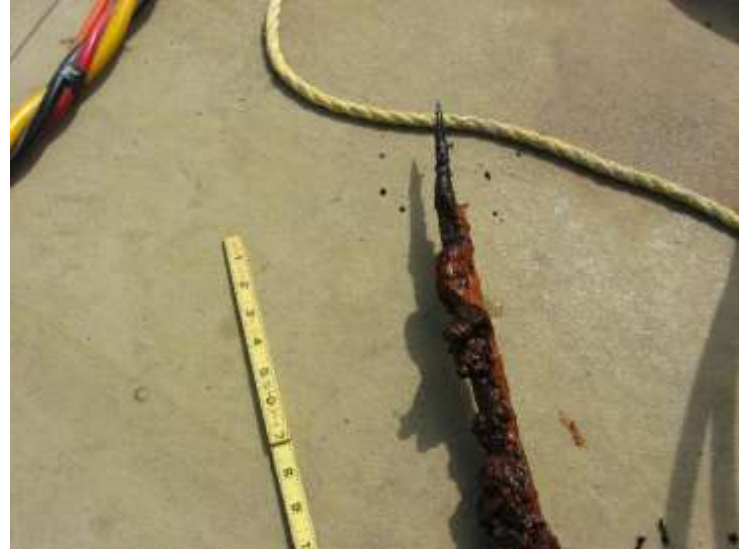
Wood Condition



Original Steel Rods and SST Bands



Condition of Steel Rods



Flange



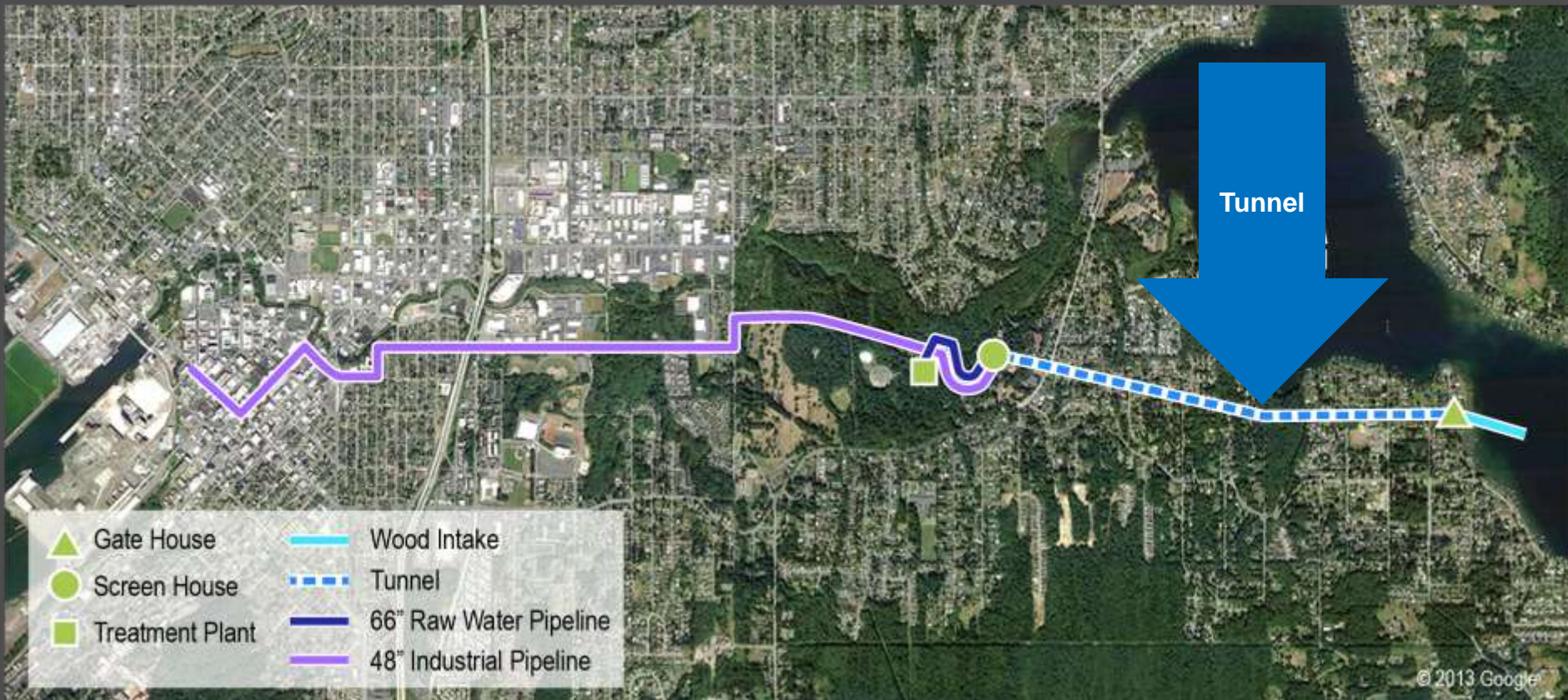
Sponge Inside Intake Pipe



Wood Stave Intake: Results

- Wood in good condition
 - Support structural components
 - Stave pipe (interior and exterior)
- SST bands in good condition
- Original steel fasteners in fair condition
- Some original steel rods corroded to failure

