Pipeline Integrity Program

Data Driven Decisions for Pipeline Replacement

WACO
December 4, 2020
Presentation Outline

• Introduction to Mesa Water District
• Genesis of the Pipeline Integrity Program
• Program Implementation
• Program Benefits
Introduction to Mesa Water District

- Special District
- Formed in 1960
- Governed by Five-member Elected Board of Directors
- Potable and Reclaimed Water
- 18 Square Mile Service Area:
  - Most of Costa Mesa
  - Parts of Newport Beach
  - John Wayne Airport
- ~24,000 retail accounts
- Service Population of ~110,000
Introduction to Mesa Water District

Key Assets

- **100% Local Supply**
  - 2 Deep wells in the lower aquifer and nanofiltration treatment plant
  - 5 Principal Aquifer Wells
  - Two more clear wells being drilled

- **Two Water Storage Tanks**
  - 18M Gallons
  - 11M Gallons
  - 1 Pressure Zone

- **317 miles of pipeline**
  - ~75% of total capital asset replacement costs
Water Infrastructure Challenges

2019 State of the Water Industry Report

Table 3. Top 10 issues facing the water industry as ranked by all participants, 2015–2019

<table>
<thead>
<tr>
<th>Rank</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Renewal and replacement of aging water and wastewater infrastructure</td>
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<td>10</td>
<td>Compliance with future regulations</td>
<td>Groundwater management and overuse</td>
<td>Water conservation/efficiency</td>
<td>Governing board acceptance of future water and wastewater rate increases</td>
<td>Cost recovery (pricing water to accurately reflect the cost of service)</td>
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Water Infrastructure Challenges

Pipes ~75% of total system Renewal Cost

Asset Renewal Program
Genesis of the Pipeline Integrity Program
Pipeline Renewal & Replacement

If we had to replace all of our pipelines in 100 years:

- How much would it cost?
- How would we do it?
- How would we fund it?
System Overview - 317 Miles of Pipeline

**Material Type**
- ACP: 74%
- Ferrous: 14%
- PVC: 12%

**Installation Decade**
- 1960's: 32%
- 1950's: 21%
- 1970's: 17%
- 1980's: 19%
- 1990-1999: 7%
- 2000-2009: 4%
- 1920-1929: <1%
- 1940-1949: <1%
- 1960-1969: 21%
- 1970-1979: 17%
- 1980-1989: 19%

**Pipe Diameter (inches)**
- 2
- 3
- 4
- 6
- 8
- 10
- 12
- 14
- 16
- 18
- 20
- 24
- 30
- 36
- 42

**Pipe Length (miles)**
- 0
- 50
- 100
- 150
## Age-based Useful Life Assumptions

<table>
<thead>
<tr>
<th>Material</th>
<th>Average Age-Based Useful Life</th>
</tr>
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<tbody>
<tr>
<td>ACP</td>
<td>75</td>
</tr>
<tr>
<td>CIP</td>
<td>65</td>
</tr>
<tr>
<td>CMLC</td>
<td>80</td>
</tr>
<tr>
<td>CCP</td>
<td>80</td>
</tr>
<tr>
<td>DIP</td>
<td>82.5</td>
</tr>
<tr>
<td>PVC</td>
<td>85</td>
</tr>
</tbody>
</table>
Age-Based Replacement Costs

- $272M in the first 30 years
- $552M to replace all pipelines in 100 years
Pipeline Integrity Program Goals

- Strategic pipeline replacement
  - Maximize investment
  - Replace at end of Useful Life
  - Transparent and Dependable Decision Making
Data Driven Decisions

High Breaks

Non-Destructive Testing

Condition Assessment

Failed

Renewal

Low Breaks

Operate

Test when Exposed

Not Failed
Data Driven Decisions

Condition Assessment of Water Mains

Non-Destructive Testing

Break Assessment

High Breaks

Low Breaks

Operate

Test when Exposed

Condition Assessment

Duration Until Next Break (Years)

$y = 17.925x^{-1.094}$

$R^2 = 0.9166$

Failed

Renewal

97%
Transforming Challenges... into Opportunities

Test when Exposed

### Metal/PVC Pipe Sampling (Rare)
- Only sample if the break is severe and pipe must be replaced.
- Remove the broken pipe piece plus a 2 ft. of either side.
- Label the sample with the work order number, date, and location and place in the sample bucket.

