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Water Research Foundation℠

How to Economically and Accurately Assess the Condition of Small-Diameter Water Mains

Dan Ellison January 29, 2019

HDR

Déjà Vu?

- Abbreviated, but more frank
- Minus Dave Spencer
- Minus Q & A
- Unabridged is found here:

http://www.waterrf.org/resources/webcasts/Pages/on-demand.aspx

Because NDE is seldom used for small mains.....

- Relatively **strong mains are discarded** because they are perceived to be weak
- **Unnecessary breaks occur** because some weak mains are left in service too long
- **Renewal methods are not always appropriate** for the condition of the host main

NDE is rarely used for small water mains, because…

» **Cost**: "Money is better spent on renewal"

» **Risk**: "Something could go wrong"

» **Misunderstanding**: "Old mains have no value"

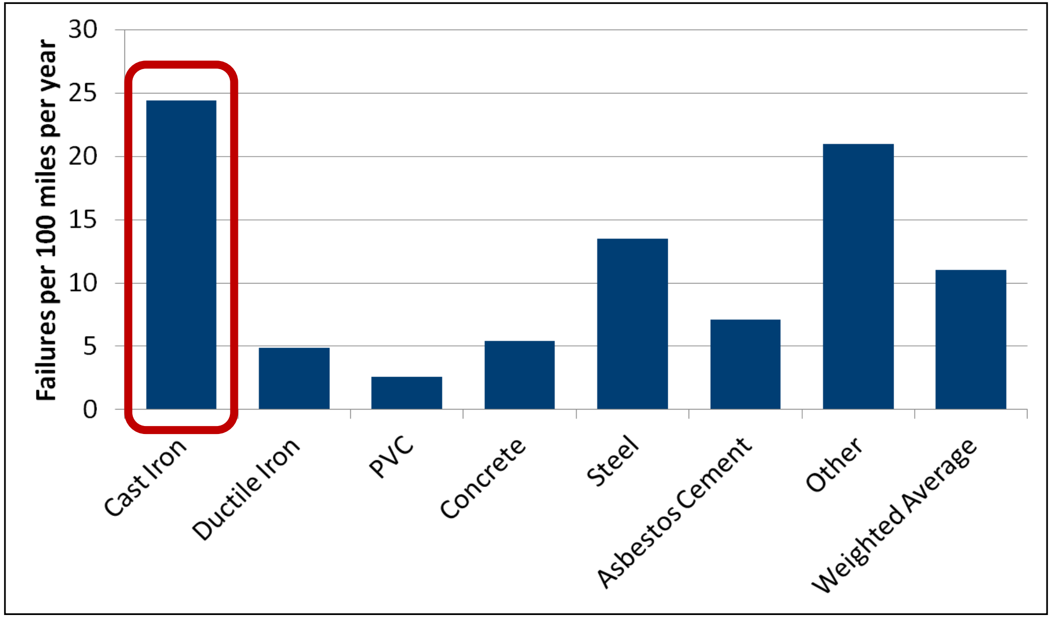
» **Uncertainty**: "What do the data indicate?"

THIS IS IMPORTANT!!!

» Because small mains break the most

» Because cast iron mains break the most

SMALL MAINS are our CANARIES in the coal mine



Failure rates from survey of 188 North American Utilities

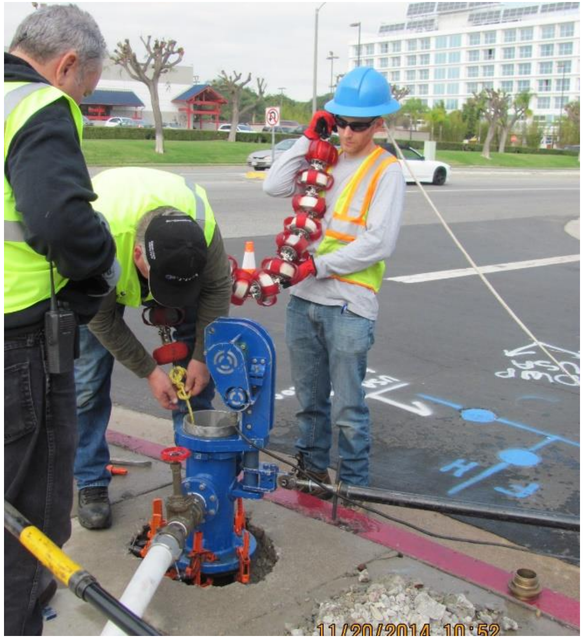
Source: Utah State University (Folkman), 2012

Finding Ways to Effectively Use NDE on Small Mains

Project 4471: Leveraging NDE

» Use NDE to “sample”