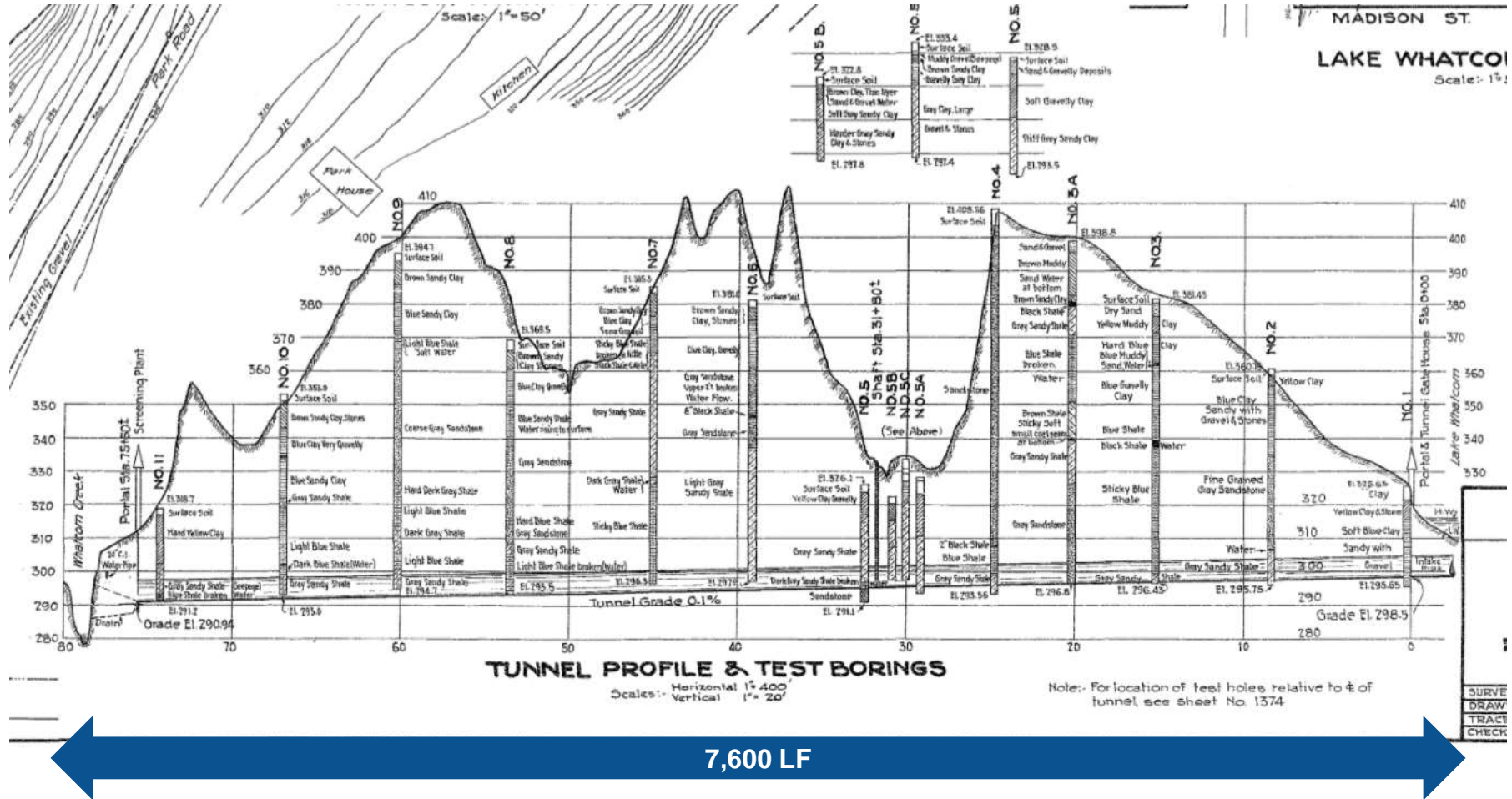
Tunnel



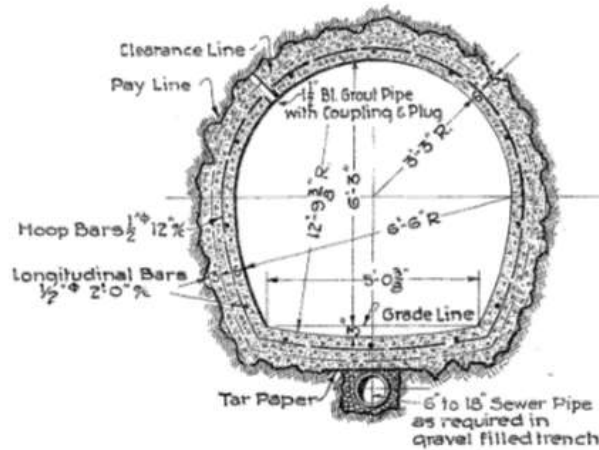
Tunnel Inspection Activities

- Underwater Laser Scanning (2012)
- Man-Entry Inspection (2015)
- Tunnel Data Analysis

Tunnel Profile

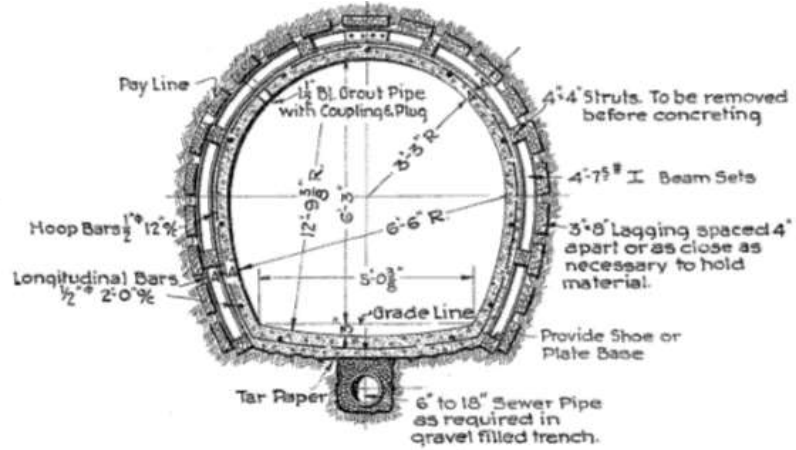


Tunnel Section



SECTION A

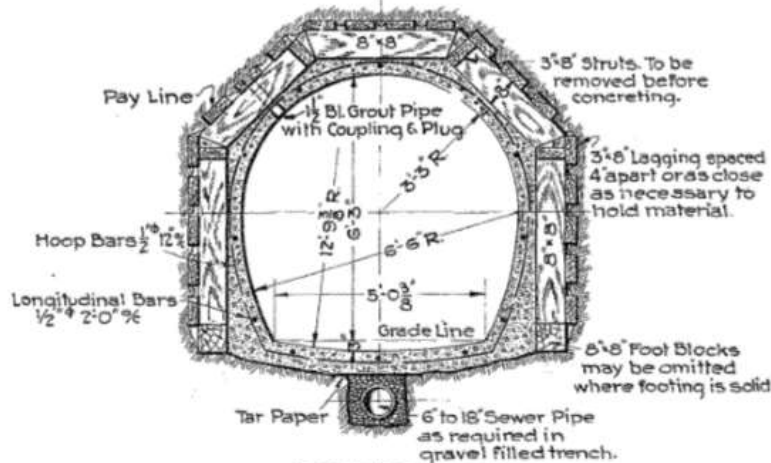
Scale: $\frac{1}{2}'' = 1'-0''$



SECTION B

Scale: $\frac{1}{2}'' = 1'-0''$

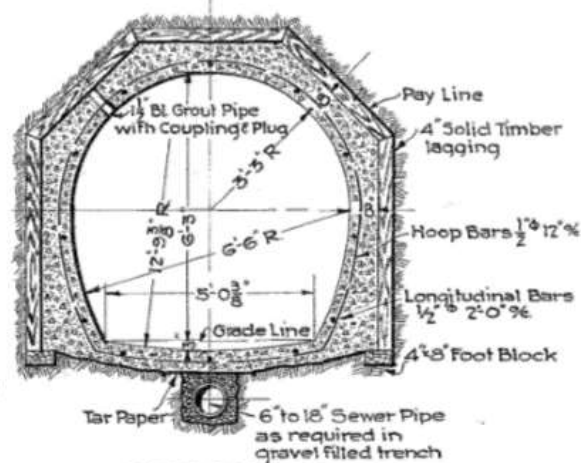
Skeleton Sets may be used omitting Lagging.



