Upgrading Large Diameter Pipelines Under Challenging Seismic Conditions

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San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

Kennedy/Jenks Consultants

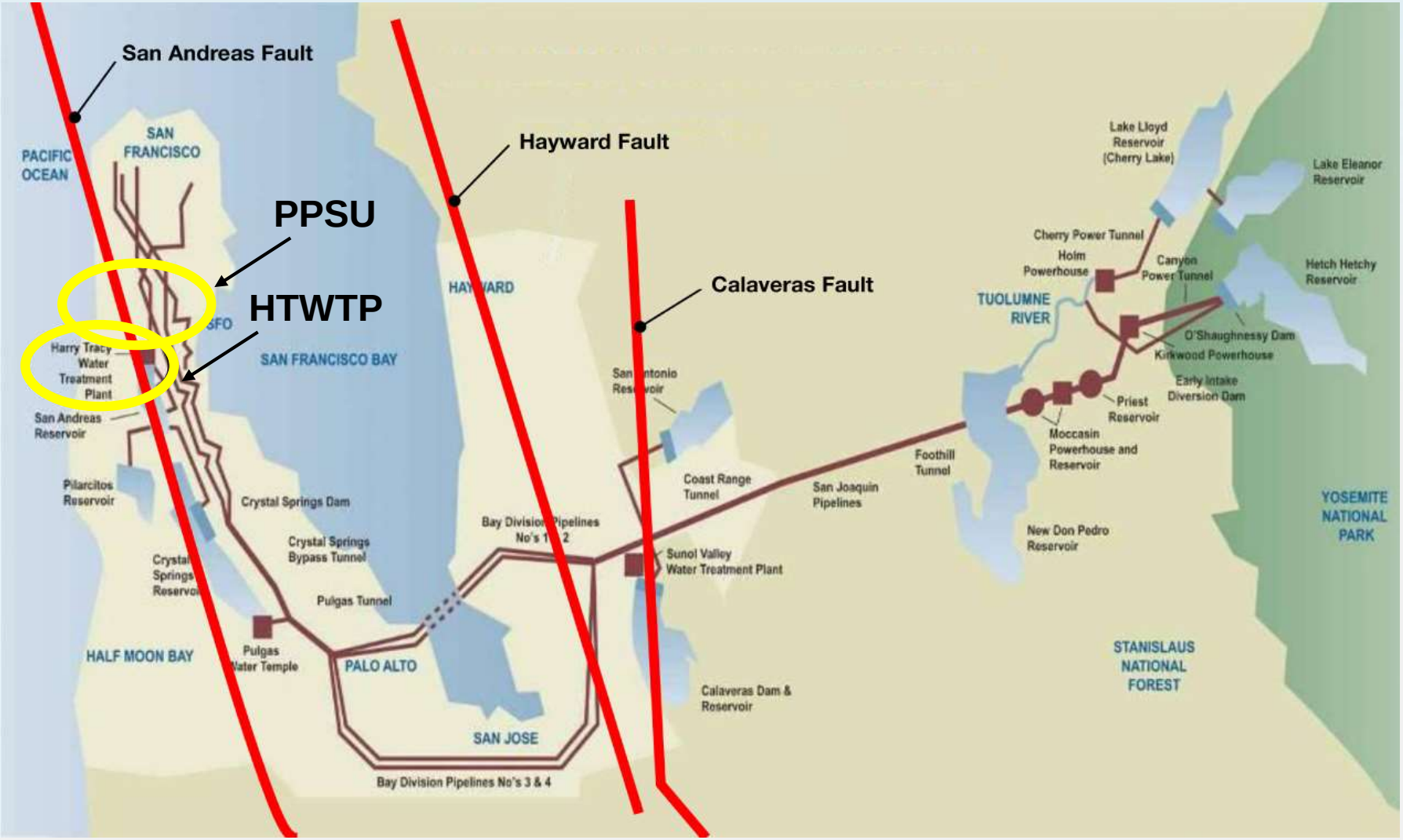
Presentation Outline

- 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

SFPUC Hetch Hetchy Water System



HARRY TRACY WATER TREATMENT PLANT – LONG TERM IMPROVEMENTS PROJECT

Harry Tracy WTP Overview

- Built in 1972 and expanded in 1988, 1992 and 2011-2015
- Direct filtration plant
- Rated capacity: 140 MGD
  - Sustainable capacity: 90 MGD
  - Average Flow: 20 - 40 MGD
- Plant challenges
  - San Andreas Fault
  - Site limitations

