Multiple Pipeline Tools Used to Rehab/Replace 7-mile Pressure AC Main

CA NV AWWA, Pipeline Rehabilitation Committee

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Multiple Tools Outline

- Project Overview
- AC Pipe Investigations
- Five Phased Rehabilitation and Replacement Approach
- Rehab and Replacement Tools and Lessons Learned
- Project **Cost Summary**

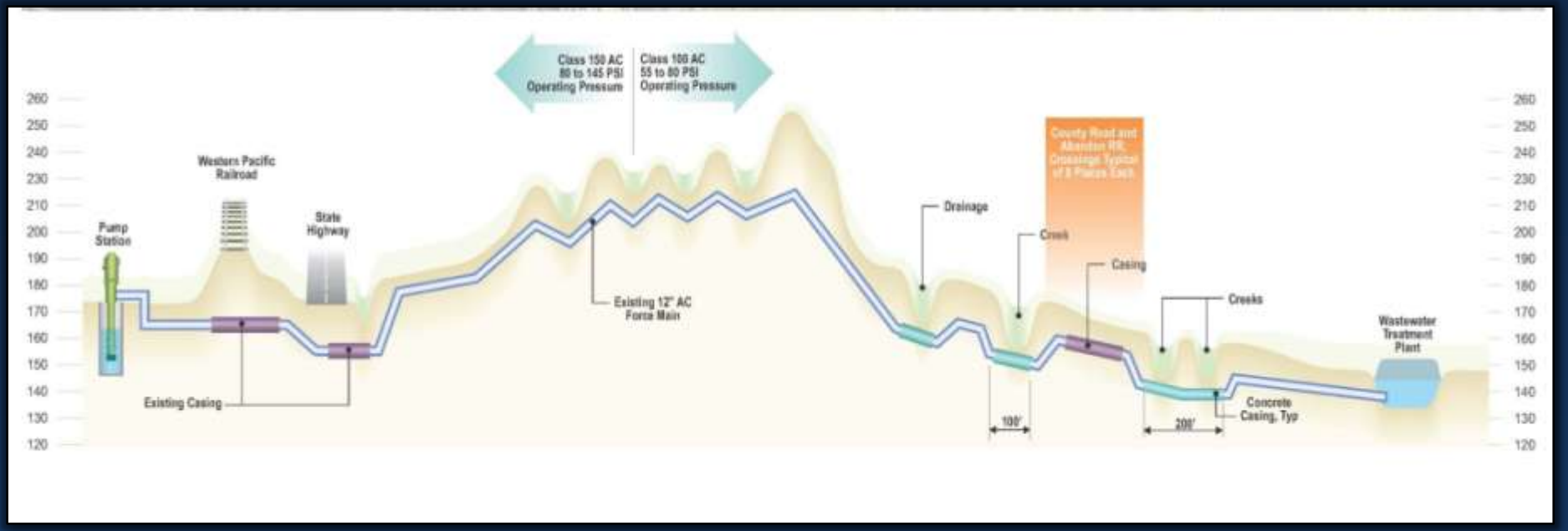
Project Overview

- 7-mile AC Pipeline – Industrial Wastewater Force Main constructed in 1976
- Conveys tomato (1976 to 1999) and fruit canning (2000 to present) waste from Factory to Industrial Waste Treatment and Land Application site

Pipeline Break History

- Over 10 breaks, varying from 1 to 3 per year for over a decade

Pipe Profile



AC Pipe Investigations

- Client had inadequate funds to replace pipeline, and factory shutdown cost up to $1M per day
- Risk Analysis - estimate pipe condition, ability to meet service conditions, and remaining useful life
  - Evaluated breaks from 1984 to 2008
  - Conducted “C” factor test
  - Investigated pipe construction
- RWQCB closely monitoring industrial sewer spills from pipeline breaks

Methods to Investigate Pipe Breaks

- Photograph and physically review specimens
- Measured by caliper micrometer and depth of softness of the surface by Starrett® pitting gauge

Pipe Breaks

- Circumferential breaks – flexural displacement load
- Longitudinal breaks – internal pressure and bursting failure

Pipe Break Investigation

Year	Class 150, 1.25” wall thickness	Class 100, 0.85” wall thickness	No. of Breaks	Wall Thickness measured, in.	Estimated Remaining Useful Life
1988	X		1	1.125”	30 years
1995	X	X	2	1.055” / 0.73”	5 to 10 years
1998	X		1	1.03” / 0.63”	3 to 7 years
2002		X	3	0.535” to 0.55”	2 to 5 years
2004		X	2	0.60” to 0.631”	2 to 5 years

Average pipe loss 10 to 15 mils/yr interior and 1 to 2 mils/yr exterior

1998 - Conducted “C” Factor Test

- No services along pipeline
- Used external ultrasonic flow meter
- Added pressure gauges along alignment at CAVs
- Operated pumps and measured pressure
- Estimated Hazen Williams “C” factors by pipe segments
- Results: HW “C” 85 to 105 for Class 150 AC
- Impacts: Increased Pressures for Class 150 AC and conveyance capacity reduced