SECTION C

Scale: $\frac{1}{2}'' = 1'-0''$

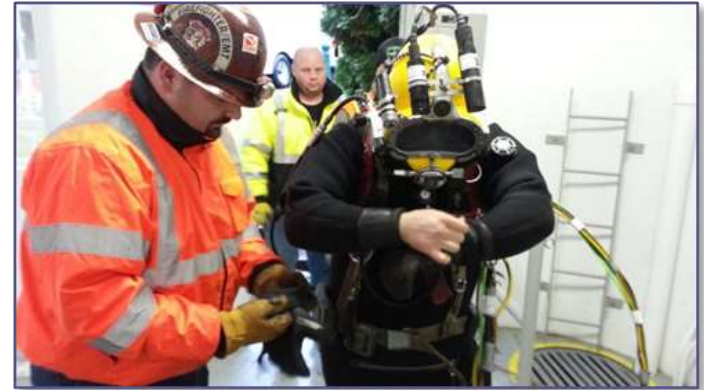
Skeleton Sets may be used omitting Lagging



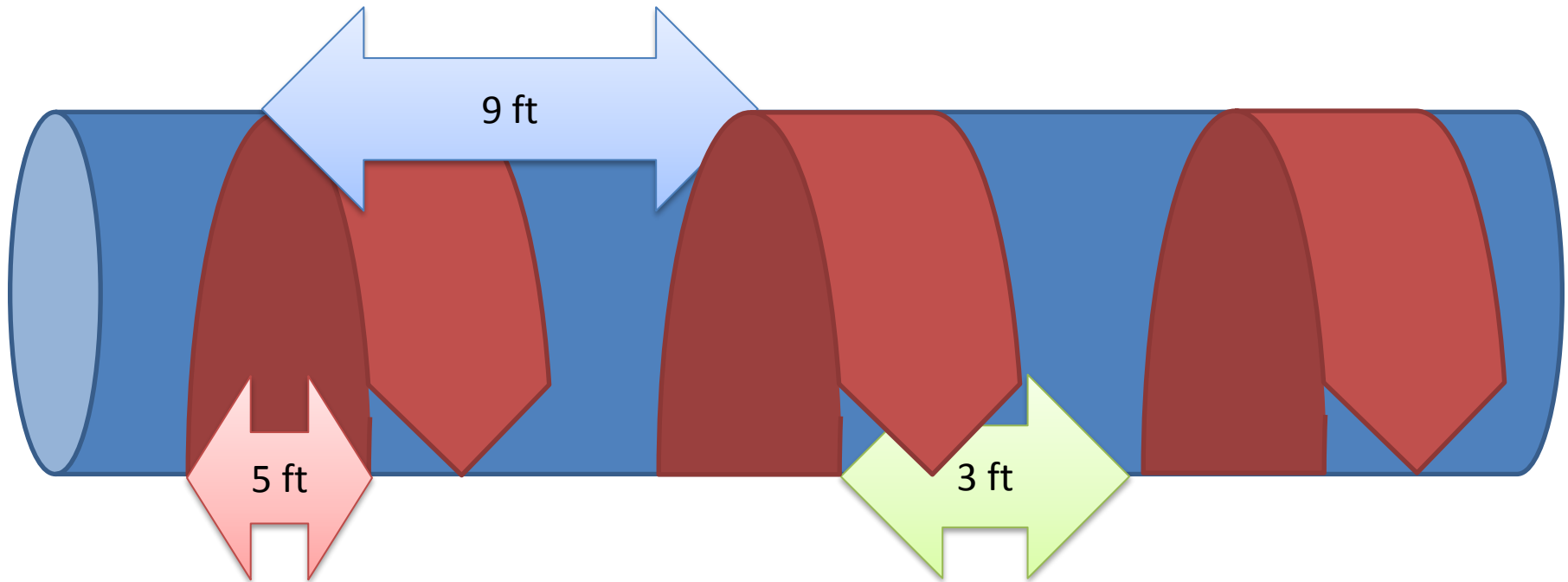
SECTION D

Scale: $\frac{1}{2}'' = 1'-0''$

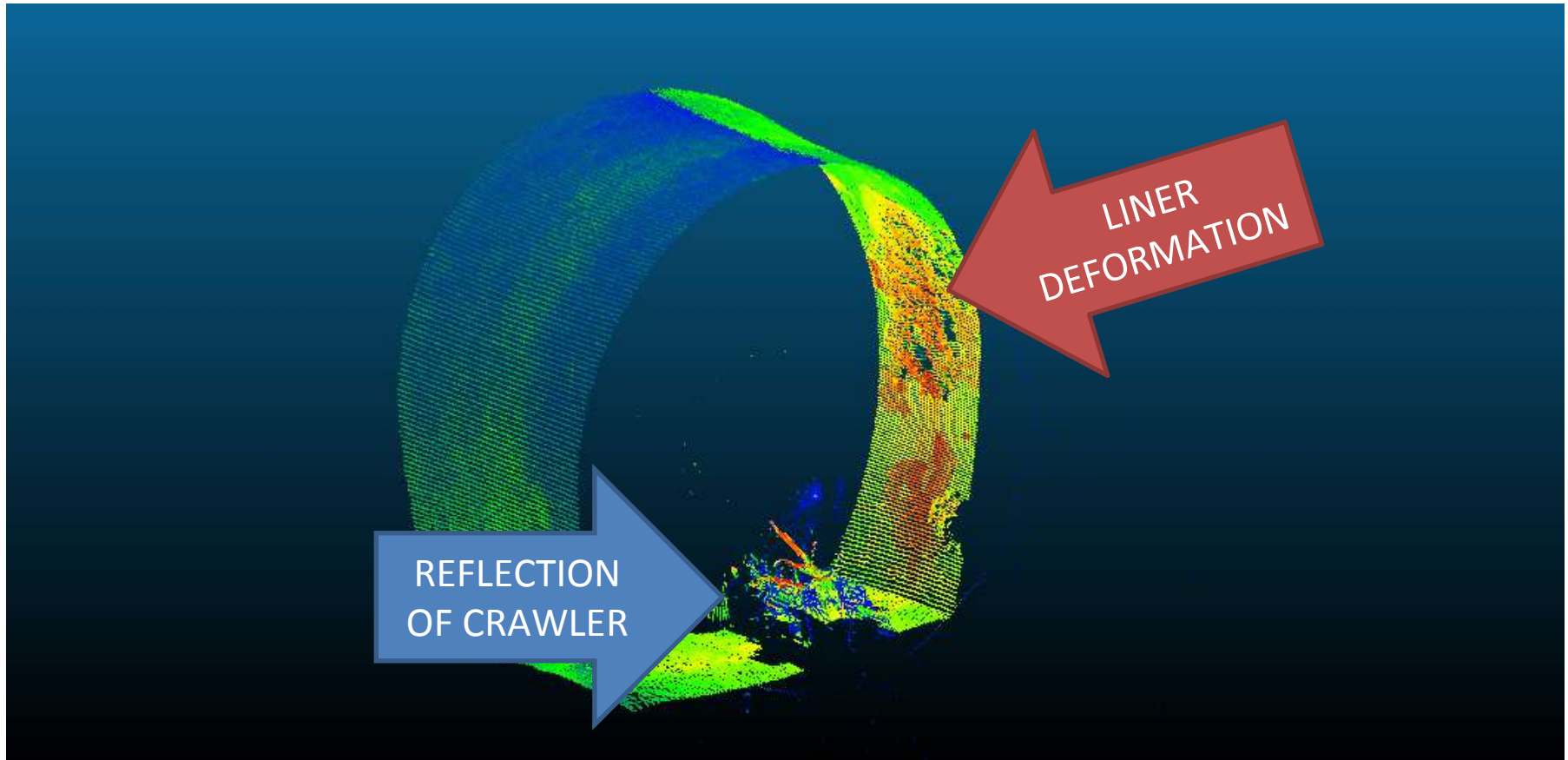
Laser Scanning: Field Photos



Laser Scanning: Data Gathered

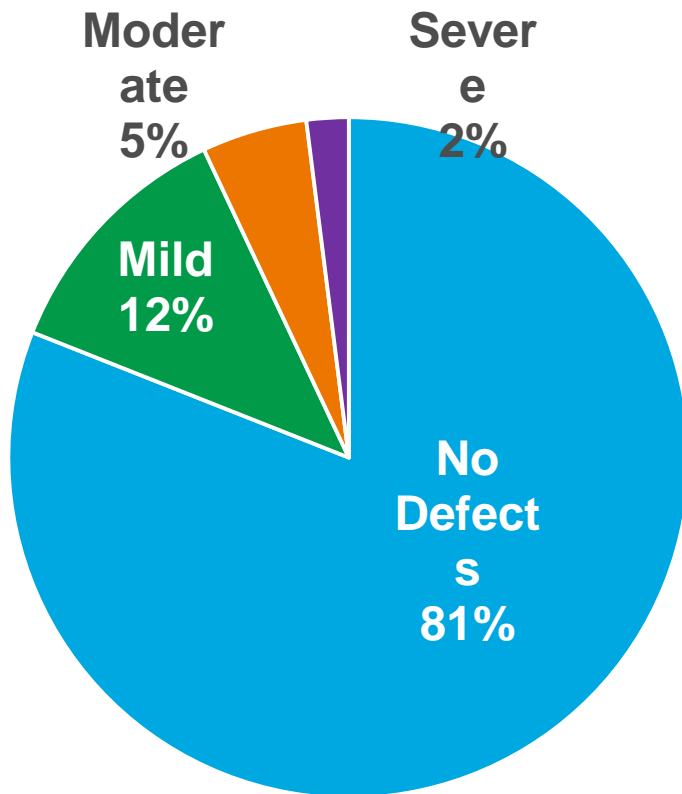


Laser Scanning: Example Output