» Employ where easy



Project 4473: Assess and Fix

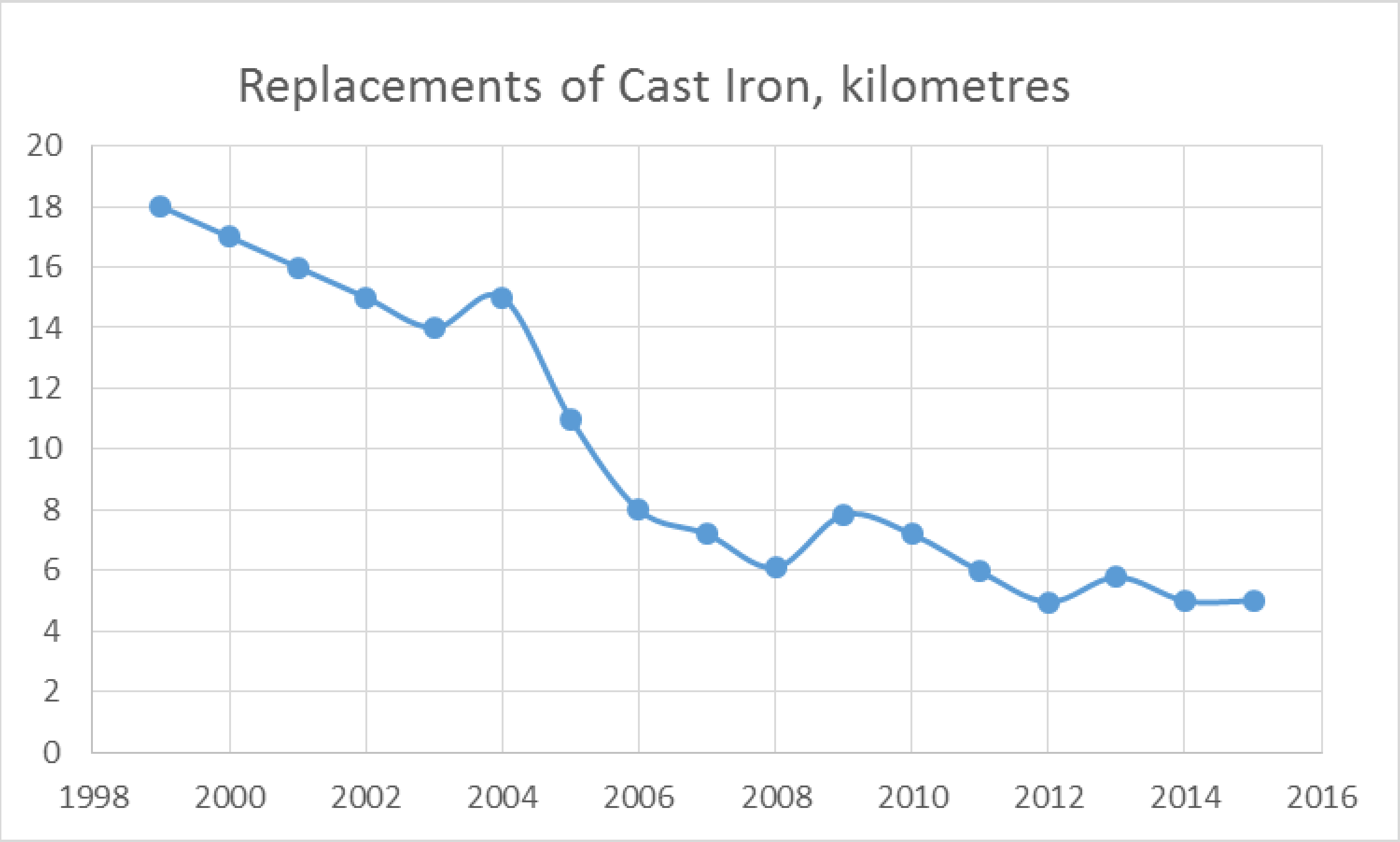
» Perform NDE with rehab

» Tailor rehab using NDE

WRF 4471 Participating Utilities

Calgary Case Study: Using NDE to optimize

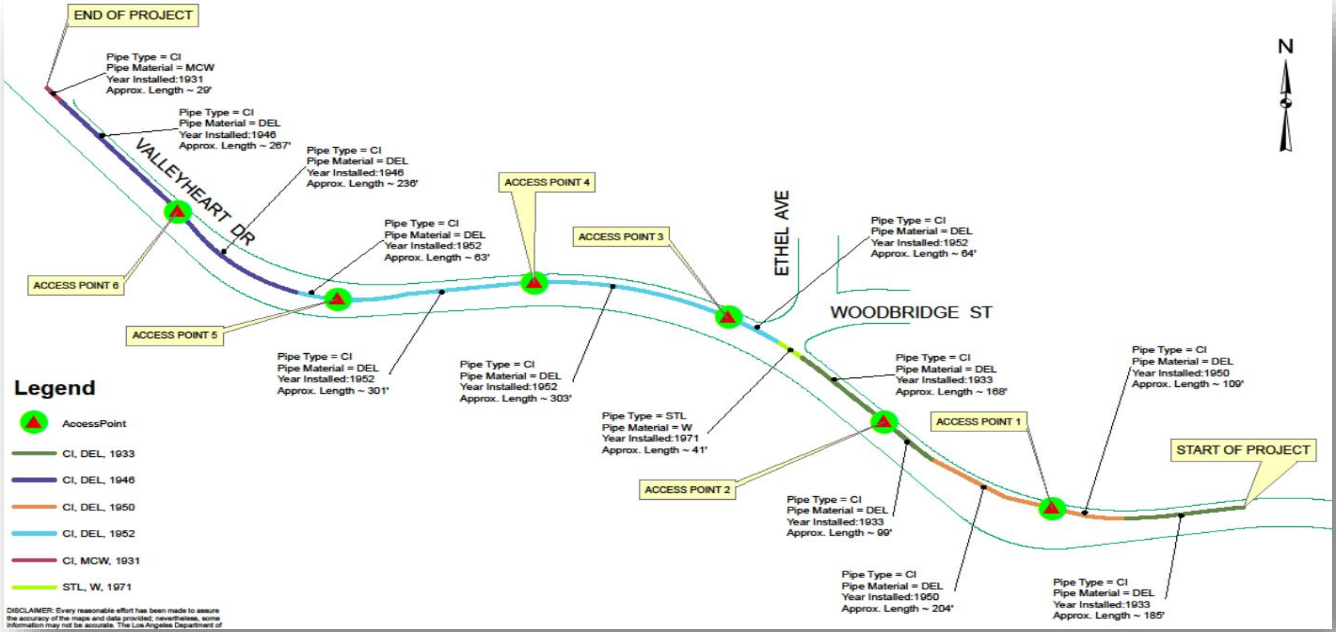
- 8% (
- “Bac
- 50%
- Rep
- Cost



Project 4471, Phase 1: Valleyheart Tests, LADWP

2000-ft, 6-inch main, discarded in 2010

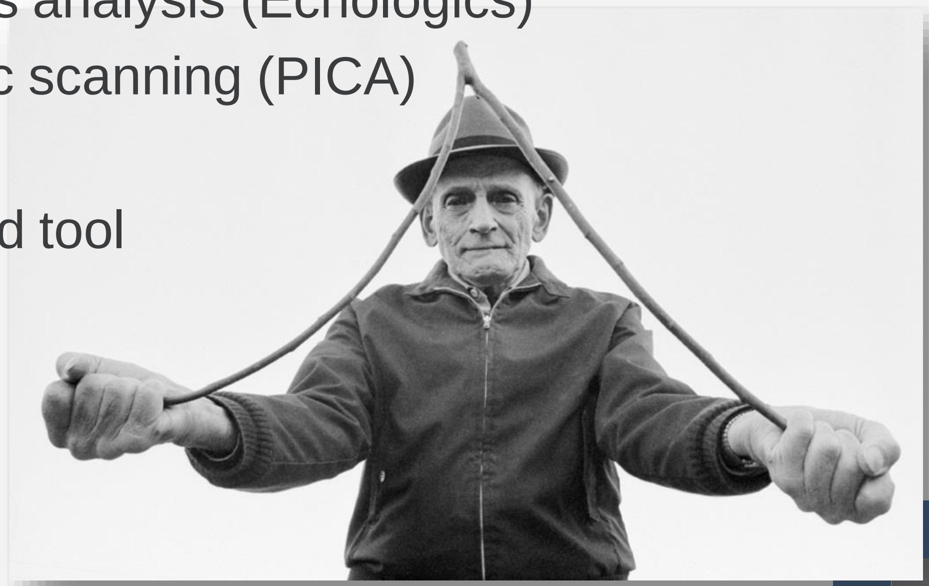
- 1933 (unlined spun cast)
- 1946, 1950, 1952 (factory-lined spun cast); 1971 welded steel CML



Four Technology Firms Proposed Five Methods

1. Push-in video/audio probe (JD7 / Wachs)
2. Keyhole broadband electromagnetic scanning (Rock Solid)
3. In-pipe broadband electromagnetic scanning (Rock Solid)
4. Acoustic velocity pipe wall thickness analysis (Echologics)
5. In-pipe remote-field electromagnetic scanning (PICA)

Pure did not have an appropriately-sized tool



Push-in probe (**Investigator**)

- Entry through 2-inch tap
- **Video / audio (Wachs Water Service / Genivar)**
- Advantage: little disruption of operation
- Limitations:
  - Can only be pushed a hundred feet, more or less
  - Time consuming; degree of inspection is limited
  - Provided no condition information

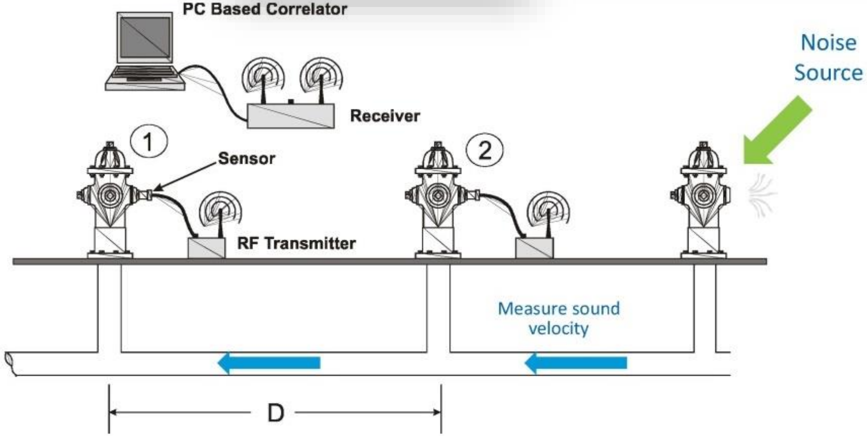
Broadband electromagnetic (Rock Solid)

- » External scanning using vacuum-excavated keyhole
- » Internal scanning of drained pipe
- » Limitations
  - Limited coverage
  - Time consuming
  - Dry, straight pipe needed for in-pipe inspection

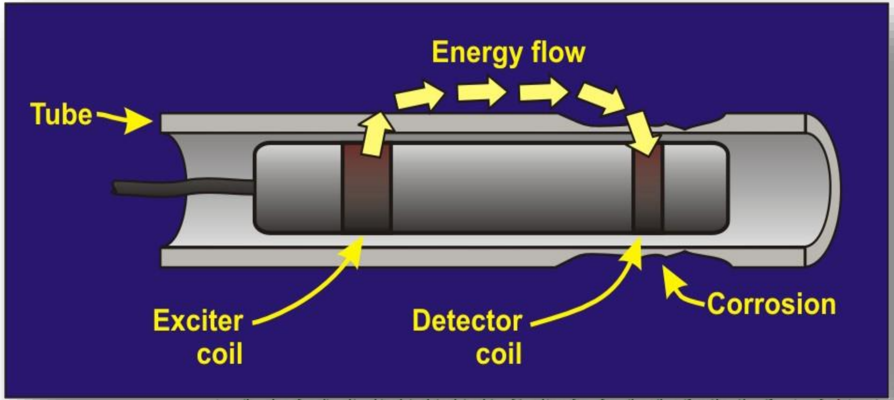
Acoustics velocity testing (Echologics)

- **Non-Invasive.** Pipe access using existing appurtenances or vacuum-excavated keyholes.
- Provides **average thickness** between transducers
- Limitations:
  - **Does not detect isolated pitting**
    - **Information can be lost in data noise**

