Upgrading Large Diameter Pipelines Under Challenging Seismic Conditions

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Presentation Outline

- Overview of SFPUC’s Water System Improvements Program (WSIP)
- Harry Tracy Water Treatment Plant (HTWTP) - Long Term Improvements Project (LTIP)
  - Design
  - Construction
- Peninsula Pipeline Seismic Upgrades (PPSU) Project
  - Design
  - Construction
**SPFUC’s Water System Improvements Program (WSIP)**

- **Hetch Hetchy Regional Water System**
  - Provides 260 millions gallons per day
  - To over 2.5 million Bay Area residents
  - Travels 167 miles by gravity
  - Crosses 3 faults

- **Water System Improvements Program (WSIP)**
  - $4.6 billion program
  - Seismically protect the water system
  - Assure reliable and adequate supply in case of catastrophic event or drought conditions
HARRY TRACY WATER TREATMENT PLANT – LONG TERM IMPROVEMENTS PROJECT
Harry Tracy WTP Overview

- Direct filtration plant
- Rated capacity: 140 MGD
  - Sustainable capacity: 90 MGD
  - Average Flow: 20 - 40 MGD
- Plant challenges
  - San Andreas Fault
  - Site limitations
Seismic Design Criteria

- Seismic Reliability:
  - Sustain limited damage following Maximum Credible Earthquake on San Andreas Fault
  - Deliver 140 MGD within 24 hours after event

- BSE-2 (Basic Safety Earthquake-2) per ASCE 41
  - 2,475 year return period earthquake
  - 2% occurrence in 50 years
  - Maximum Credible Earthquake of 7.9
HTWTP Pipeline Improvements

- **Treated Water (TW)**
  - Parallel to and crosses Western Fault
  - Abandon 78” TW (Line “N”) from existing reservoirs
  - New 78” TW pipe from new reservoir
  - Slipline 60” TW (Sunset Branch) with 48” pipe

- **Raw Water (RW)**
  - Crosses Eastern Fault then runs parallel to Western Fault
  - Abandon 60” RW (San Andreas No. 3 - SA#3)
  - New 72” RW
    - Above ground with piers
    - Buried
HTWTP Pipeline Improvements

- 78” TW
- 72” RW
- 66” TW Line N
- 48” TW Sunset Branch
- 72” RW
Sliplining 60” Treated Water (Sunset Branch Pipeline)

Geological Cross Section
Sliplining 60” Treated Water (Sunset Branch Pipeline)

- Existing 60” cement mortar lined and coated steel pipe
- Slipline with 48” polyeurethane lined steel pipe
  - 0.75 to 0.5-inch thick pipe
  - Butt welded joints
- 220 foot length of pipe
- 53% slope, transitioned into 33% slope
- Anchor block on top and bottom of alignment, reinforced with drilled caissons
- Slipline from either end of pipe
- Open pipe in the middle to weld
72” Treated Water (Sunset Branch)

53.3% Slope

33.0% Slope
48” Treated Water (Sunset Branch)
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## 72” Raw Water (SA#3)

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<th>Pros</th>
<th>Cons</th>
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<td><strong>Above Ground</strong></td>
<td>• Less impact to existing pipelines</td>
<td>• Higher Cost&lt;br&gt;• Higher security risk&lt;br&gt;• Will need to coordinate with PG&amp;E to reroute existing overhead electrical&lt;br&gt;• Change aesthetics of plant (would look like an oil refinery!)</td>
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<td><strong>Buried</strong></td>
<td>• Lower cost&lt;br&gt;• Lower security risk&lt;br&gt;• Not visible</td>
<td>• More extensive maintenance&lt;br&gt;• More impact to SA3 during construction</td>
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72” Raw Water (SA#3)

- **Initial Design**
  - All above ground
  - Rejected due to aesthetics

- **Final Design**
  - Portion above ground with pipe saddles set on caissons
  - Transition to buried pipeline
  - 7/8-inch thick steel pipe
  - Butt welded joints
72” Raw Water (SA#3)
72” Raw Water (SA#3)
72” Raw Water (SA#3) and 60” Treated Water (Line N)
72” Raw Water (SA#3) and 60” Treated Water (Line N)
Lessons Learned During Construction

- Pipeline construction went relatively smoothly
- Complete slipline of pipeline before installation of connection points
- Consider crotch plate sizing during design, to avoid conflict with appurtenances
- Confirm existing grade/cover prior to installation
PENINSULA PIPELINE SEISMIC UPGRADE (PPSU) PROJECT
PPSU Overview

- **Project goal**
  - Increase pipeline reliability during potential seismic events
  - Improve the reliability of supply from the HTWTP to the San Pedro Valve Lot

- **Transmission Pipelines from HTWTP**
  - San Andreas No. 2 (SAPL2)
  - San Andreas No. 3 (SAPL3)
  - Sunset Branch Pipeline (SSBPL)

- **Pipelines cross the Serra Fault and Colma Valley liquefaction zones**

- **Five project sites on San Francisco Peninsula in San Mateo County**
  - Colma, South San Francisco, San Bruno and Millbrae
PPSU Project Description

- **Millbrae Site**
  - Replacement of 900 feet of 61” SSBPL
  - Crosses the Serra Fault
  - Residential area, densely covered steep slopes, golf course
  - Open trench construction

- **San Bruno South Site**
  - Replacement of 1,120 feet of 54” SAPL2 and 990 feet of 66” SAPL3
  - Crosses the Serra Fault
  - Two parallel pipelines; cross through steep slopes, active roadway, condo parking lot
  - Open trench construction
PPSU Project Description, Cont.

- **San Bruno North Site**
  - Structural support of 61” SAPL2 within an existing concrete box tunnel
  - Addition of two concrete supports within the tunnel

- **South San Francisco Site**
  - Replacement of 665 feet of 54” SAPL2
  - Colma Valley liquefaction zones
  - Trenchless technology

- **Colma Site**
  - Replacement of approximately 685 feet of 54” SAPL2
  - Colma Valley liquefaction zones
  - Open trench; crossed existing concrete culvert
Design Challenges

- Coordination with residents, golf course, condominium owner
- Location of existing pipelines
  - Inaccurate as-built drawings
  - Potholing not possible in all locations
- Strict shutdown schedule to coordinate with HTWTP construction
- Seismic conditions required design of thick-walled pipe with creative connection and trench details
Residential Improvements over R.O.W.
Thick Eucalyptus Grove over R.O.W.
Golf Course over R.O.W.
Condo Parking Lot over R.O.W.
PPSU Design

- Strengthen pipes
  - Steel pipe thicknesses up to 1-1/4 inch
  - Mostly butt-welded joints
  - Reinforced concrete-encased joints with studs
- Provide flexibility for pipe movement within trench
  - Expanded Polystyrene (EPS) Foam
  - Controlled Density Fill
  - Reinforced mudslab to support pipe
  - Gravel
  - Sand
Millbrae Site
Lessons Learned During Construction

- Confirm pipe location during design (horizontally and vertically)
- Confirm existing nearby utilities during construction
- Consider how to support pipe during construction
- Consider how to access pipe for welding during construction
- Consider width of trenches and required shoring, in relation to parallel pipes and final grades
- Consider sources of water for hydrostatic testing
Questions?

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