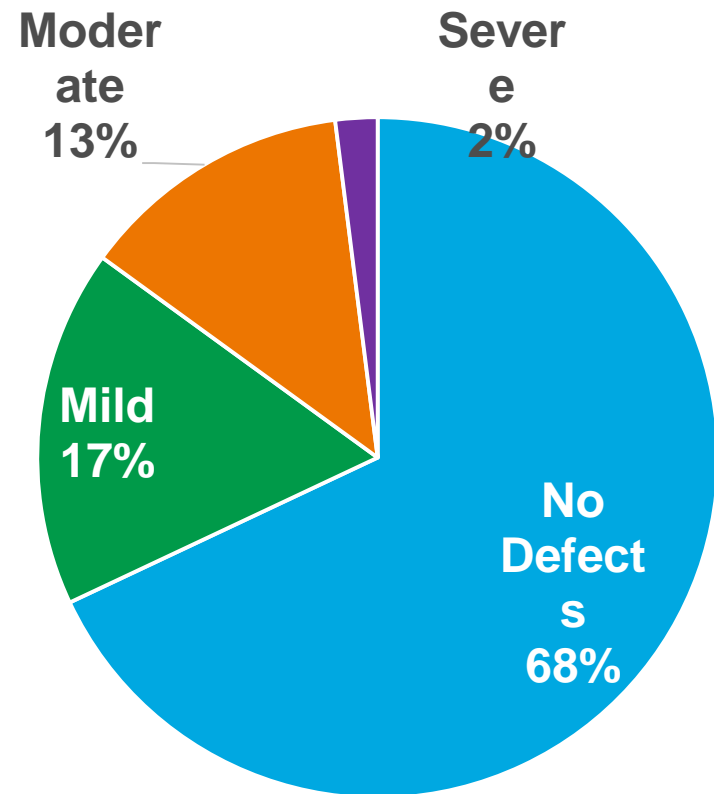


Laser Scanning: Interpretation

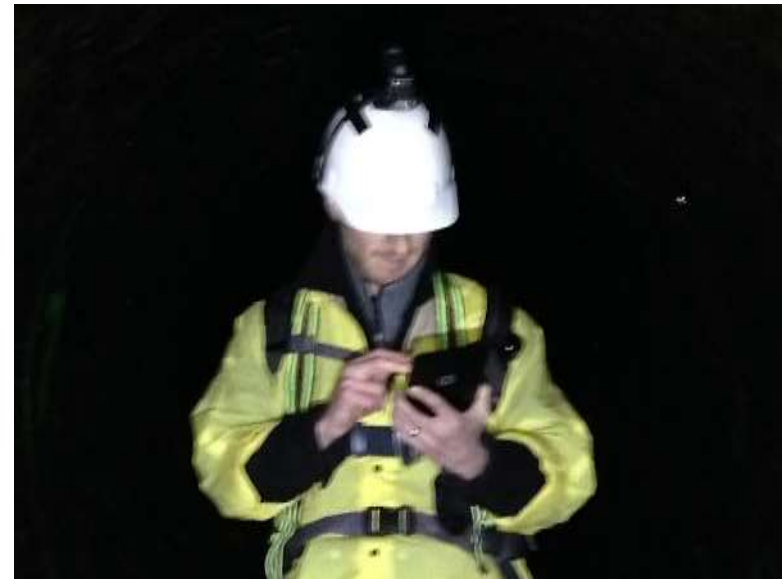
West



East



Man-entry Tunnel Inspection



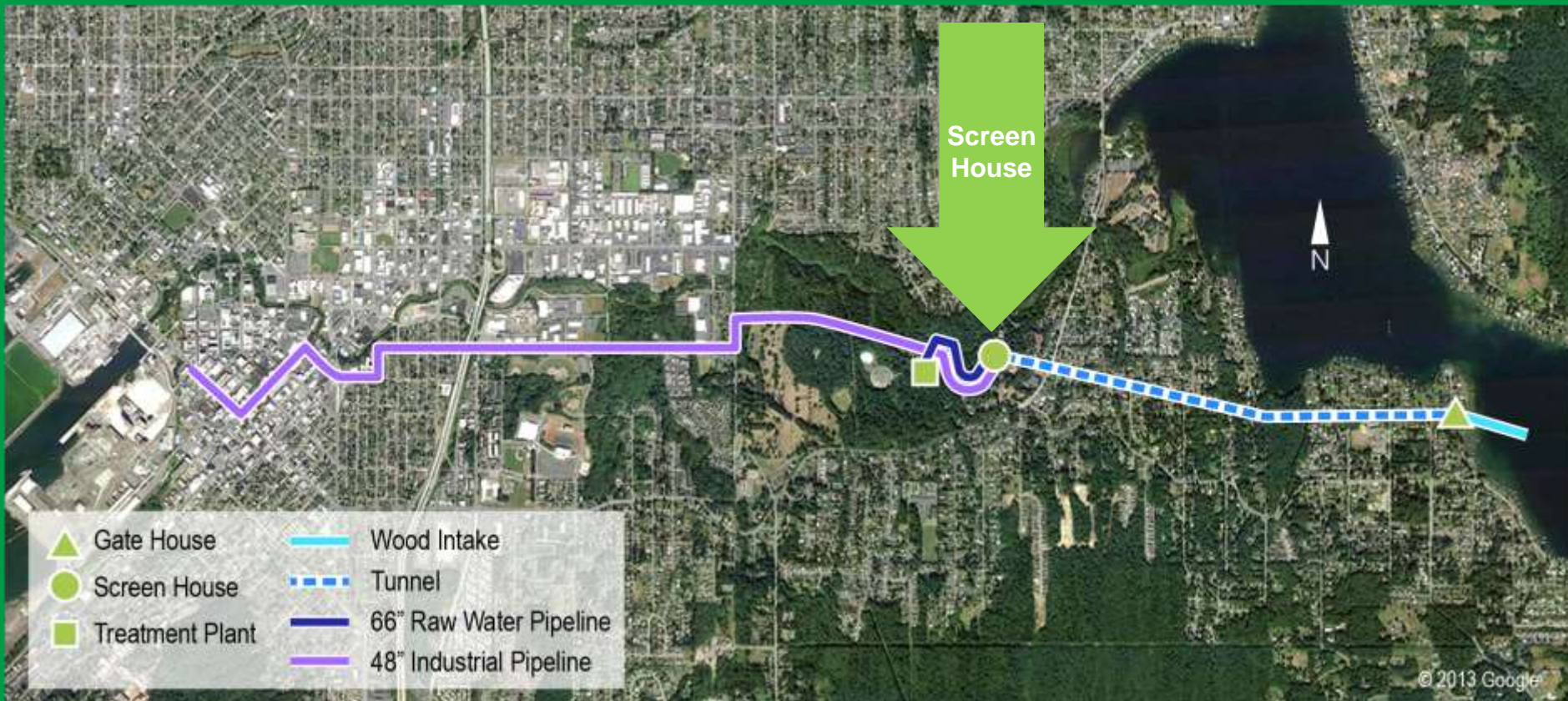
Man-entry Tunnel Inspection



Tunnel: Results

- No major deformation
- Isolated liner defects
- Limited, minor fracture acceleration
- Next Step: Point repairs, monitoring plan