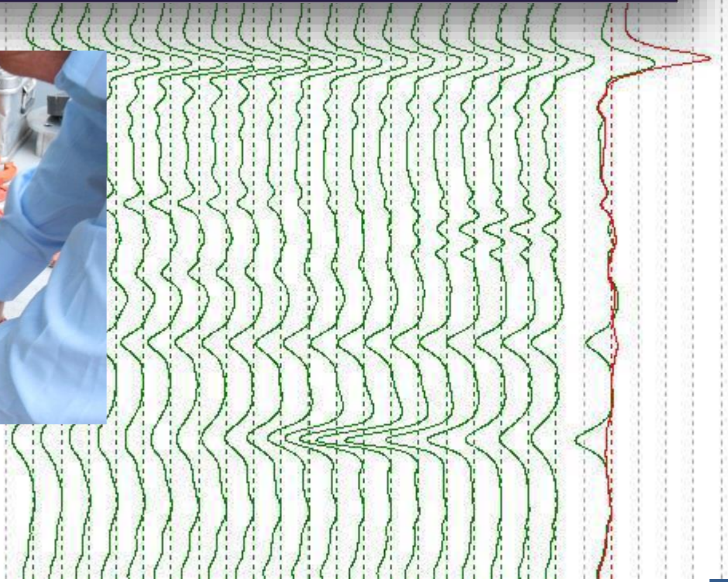
$$v = v_o \times \sqrt{\frac{1}{\left[1 + \left(\frac{D_i}{t_r}\right) \times \left(\frac{K_l}{E}\right)\right]}}$$



Remote-field testing (PICA SeeSnake)



- Generates / detects electromagnetic field
- Pros
  - High resolution detection of defects
  - Long runs possible
  - Proven over two decades
- Cons
  - Requires outage for pipe access



Using the SeeSnake on Valleyheart

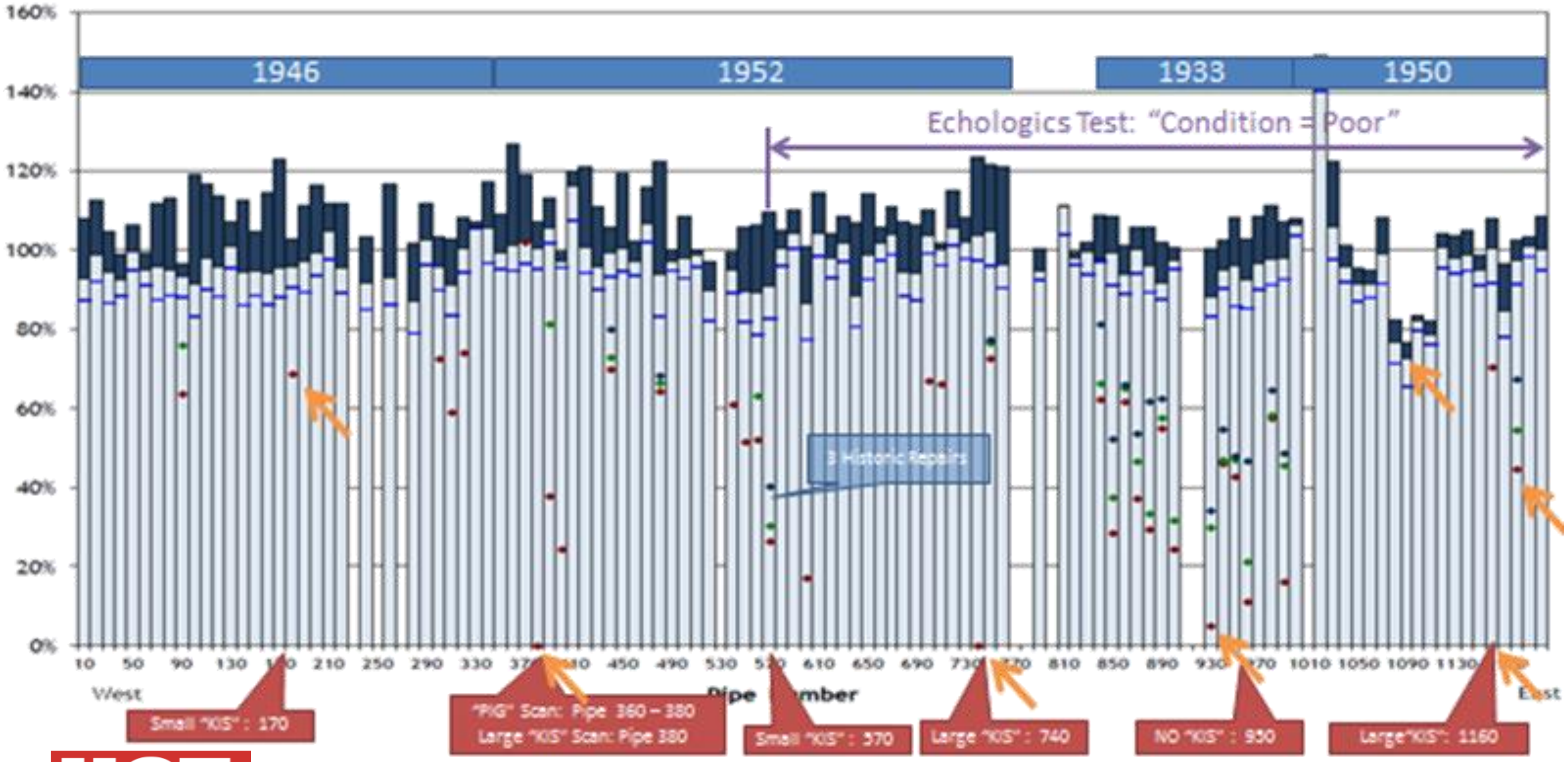
Inserting the tool into the launching port. Normally this tool is launched from a fire hydrant's vertical drop leg.

This custom hydrant guides the rope past a seal. By using clamps to hold the hydrant in place, flange patterns don't have to match.

Ready to launch. The fire hose provided water to push the tool to the far end of the main. A plastic sheet contains water that leaks from the assembly. The hydrant is braced to the trailer to counteract the winching force.

The location of the NDE tool is tracked by measuring the amount and speed of tether rope deployment. Underneath the table is the motor used to winch back the tool. All tools and equipment were powered from a small electrical generator.

Exhumation plan with a focus on 1933 pipe

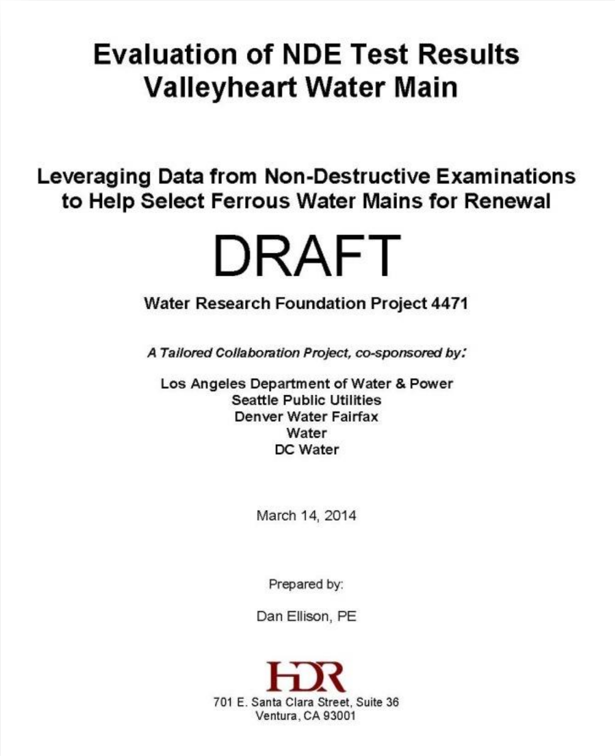


= Proposed Extraction

Seven pipe segments were split longitudinally into 14 pieces, then sandblasted.

Uncorroded pipe measurements were generally 7/16-inch thickness (0.43 inch).