### AC Sampling (Common)
- Only sample if the break is severe and you must cut the pipe.
- Remove the broken pipe area plus 2 ft. on either side.
- Label the sample with the work order number, date, and location and place in the sample bucket.

### Final Checks & Close Out
- Verify pipe material and size.
- Check that pictures have been uploaded.
- Check that all samples have been collected and labeled.
- Place samples on pallet in warehouse.
- Refill bucket supplies if necessary:
  - Plastic wrap
  - Sharpies & labels
  - Resealable bags
  - Tape
  - Charged voltmeter (9v battery)
  - Deionized or distilled water
  - Wire brush

### Break Assessment
- High Breaks
  - Non-Destructive Testing
  - Condition Assessment
  - Renewal
- Low Breaks
  - Operate

### Test when Exposed

**Condition Assessment**
- Failed
  - Test when Exposed
  - Renewal
- Not Failed
  - Operate
Test when Exposed

Extract Sample at weakest point

EDS - Remaining Wall

Unhealthy
Active Corrosion
Healthy
Active Corrosion

Remaining Ca
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

Inner
1 2 3 4 5 6 7 8 9
Wall Location
Outer
Test when Exposed

Age = 0
Assume no corrosion

Results of 42 AC Samples

<table>
<thead>
<tr>
<th>Age-Based Useful Life</th>
<th>Condition-Based Useful Life</th>
<th>Gain in Useful Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 years</td>
<td>142 years</td>
<td>+67 years</td>
</tr>
</tbody>
</table>

Remaining Wall Age

Assume no corrosion

Avoid ~$260M In Unneeded Near-term Replacement
Test when Exposed

Pipe Sample

Photo

Soil

CP Test Station Installation

Anode

Potential Reading
Cost Effective Decision Making

Healthy

Not Healthy

Fix the right pipe at the right time
Soil Sampling (All Pipe)

- Locate native soil as close to pipe depth as possible, that hasn't been contaminated by potable water.
- Collect ~1 pound (quart freezer bag partially filled).
- Label the soil sample with the work order number, date, and location and place in the sample bucket.
- Only sample if the break is severe and you must cut pipe.
- Remove the broken pipe area plus 2 ft. on either side.
- Label the soil sample with the work order number, date, and location and place in the sample bucket.

Metallic/PVC Pipe Sampling (Rare)

- Place soil bag in the soil sampling bucket.
- Label the sample with the work order number, date, and location and place in the sample bucket.
- Is an AC cut needed?
- Can you obtain a piece with the full pipe wall?

Finalize Work Order

- Verify pipe material and size.
- Check that pictures have been uploaded.
- Check that all samples have been collected and labeled.
- Place samples on pallet in warehouse.
- Refill bucket supplies if necessary:
  - Plastic wrap
  - Sharpies & labels
  - Resealable bags
  - Tape
  - Charged voltmeter (9v battery)
  - Deionized or distilled water
  - Wire brush

How data will be used to make decisions

- Action
- Cost
- Risk
Data Driven Decisions

<table>
<thead>
<tr>
<th>Non-Destructive Testing Trigger</th>
<th>Number of Breaks</th>
<th>Annual Break Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution (14” Dia. and smaller)</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Transmission (16” Dia. and greater)</td>
<td>2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

3%

High Breaks

Not Failed

Condition Assessment

Failed

Renewal

97%

Low Breaks

Operate

Test when Exposed

Mesa Water District
## Non-Destructive Testing

### Condition Assessment of Water Mains

#### Table 3-1: Available inspection technologies for pressure pipe (continued)

<table>
<thead>
<tr>
<th>Method</th>
<th>Real Conductor Survey</th>
<th>Acoustic</th>
<th>Remote Field Electromagnetic</th>
<th>Ultrasonic</th>
<th>Magnetic Flux Leakage</th>
<th>Broadband Electromagnetic</th>
<th>Other</th>
<th>Typical Recommended Approach</th>
</tr>
</thead>
</table>
| Steel (AWWA C100) | Assess potential for stress corrosion cracking. | Acoustic velocity can detect grain deterioration. | Used for detailed internal scans of both CML and core-CML pipes. | | | | | 1. Corrosivity survey
| | | | | | | | | 2. Piping-wall potential cathodic protection assessment. |
| | | | | | | | | 3. Remote field electromagnetic or magnetic flux leakage. |
| Copper | Assess potential for metal deterioration. | n/a | Used for detailed internal scans of pipes. | n/a | n/a | n/a | n/a | 1. Corrosivity survey
| Plastic Pipe (BPEE – AWWA C80) | n/a | n/a | n/a | n/a | n/a | n/a | 1. Review of drawings, specifications, and inspection records
| Polyethylene (PE) | n/a | n/a | n/a | n/a | n/a | n/a | 2. Formulate examination of early or frequent failures have occurred.