Screen House

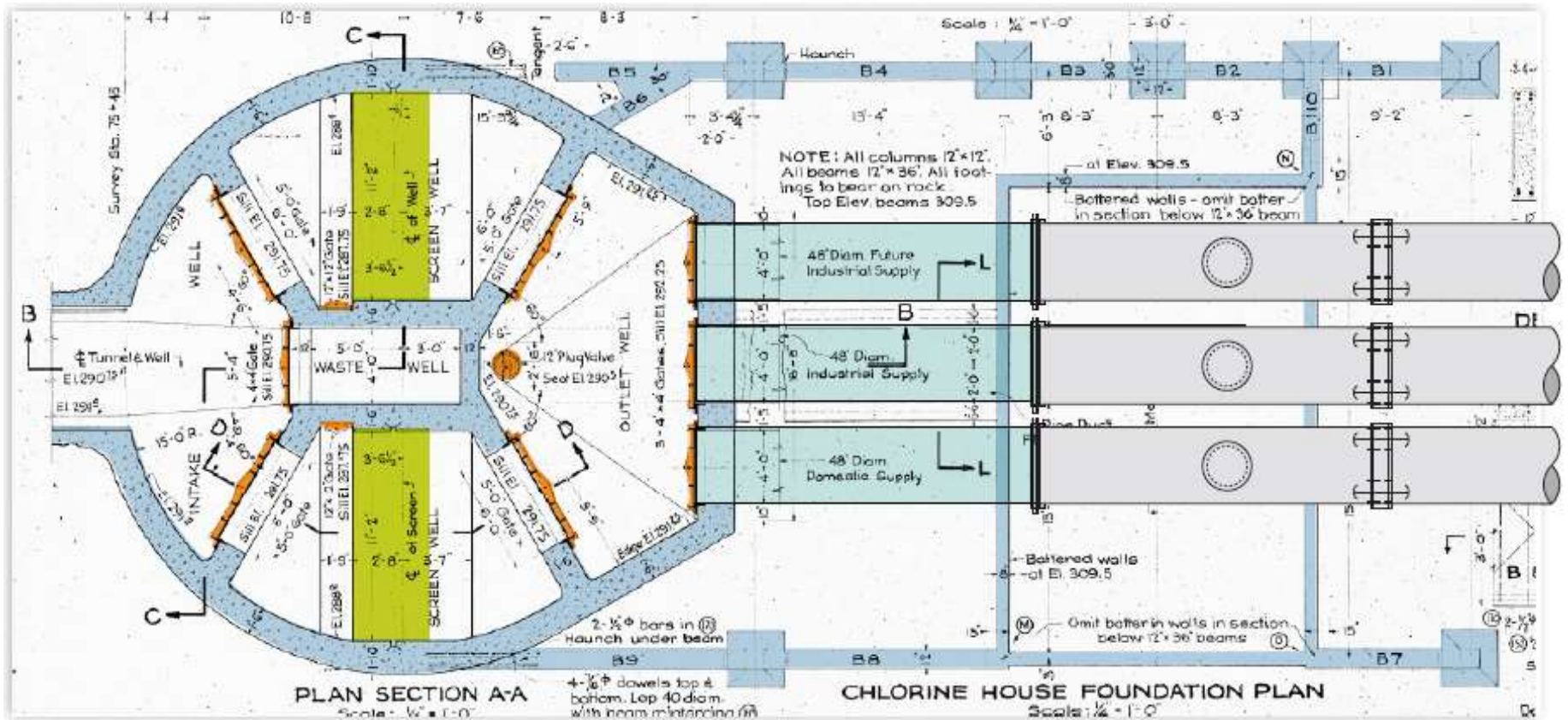


Screen House



Screen House Inspection Elements

- Traveling screen
- Slide gates
- Concrete structure
- Steel pipes



Travelling Screens



Slide Gate



Internal Steel Pipe Condition



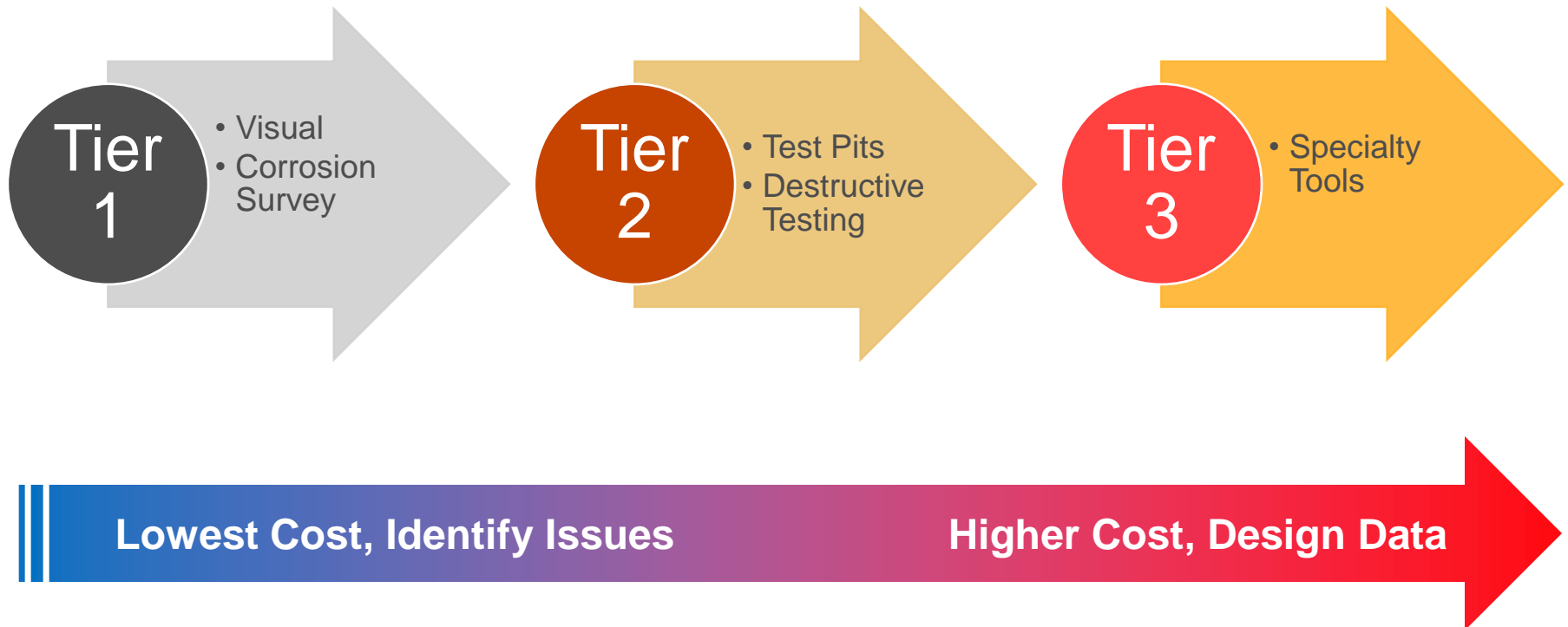
Screen House: Results