Phase 1: Side-by-side technology comparisons



Evaluation of NDE Test Results
Valleyheart Water Main

Leveraging Data from Non-Destructive Examinations
to Help Select Ferrous Water Mains for Renewal

DRAFT

Water Research Foundation Project 4471

A Tailored Collaboration Project, co-sponsored by:

Los Angeles Department of Water & Power
Seattle Public Utilities
Denver Water Fairfax
Water
DC Water

March 14, 2014

Prepared by:

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Ventura, CA 93001

- » **Water Research Foundation Project 4471**
- » 5 technologies applied to 2000 feet of CI pipe

Phase 1: Findings and Conclusions

- No perfect method; interpretation is art and science
- **In-pipe remote field technology provided depth and breath**
- 80 percent of Valleyheart main was “Good” to “Excellent”
- A cost-effective strategy for Valleyheart main might have been:
  - Line the unlined 1933 pipe
  - Install a few anodes near repair areas

How to Use NDE Effectively on Water Mains

» **Access**: Scan 6”/8” mains thru hydrants

» **Target**: Mains likely to be most corroded

» **Sample**: Various vintages in various areas

» **Leverage**: Extrapolate information to mains of similar vintage and area (siblings)

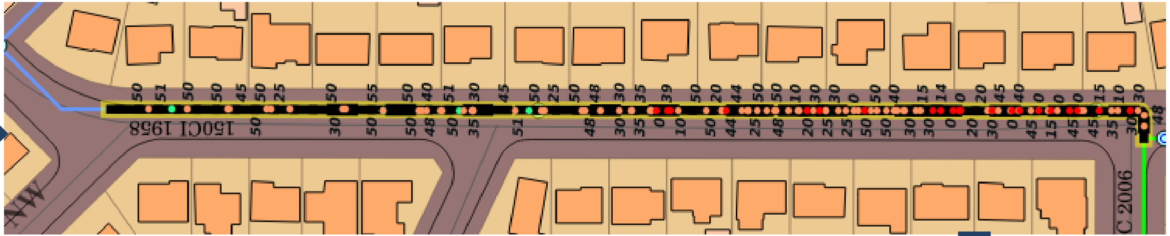
PHASE 2: EACH UTILITY CHOSE RFT TO TRY IN THEIR SYSTEM


DWP
TER-POWER

Leveraging Lessons Learned from Calgary

Calgary
(~100 mi since 1999)

Stored Data in GIS

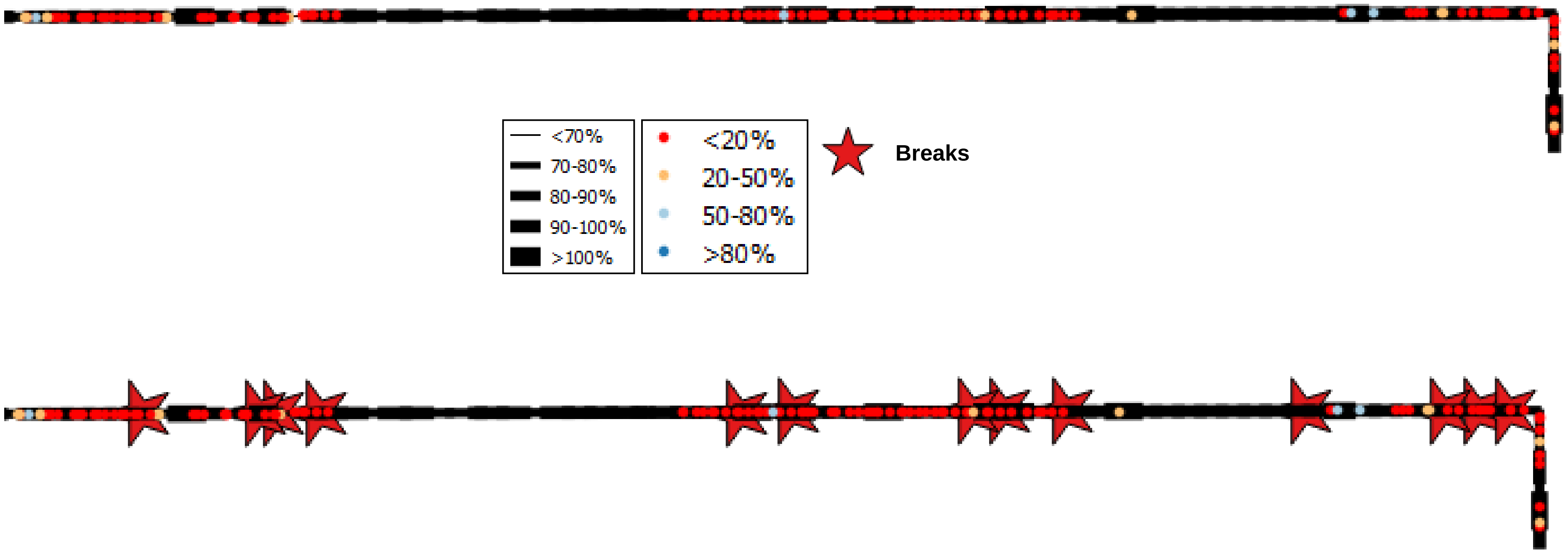


Institutional Knowledge:

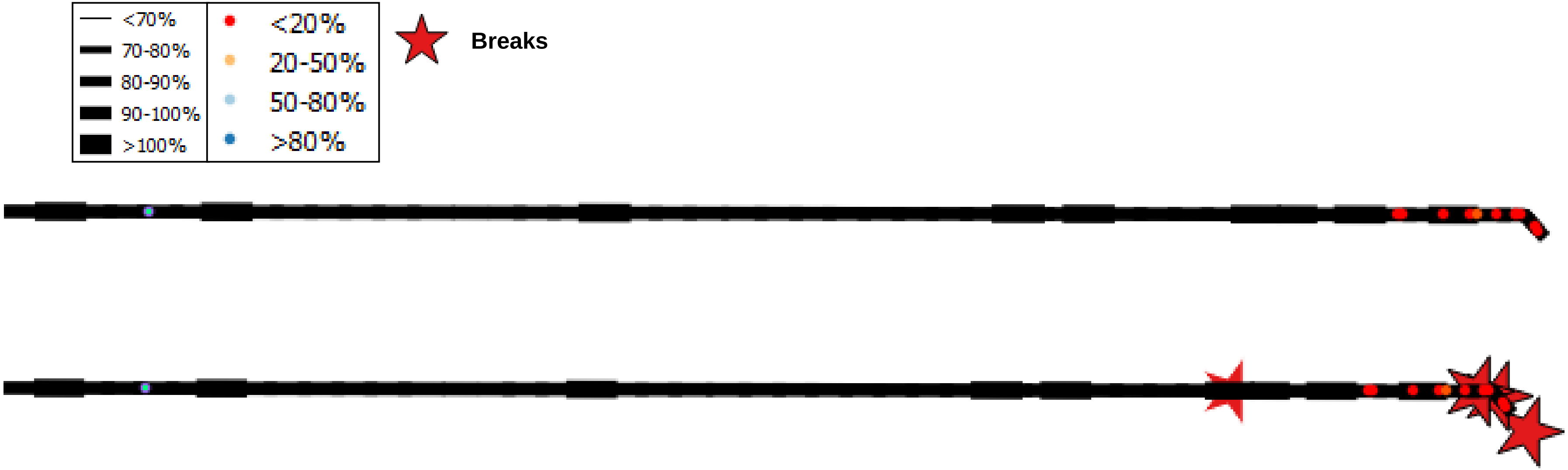
- SeeSnake is effective
- Pits drive breaks

WRF Step 1: Examples to Validate Institutional Knowledge

Validating Institutional Knowledge
Example 1 (~1,300’)



Calgary SeeSnake Results – Example 2



Analysis: Why did these breaks occur?

- **Primary Predictor - Pit depth and density**
- Data supports theory that **multiple deep pits more likely to result in catastrophic failure** (3 breaks)

Pit Count		Worst Pit: Thru Pit (0% RW)	Worst Pit: Deep Pit (1-30% RW)	Worst Pit: Modest Pit (31-50% RW)	Worst Pit: Shallow Pit (Greater than 50% RW)
Pit Count	No Pits	5			
Pit Count	Isolated Pit	130	68	23	20
Pit Count	Multiple Pits	208	79	66	17

Figure 7-5. Annual Break Rate (per 100 miles) by Pit Depth and Density. *This shows a strong correlation between pit data and the likilihood of future breaks*