### Table 3-1: Available inspection technologies for pressure pipe

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<th>Method</th>
<th>Soil Conductivity Survey</th>
<th>Acoustic</th>
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</table>
| Resistivity Survey | Assess potential for AC current induction (off and on) | Acoustic velocity can detect grain deterioration. | Changes in electromagnetic fields are used to detect corrosion pits and other defects. | Changes in magnetic fields are used to detect corrosion pits and other defects. | Changes in electromagnetic fields are used to detect corrosion pits and other defects. | Shaping of pipes for visual physical tests | Visual examination | 1. Test of opportunity areas from repairs and service taps. 2. GE mapping of soil, leaks, breaks, and condition.

**Notes:**
- AC: active conductor.
- CML: cast metal liner.
- CML: core metal liner.
- GIS: geographic information systems.
- HDPE: high-density polyethylene.
- PE: polyethylene.
Non-Destructive Testing (AC)

Remaining Wall (e-Pulse)

Advantages:
1. Fast / Low Cost
2. Low Risk & Community Impact
Data Driven Decisions

Break Assessment
- 3% of High Breaks
- 97% of Low Breaks

Non-Destructive Testing

Condition Assessment
- Failed
- Not Failed

Replacement

<table>
<thead>
<tr>
<th>Distribution (14” Dia. and smaller)</th>
<th>Remaining Useful Life</th>
<th>Number of Breaks</th>
<th>Annual Break Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10 years</td>
<td>5</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th>Transmission (16” Dia. and greater)</th>
<th>Remaining Useful Life</th>
<th>Number of Breaks</th>
<th>Annual Break Rate</th>
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<td>&lt;10 years</td>
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Operate

Test when Exposed

Renewal
Data Driven Decisions

Non-Destructive Testing

Break Assessment

High Breaks

Low Breaks

Operate

Test when Exposed

Condition Assessment

Failed

Not Failed

Renewal

97%

3%

Operate

97%

3%
Priority Metallic Pipe Replacement Project

Project 1951 CMLC (4.7 mi)  27 Breaks; Break Rate = 0.32
Alternatives to Replacement

Valves Spacing Policy
• Purpose: Control or Stop Flow
• District: 4,400 main valves
• Investment: 168 inoperable valves
• Over time, add 422 valves in optimal locations

Avoid ~$270K In Unneeded Replacement
Managing Aging Infrastructure

- Pipeline Integrity Program
- Opportunistic Testing
- Condition Based Renewal & Budgeting
- Optimizing Valve Spacing
- Pressure Management

![Graph showing the relationship between age and break rate for different pressure swings.](image-url)
Pressure Management

1. **Training**
   - Slow opening and closing of valves to prevent surges

2. **Pressure Monitoring & Automated Control**

3. **Design**
   - SCADA alarms for high or low pressures
   - Electric motor-driving pumps with VFDs
   - Gas-driving pumps ramp up to full RPM
   - Pressure monitoring at all tanks, wells, import stations
   - Dedicated Pressure Monitoring Stations
     - Redundant Pressure Monitors at each Reservoir
Program Benefits
Updated Cost Curve

$272M (2013) for assessments/replacements in the first 30 years

$11M for assessments/replacements in the first 30 years

$552M (2013) to replace pipelines in 100 years

$131M to replace pipelines in 100 years
100 Year Pipeline Replacement Evolution

2013: Industry Average Age-Based Replacement
- All pipelines replaced in 100 years: $557M
- First 30 years (2013-2043): $273M

2019: Breaks + Condition-Based Replacement
- All pipelines replaced in 100 years: $131M
- First 30 years (2013-2043): $11M
Continuous Improvement

Data Driven Decisions
- Material
- Installation year
- Project Cohort
- Depth
- Break date and location
- Non-destructive testing
- Wall thickness
- Remaining Useful Life
- Soil properties
- Traffic loading
For More Information


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