- Concrete structure in good condition
- Travelling screens in good condition
- Slide gates
 - Heavy tuberculation
 - Some corrosion loss
 - Replacement needed
- Steel pipes (3) need rehabilitation

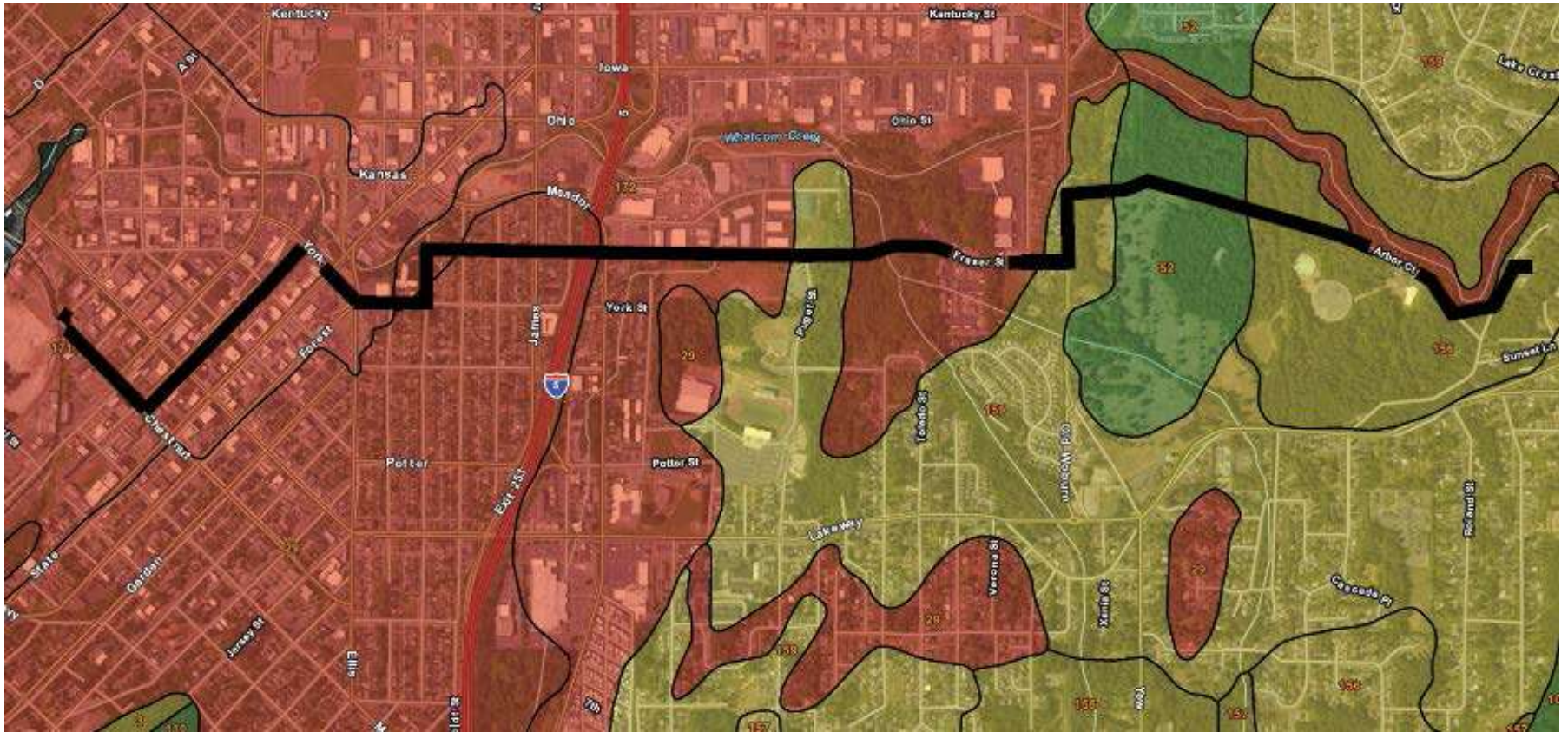
Industrial Pipeline



Tiered and Adaptive Plan (TAP)