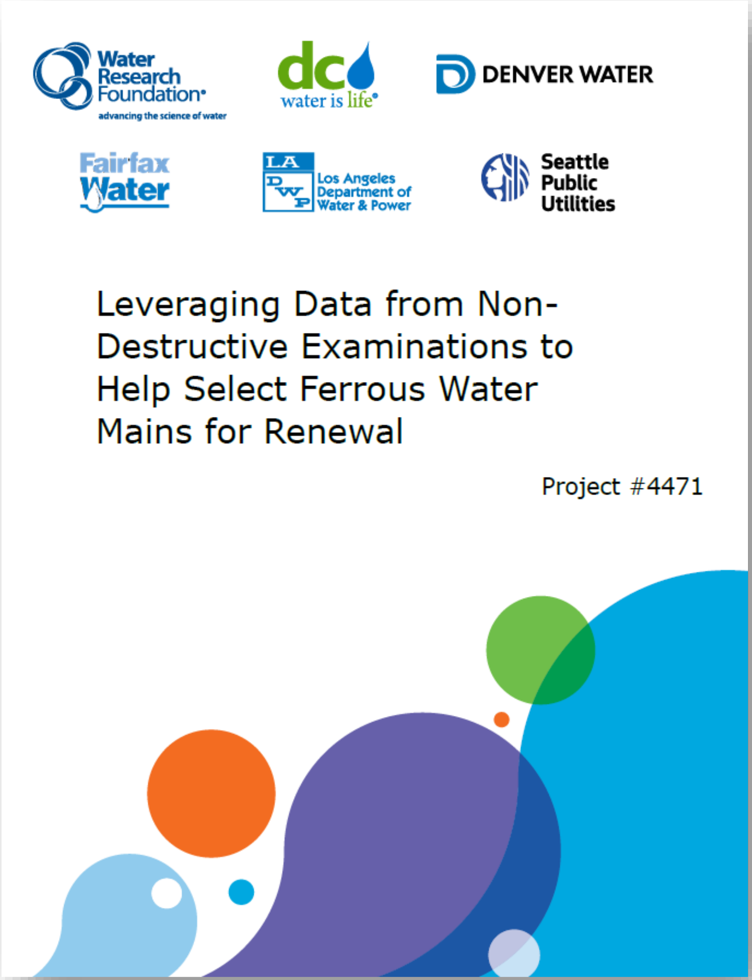
Benefits of NDE

1. Extend the lives of some mains
2. Prevent unnecessary breaks on other mains
3. Identify the most cost effective renewal technology and project limits
4. Increase confidence in decision making

Save money

Good Condition

Poor Condition



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DENVER WATER
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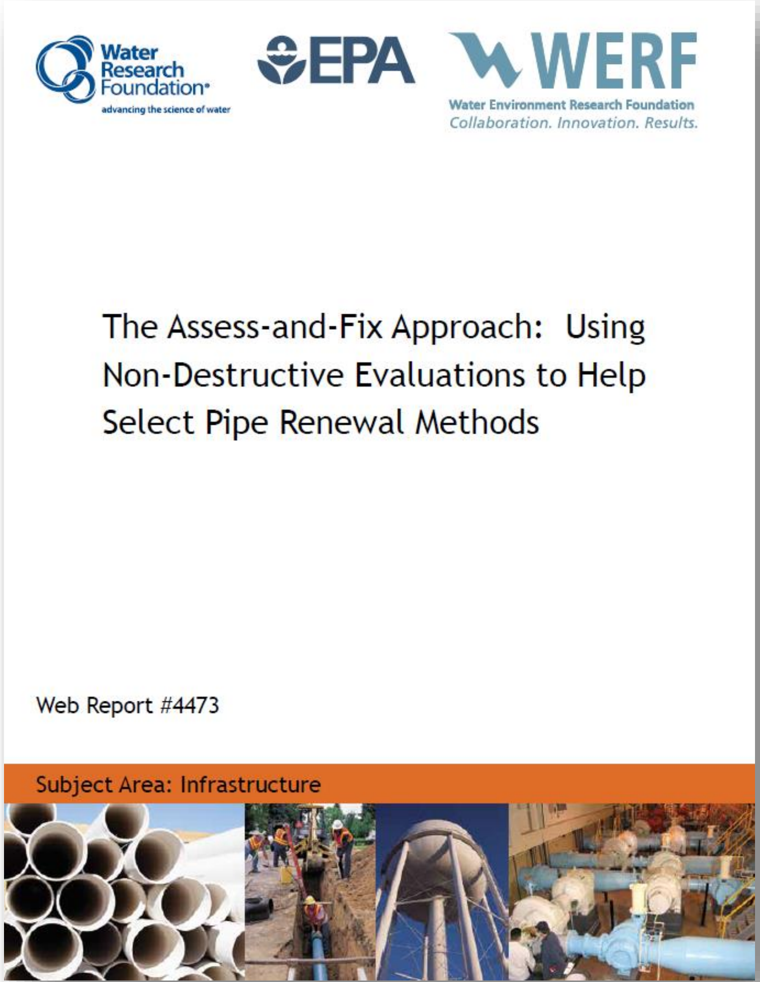
LA DWP Los Angeles Department of Water & Power
Seattle Public Utilities

Leveraging Data from Non-Destructive Examinations to Help Select Ferrous Water Mains for Renewal

Project #4471



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EPA
WERF
Water Environment Research Foundation
Collaboration. Innovation. Results.

The Assess-and-Fix Approach: Using Non-Destructive Evaluations to Help Select Pipe Renewal Methods

Web Report #4473

Subject Area: Infrastructure

Questions?

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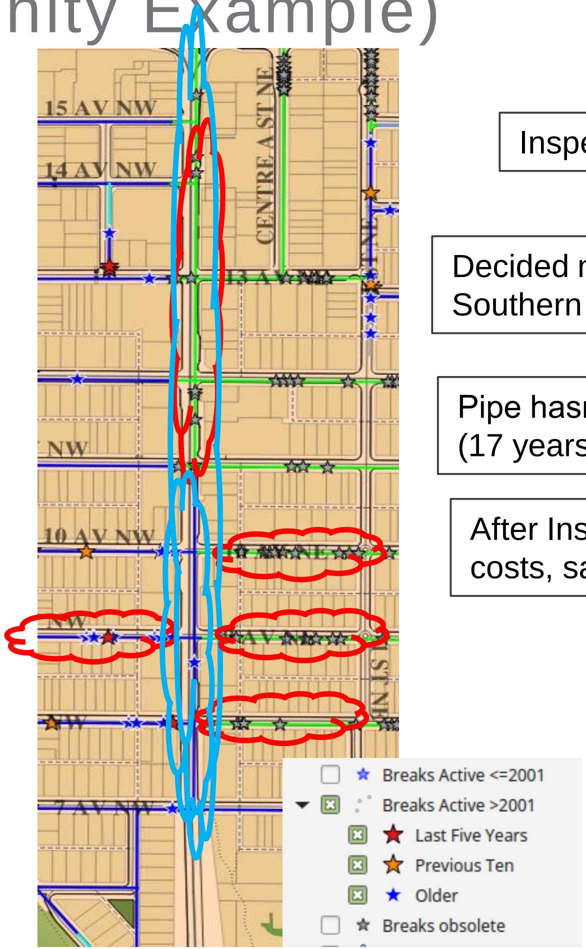
Decision Optimization (Opportunity Example)

Calgary - Centre Street Bridge
Historic Landmark & Transport Corridor

Planned Shut Downs Once Every 20 Years (2000)

Decision: Replace 1946 CI Pipe?

Easy Decision: Replace	Hard Decision: Replace?	Break Clusters on Adjacent Street



Inspected Pipe

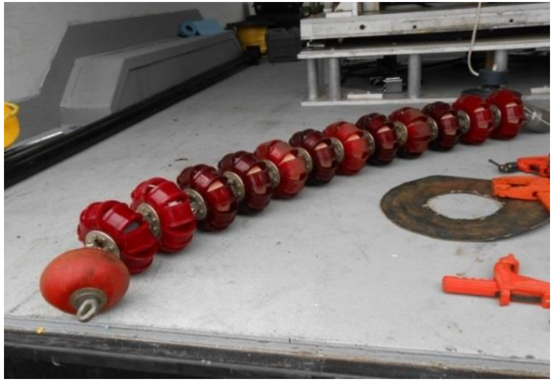
Decided not to replace Southern section

Pipe hasn’t broken yet (17 years)

