MANAGING A PCCP REHABILITATION PROGRAM

WATER RESEARCH FOUNDATION – LARGE PRESSURE PIPE STRUCTURAL REHABILITATION CONFERENCE

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SAN DIEGO COUNTY WATER AUTHORITY

• Wholesale water agency
• Infrastructure
  – Reservoir
  – Water Treatment Plant
  – Hydroelectric
  – Pipelines: 300 miles
### Pipe Material

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Length (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prestressed Concrete (PCCP)</td>
<td>82</td>
</tr>
<tr>
<td>Welded Steel (WSP)</td>
<td>120</td>
</tr>
<tr>
<td>Reinforced Concrete</td>
<td>86</td>
</tr>
<tr>
<td>Bar-Wrapped</td>
<td>12</td>
</tr>
</tbody>
</table>

### Graph
- **PCCP**: 28%
- **Steel (WSP)**: 40%
- **Reinforced Concrete**: 28%
- **Bar-Wrapped**: 4%
ASSET MANAGEMENT PROGRAM

PCCP FAILURES – 1979, 1980, 1982

Newspaper Article

Pipe Damage
RELINING (SLIP LINING)

- Steel liners
- Limited Area
  - Single contract
  - High pressure
- Length: 5 miles

Steel Liners Inserted into Pipe (1982)
PCCP FAILURES – 1990 AND 1993

Internal - Cylinder Leak/Corrosion

Damaged Pipe
HEADLINES

Neighborhood fear renewed over pipeline

Break Raises Questions About Best Pipe Types

Three S.D. Districts Placed on Strict Water-Use Rules

- Emergency: Break in major pipeline triggers Stage 4 alert; outdoor watering and washing of cars forbidden.

400,000 face water crisis here

East County and South Bay could run dry
AQUEDUCT PROTECTION PROGRAM

• Board established (1991)
  1. Inspect PCCP
  2. Evaluate service life
• Repair and replacement (1993)
  – Relining program
  – Planned all PCCP (82-miles)
  – Budget: $787M
PCCP FAILURES – 2006 AND 2008

Erosion Damage

Pipe Damage at Joint
RISK MANAGEMENT

• Data - few wire breaks

• Many factors
  1. Wire breaks (53%)
  2. Joints
  3. Surge events
  4. Installation/Manufacturing
  5. Design
  6. Third party damage

• Risk-Based decisions
# GATHERING DATA – PCCP

<table>
<thead>
<tr>
<th>Condition Assessment Type</th>
<th>Data Confidence</th>
<th>Year Started</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual – Internal</td>
<td>Low</td>
<td>1991</td>
</tr>
<tr>
<td>Sounding – Internal*</td>
<td>Low</td>
<td>1991</td>
</tr>
<tr>
<td>RFEC</td>
<td>Medium/High</td>
<td>1999</td>
</tr>
<tr>
<td>AFO</td>
<td>High</td>
<td>2006</td>
</tr>
</tbody>
</table>

* Only used for targeted areas of concern
PCCP MONITORING

Fiber Optic Cable Installation

Fiber Optic Cable Inside Pipe
ACOUSTIC FIBER OPTIC MONITORING

• 38-miles
• 7 Systems
• 1,300+ Wire Breaks
• $13M Total Costs
DATA MANAGEMENT

- Custom Open Source Database
- 60,000 pipe sections
- 66 major condition attributes
- 5 million data points

Condition Assessment Report
VISUALIZE DATA

• Google Earth
  1. Baseline Wire Breaks
  2. Wire Break Rate of change (activity)
  3. Consequence of Failure

• Determine Project Reaches
BASELINE WIRE BREAKS (3D)

Wire Break “Stacks”

Periodic Changes

- Wire Breaks < 20
- 20 ≤ Wire Breaks < 40
- Wire Breaks ≥ 40
WIRE BREAK RATE OF CHANGE (3D)
CONSEQUENCE OF FAILURE SCORE

1. Location
2. Other Utility Infrastructure
3. Water Authority Pipes

Future:
1. Drainage course
2. System Redundancy
CONSEQUENCE OF FAILURE (3D)

Width and Color = Score
PROBABILITY OF FAILURE SCORE

1. Pressure
2. Maximum Wire Breaks
3. Rate of Change
   - No wire breaks: 0
   - High Frequency: 5
RISK MATRIX

Rehab projects identified

- Condition Assessment
- Data Management
- Risk Assessment
- Prioritization
- Rehabilitation
- Cathodic Protection
WATER AUTHORITY EXPERIENCE

• PCCP Failures, **NOT JUST**:  
  – Wire breaks  
  – One manufacturer  
  – Class IV wire  

• Sustainable Projects
PROJECT IDENTIFICATION

1. Large Scale Rehabilitation
2. Section Repairs
   - Long Term (Steel Replacement)
   - Short Term (Carbon Fiber Repair)
## PIPELINE MANAGEMENT COSTS

<table>
<thead>
<tr>
<th>Budget</th>
<th>Cost</th>
<th>Rehab Length (miles)</th>
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</thead>
<tbody>
<tr>
<td>Spent</td>
<td>$255 Million</td>
<td>40</td>
</tr>
<tr>
<td>Remaining</td>
<td>$206 Million</td>
<td>13</td>
</tr>
<tr>
<td>Deferred</td>
<td>$326+ Million</td>
<td>29</td>
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