Soil Corrosivity Mapping Along Industrial Pipeline



Existing Cathodic Protection System



Source: San Diego State University, GIS/USDA/USGS, A/E/C Geospatial Analysis, GIS/SP, and the City of San Diego

LEGEND

- Industrial Water Supply Pipeline
- Oil Transmission Pipeline (Kinder Morgan; Olympic)
- Municipal Supply Pipeline

- IWP Test Station (located in 2014)
- Cascade Natural Gas Cathodic Protection Station

- IWP Cathodic Protection Station No.
- IWP Magnesium Anodes (Steel Pipe)

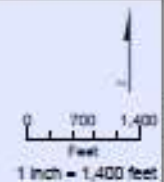


FIGURE 3
Industrial Water Supply (IWP) Pipeline
Cathodic Protection Elements

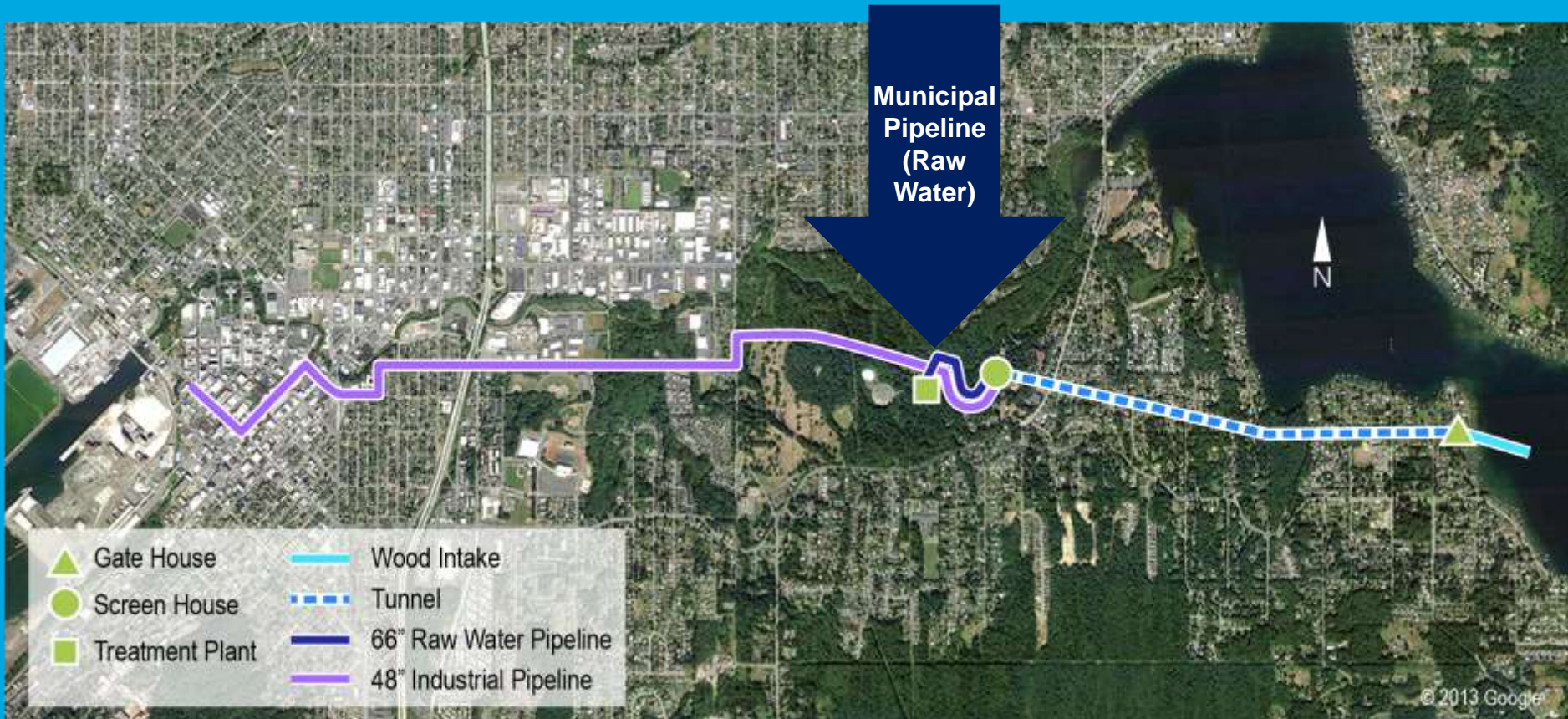
Existing CP Test Stations



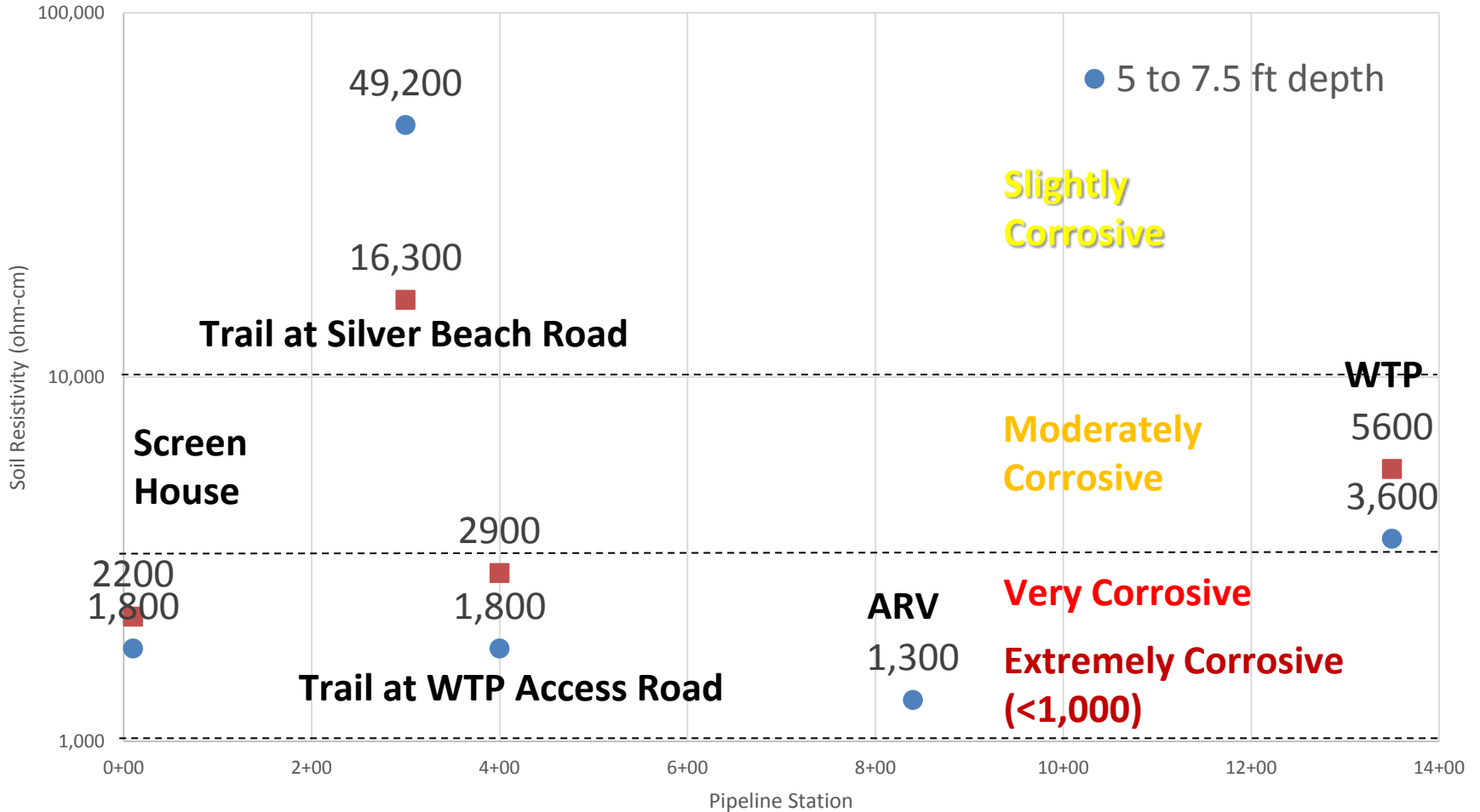
Industrial Pipeline: Results

- Existing CP system is operational and effective
- Condition assessment complete after Tier 1
- No further condition assessment warranted