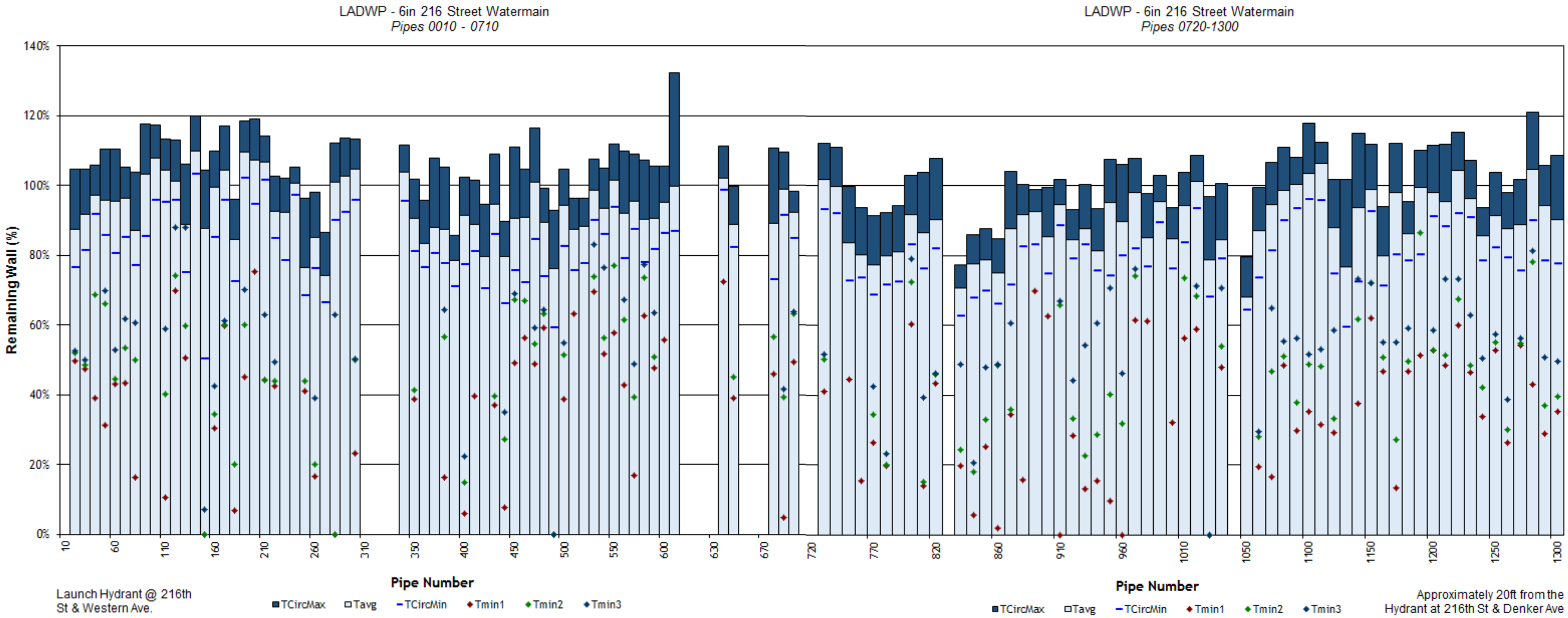
After Inspection costs, saved ~$200k

Condition Assessment is Cost Effective

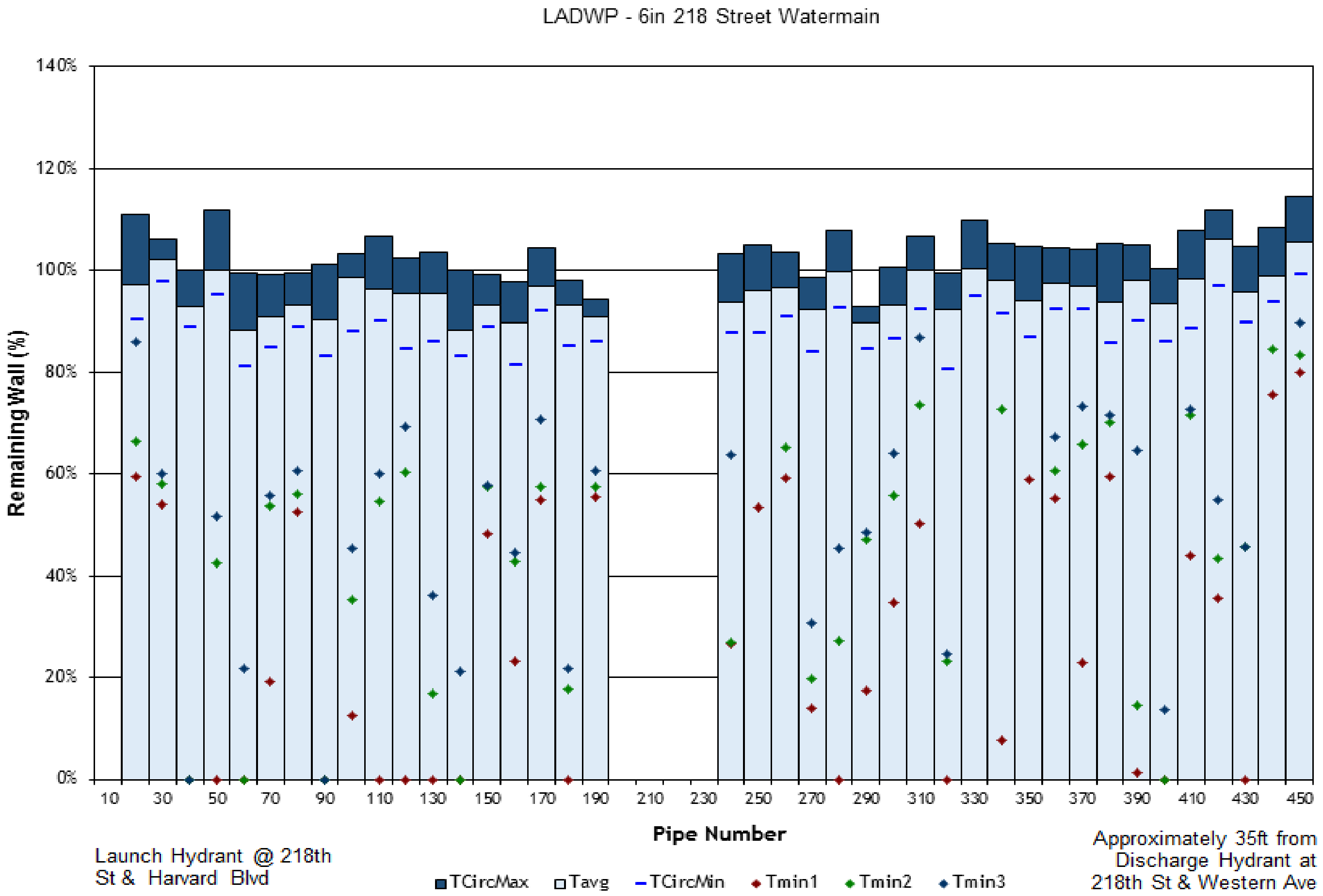
Replacement ~10-30x more $ than SeeSnake