Cause of Breaks

- Construction methods – poor backfill and bedding causing settlement and circumferential cracks
- Increased surge effects with 2nd pump activation causing longitudinal cracks
- Deterioration of pipe wall thickness – leaching of calcium from pipe, soft fibrous profile
- Investigation and estimated useful life basis:
  - Allow up to half the wall thickness in Class 150 before critical to replace pipe
  - Reduces safety factor from 4:1 to 2:1 bursting resistance

Recommended Improvements

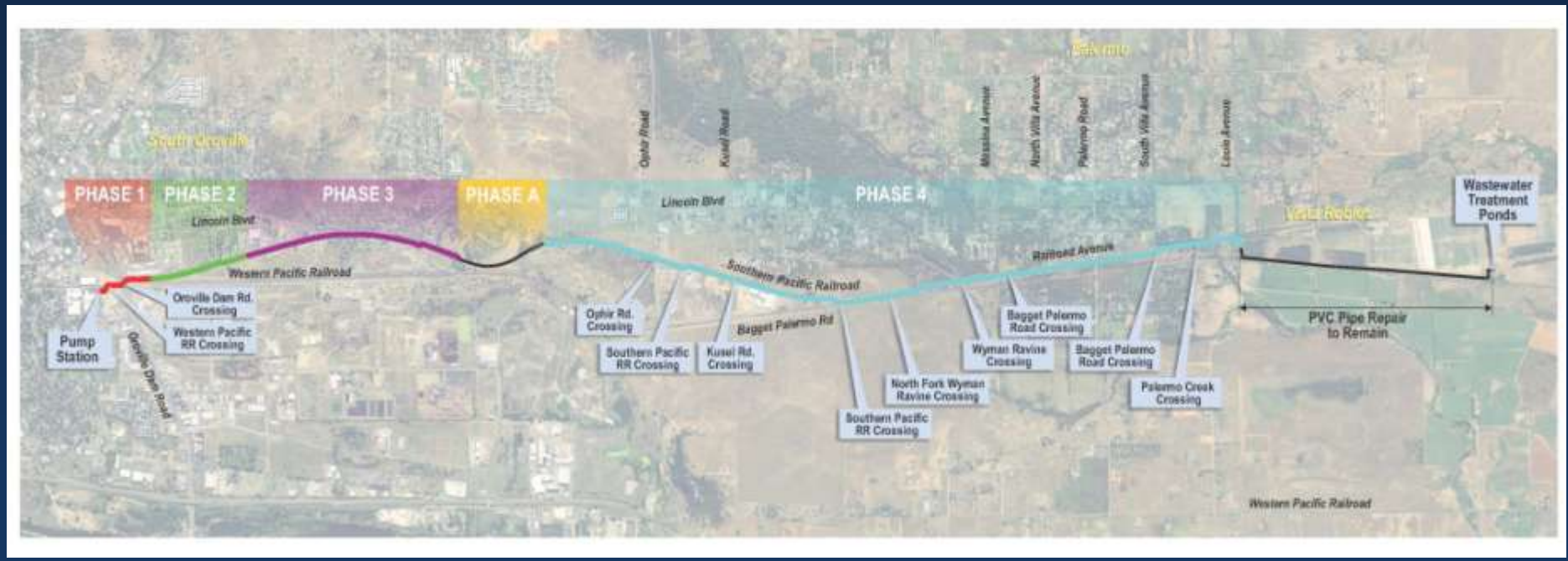
Immediate:

- Add soft start to 2nd pump to reduce surge
- Add flow monitoring system – increase pipe alignment inspection
- Develop emergency bypass system across UPRR and State Highway Crossing

Near-Term:

- Replace pipeline in phases correcting highest risk to lowest risk segments

Phased AC Pipeline Replacement



Preliminary Design Report

- Evaluated Pipe Materials & Construction Methods
  - Open cut remove & replace with PVC C900 or HDPE pipe
  - Open cut parallel PVC or HDPE pipe
  - Pipe bursting with HDPE pipe
  - Re-lining using CIPP or Fold-n-Form
  - Re-using steel casings and remove & replace existing AC carrier pipe

Evaluation of Alternatives

	Phases 1 & 2			Phases 3 & 4		
Evaluating Criteria	Alt 1-1: Open Cut	Alt 1-2: Re-lining	Alt 1-3: Combo	Alt 1-1: Open Cut	Alt 1-2: Re-lining	Alt 1-3: Combo
Constructability	6	10	8	4	10	8
Schedule to Complete	6	10	8	6	10	8
Easement requirements	6	9	8	4	10	6
Utility impacts	7	9	8	6	10	10
Active railroad and road crossing impacts	7	9	9	6	10	10
Environmental impacts	6	9	8	4	10	8
Permitting	6	10	7	6	10	8
Operational impacts - storm water collection and disposal	6	6	6	6	6	6
Ease of Operations (including pigging)	10	4	4	10	4	4
Total Project Cost	40	24	32	28	32	40
Total	**100**	**100**	98	80	**112**	108