Municipal Supply Pipeline



Tier 1 External - Soil Corrosivity



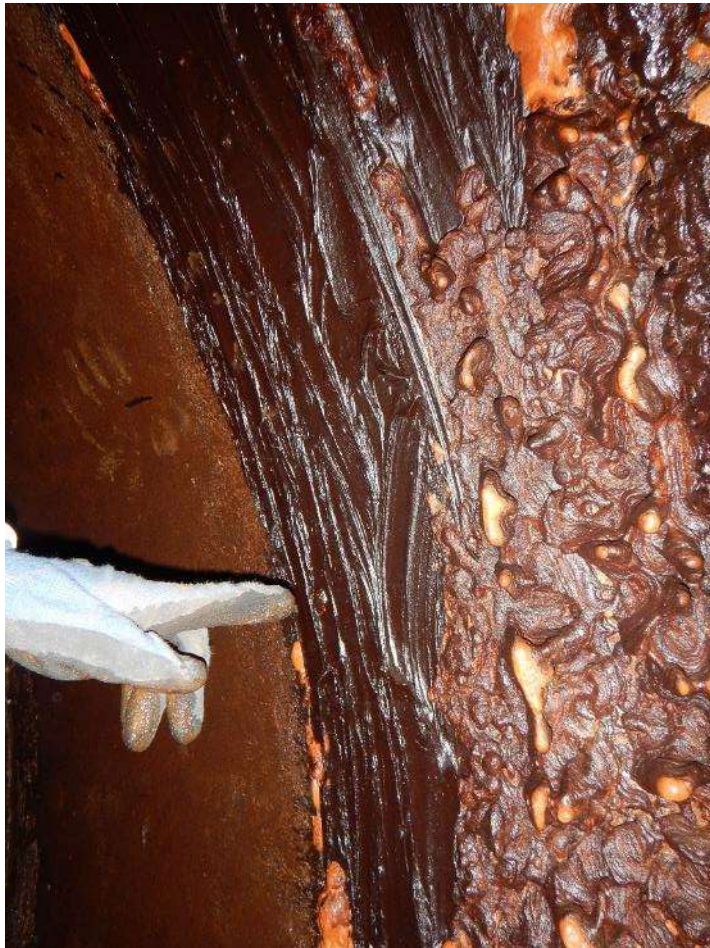
Tier 1 External -Stray Current Adjacent Industrial Supply Pipeline CP System



Tier 2 – Internal Condition



Tier 2 Internal – Concrete/Steel Pipe Joint



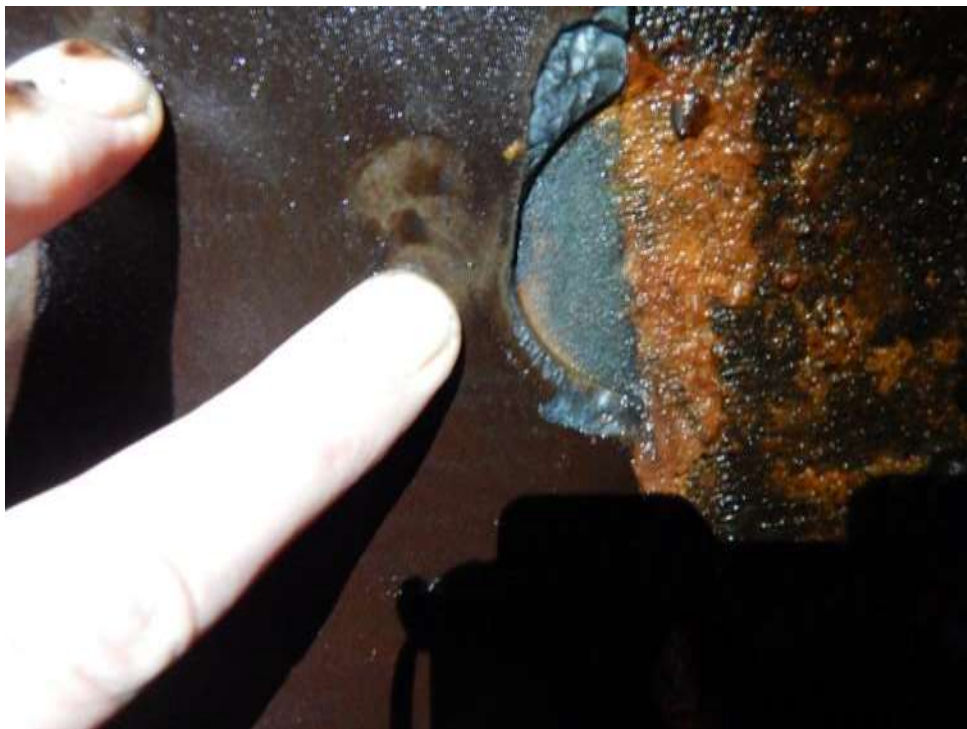
Tier 2 Internal – Pipe Wall Thickness



Tier 2 Internal - Pitting



Tier 2 Internal – Coal Tar Lining



Tier 2 Internal – Cement Mortar



Municipal Pipeline: Results

- External Tier 1 Complete
 - Corrosive soils
 - Stray current
- External Next Step: Tier 2 Test Pits
 - Evaluate coating/pipe condition
 - Test for stray current
- Internal Tier 2 Inspection
 - Coal tar enamel lining – excellent condition
 - Minor corrosion at coating defects
 - Localized repairs at few joints required

Acknowledgments





Thank You



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