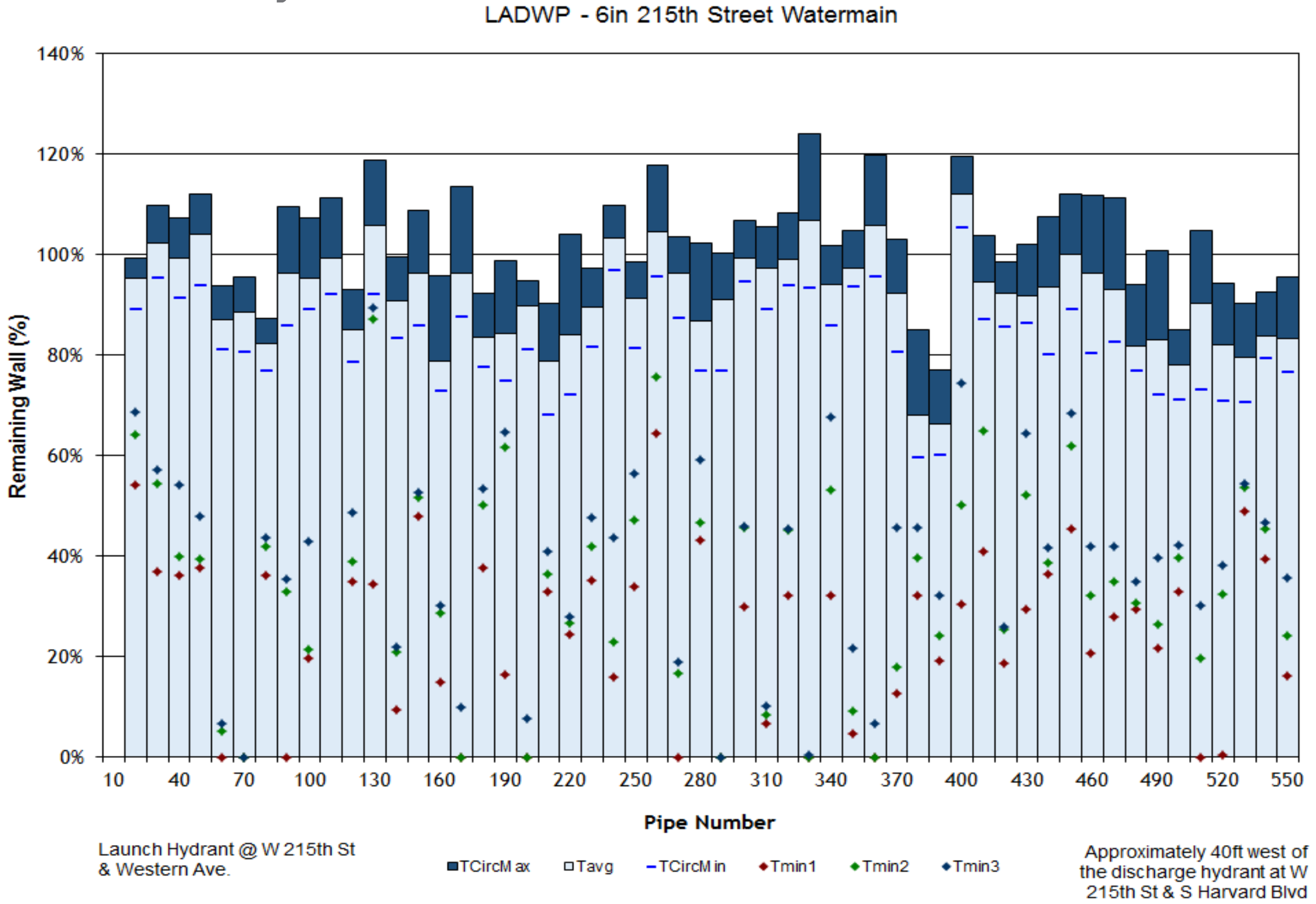
LADWP – 3 badly corroded mains



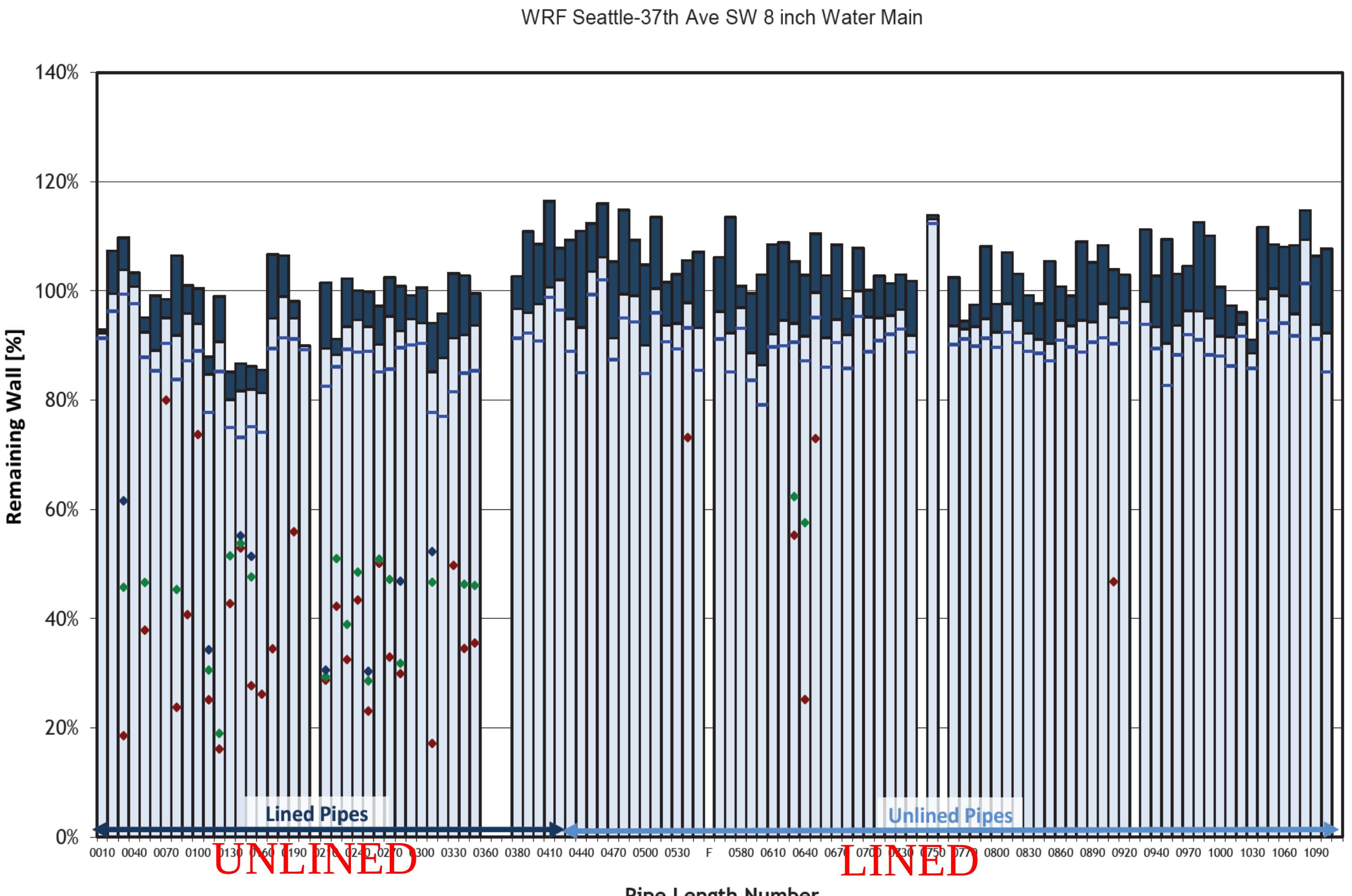
LADWP – 3 badly corroded mains



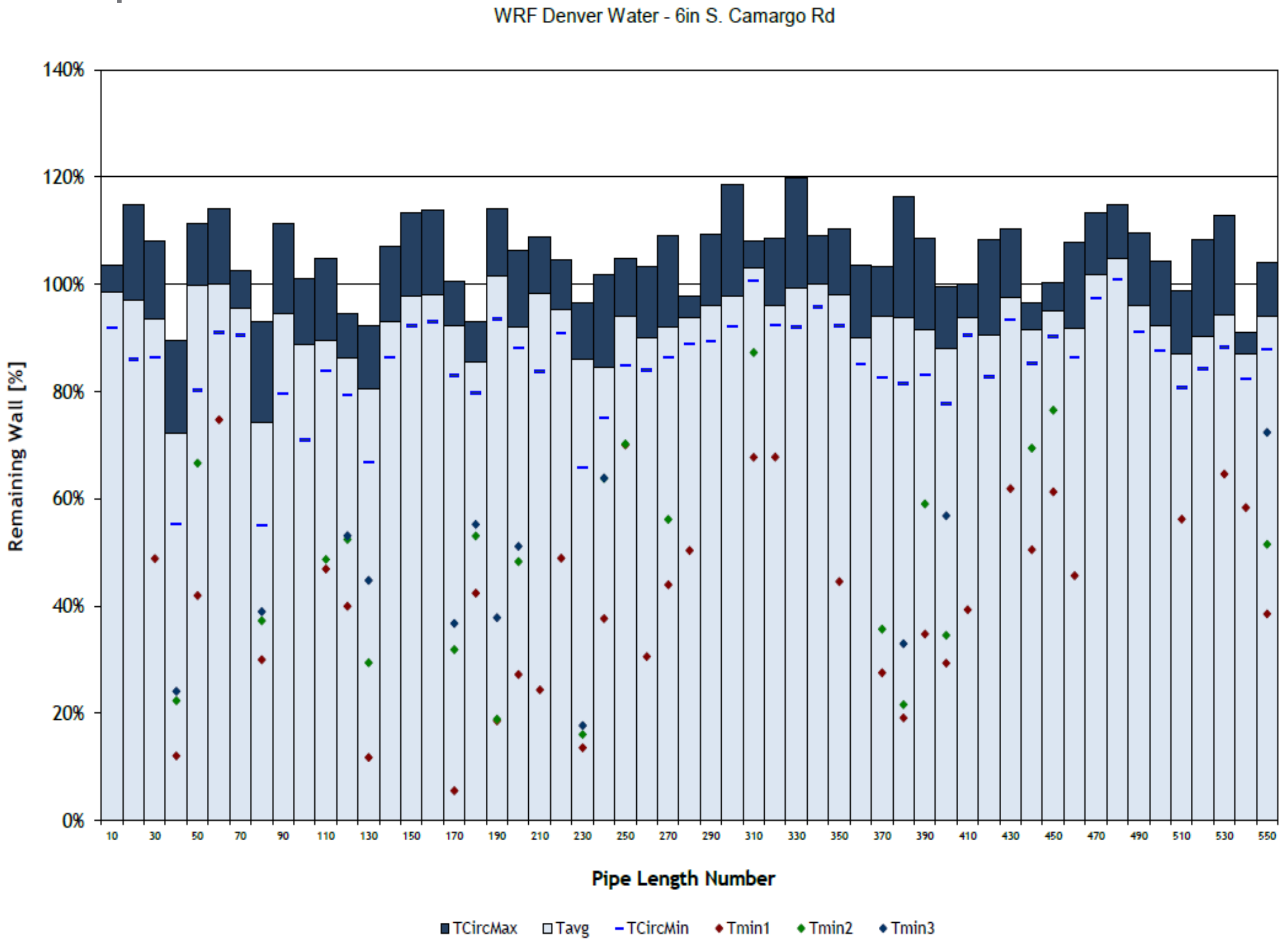
LADWP – 3 badly corroded mains



Seattle – Mild to moderate corrosion…except unlined portion



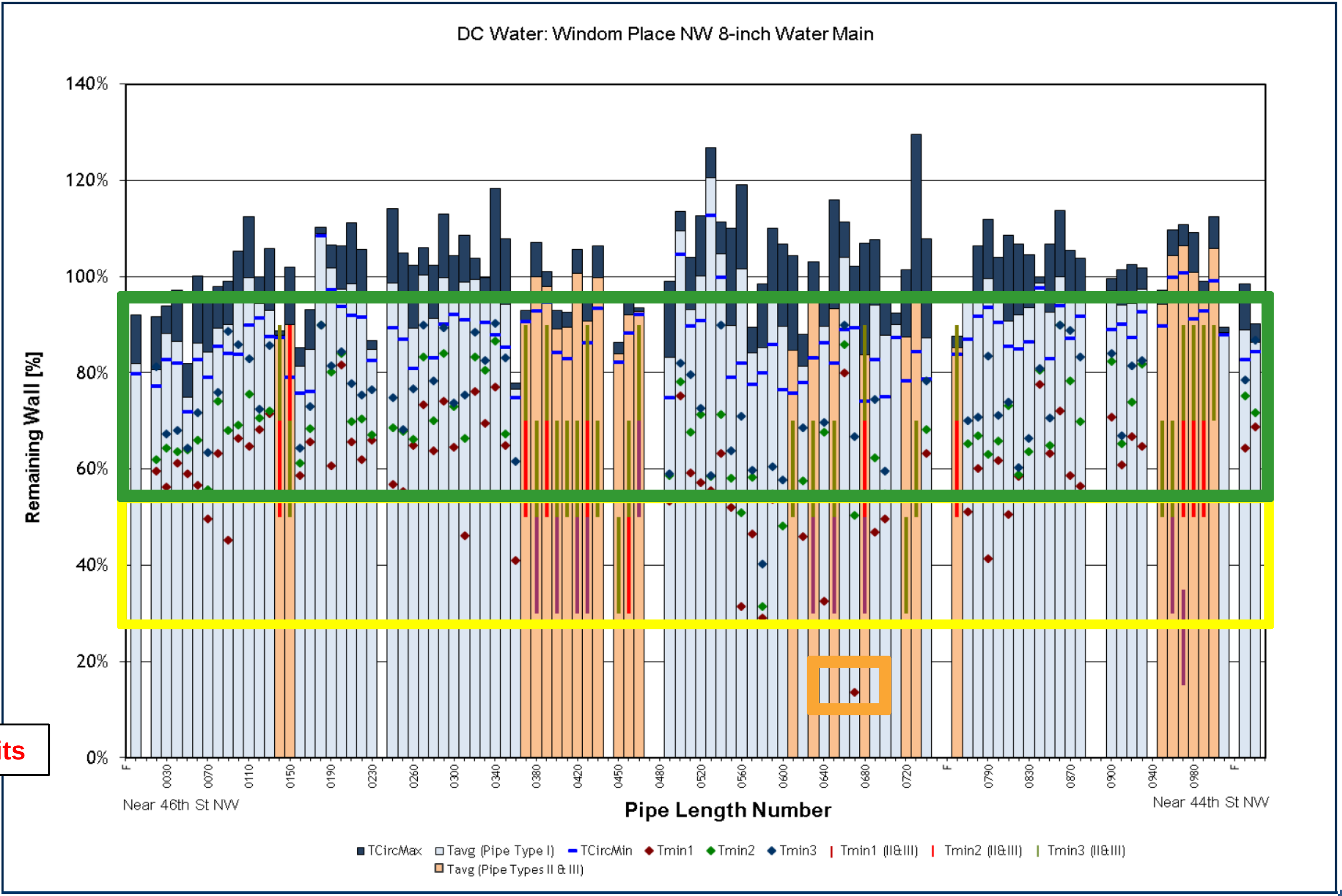
Denver – Sporadic, moderate to severe corrosion



DC Water Pilot – Windom Place NW 8” Water Main

Data verifies:

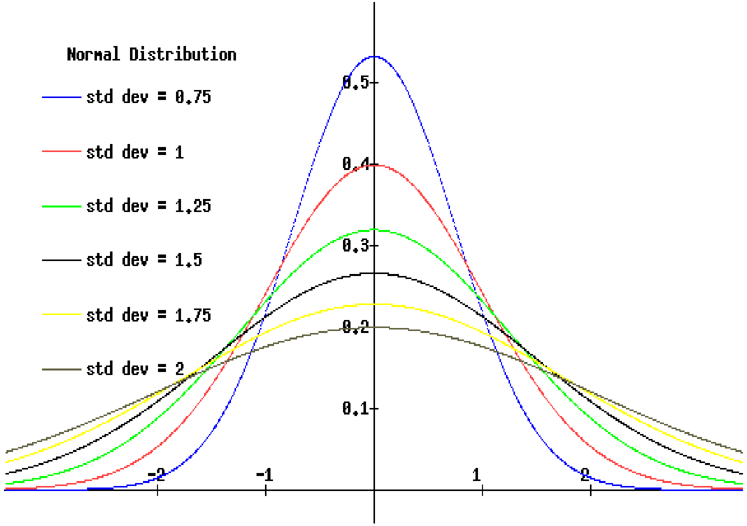
- Condition = Good
- Non-structural liner is cost-effective solution

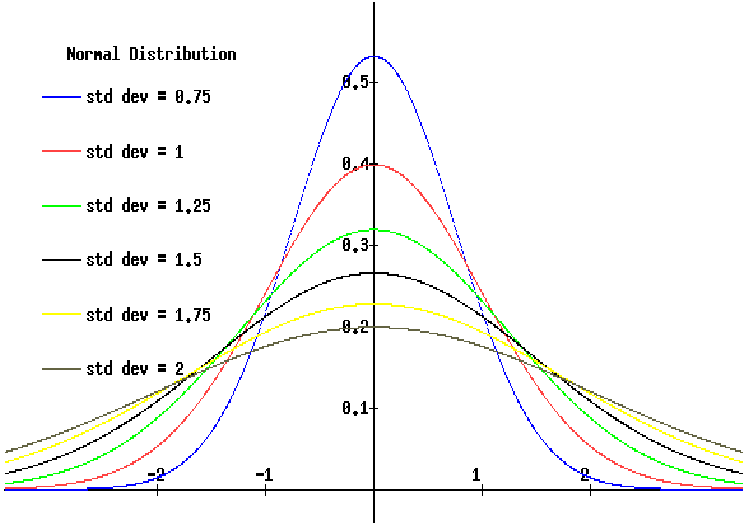


No Through Pits

Risk has four components!

Likelihood x Consequences





Keyhole Installation of Anode

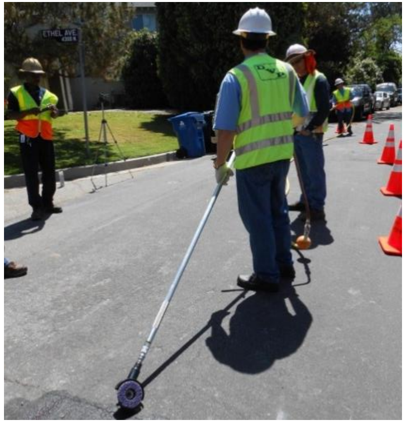
Traffic control by LADWP. The hole location was pre-marked and cleared for excavation. The location is the intersection of Valleyheart Drive and Ethel Avenue.

The coring rig positioned over excavation location.

Two persons lifted the core using a special tool that grips the center pilot hole. The core was then tipped on its side and rolled out of the way.

Vacuum excavaton was performed using a high-volume unit equipped and water jet lances.

Keyhole Installation of Anode



A long-handled, air-powered grinder with plastic abrasion disk was used to prepare the pipe surface for wire bonding.

Another long-handled tool was used for exothermically welding the anode to the pipe. [1]

Keyhole Installation of Anode

The excavations can be plated without a backhoe or other equipment. The plate has an underside ring that extends into the hole, preventing it from sliding. Plates are available that lock in place.

After backfilling using conventional methods, a layer of pea gravel was placed for leveling. This was followed by a dry-fit test to verify that the excavated core would be level with the adjacent pavement.

A grout-like bonding agent was pored into the hole. The extracted core, shown on the right side of this photo, is ready for placement.

The core is placed into the hole, then wiggled back and forth, forcing the bonding agent up the sides and center of the donut-shaped core. The core is aligned with marks made before-hand.

Assess and Fix Demo in Phoenix