Actual Pipe Materials and Construction Methods Used

- **Client wanted a new pipe & was willing to pay for it**
  - **Phase A: Open cut – parallel PVC pipeline**
  - Phase 1: Open cut - reused casings and replaced AC pipe with HDPE in casings and PVC outside of casings
  - Phase 2: Open cut – remove and replace with PVC
  - Phase 3: Open cut – remove and replace combined with parallel pipeline with PVC
  - **Phase 4: Open cut – parallel PVC pipeline with pipe bursting using HDPE at crossings**

***Phases A & 4 – direct negotiation w/ preferred contractor**

Phase 1 – Lessons Learned

- Original plan pull pipe from casings
  - Check both ends of each casing
- CO - Drilled out AC pipe in (E) casing for UPRR
  - AC haz mat trained personnel on-site
  - Special monitoring for AC friables
  - Enclosure and capture air
  - Capture and dispose of drilling muds

Phase 1 – Lessons Learned

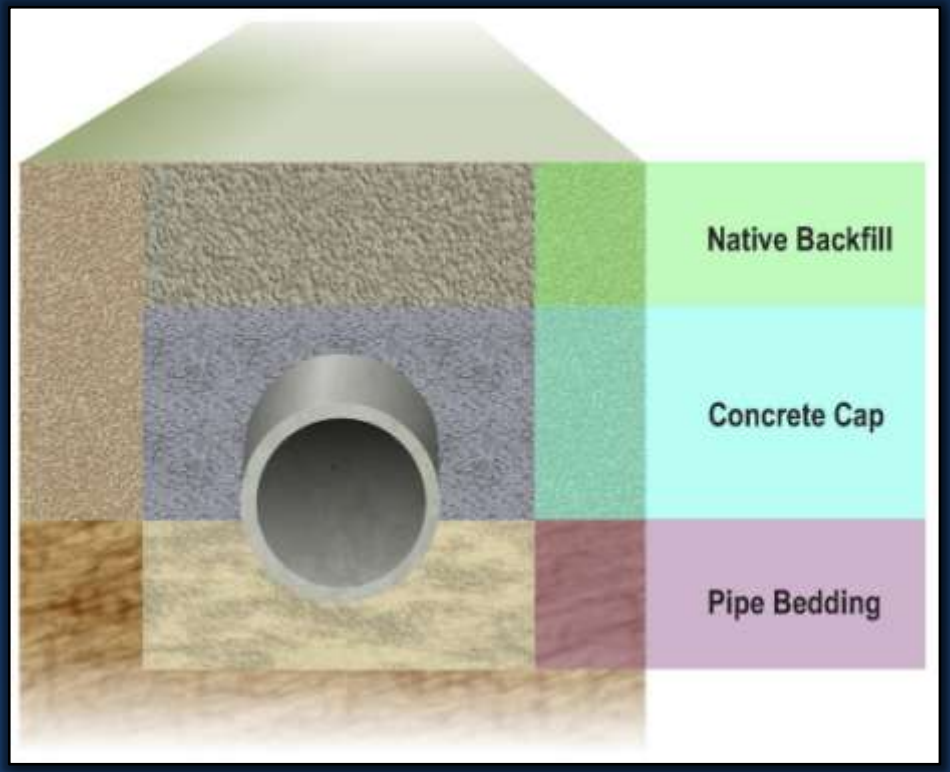
- Use an experienced trenchless contractor
- CCTV & pressure test pipe after installation
- Avoid grouting within casings if possible

Phase 4 – Investigation

- Pipe Bursting used to cross creeks – HDPE, DR 13.5, 11.80” pipe ID - no impact to pigging operation
  - Only required 1602 Streambed Alt Permit
- Excavated soil test pits for pipe bursting at creek crossings
- Limited pipe bursting to <260’ to avoid USEPA, Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP)

Phase 4 – Implemented Lessons Learned

- Investigated pipe caps – confirmed only on top half of pipe
  - Cut out sample and tested
  - Concrete compressive test – 5,880 psi
- County roads – open cut, installed casings & carrier pipe



Open Cut – Remove & Replace Lessons Learned

AC Pipe Removal and Replacement:

- Remove AC intact
- Bag AC pipe
- Dispose at landfill able to take AC pipe intact

Abandon Casing for Parallel Construction:

- Fill pipe to avoid pipe/casing failure and road settlement

Project Cost for 12” ∅ AC Pipeline Replacement

Phase (Year)	Description	Bid	Change Orders	Final	Engineers Estimate	Savings
A (2003)	2,500’ remove & replace	$156K	$0K	$156K	$211K	$55K
1 (2008)	789’ remove & replace & 243’ pull pipe from casing (CO to drill out AC)	$136K	$164K	$300K	$253K	-$46K
2 (2010)	2,429’ remove & replace + additional 1,850’ through CO	$178K	$170K	$348K	$427K	$79K
3 (2011)	1,650’ remove & replace & 2,887’ parallel pipe	$300K	$2K	$302K	$313K	$9K
4 (2013)	17,000’ parallel pipe, 380’ remove & replace, & 400’ burst	$1,121K	$0K	$1,121K	$1,137K	$16K
Total	30,128’	$1,891K	$336K	**$2,227K**	$2,350K	$103K

Questions?

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