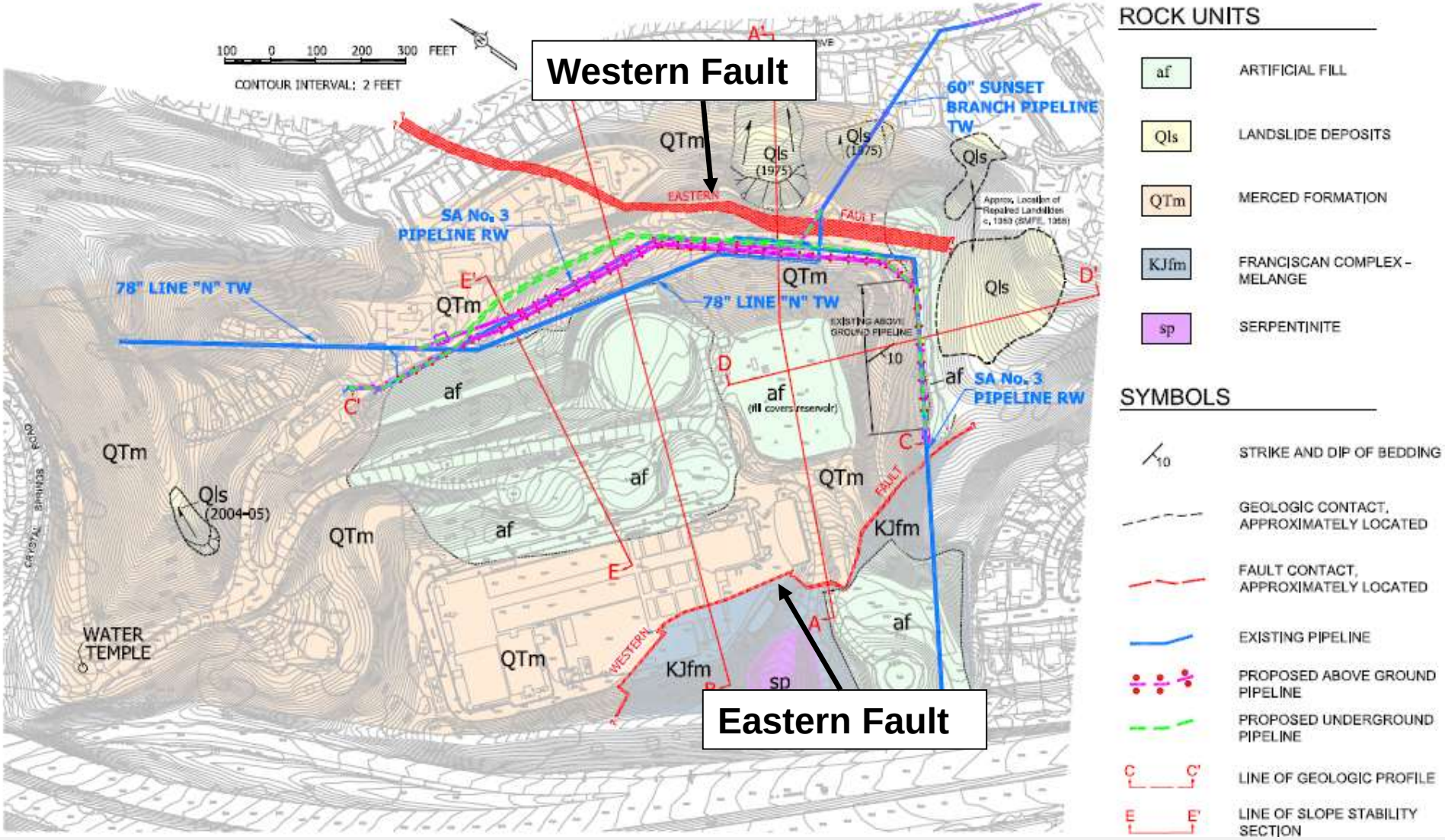
Seismic Design Criteria

- 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

Harry Tracy WTP Project Map

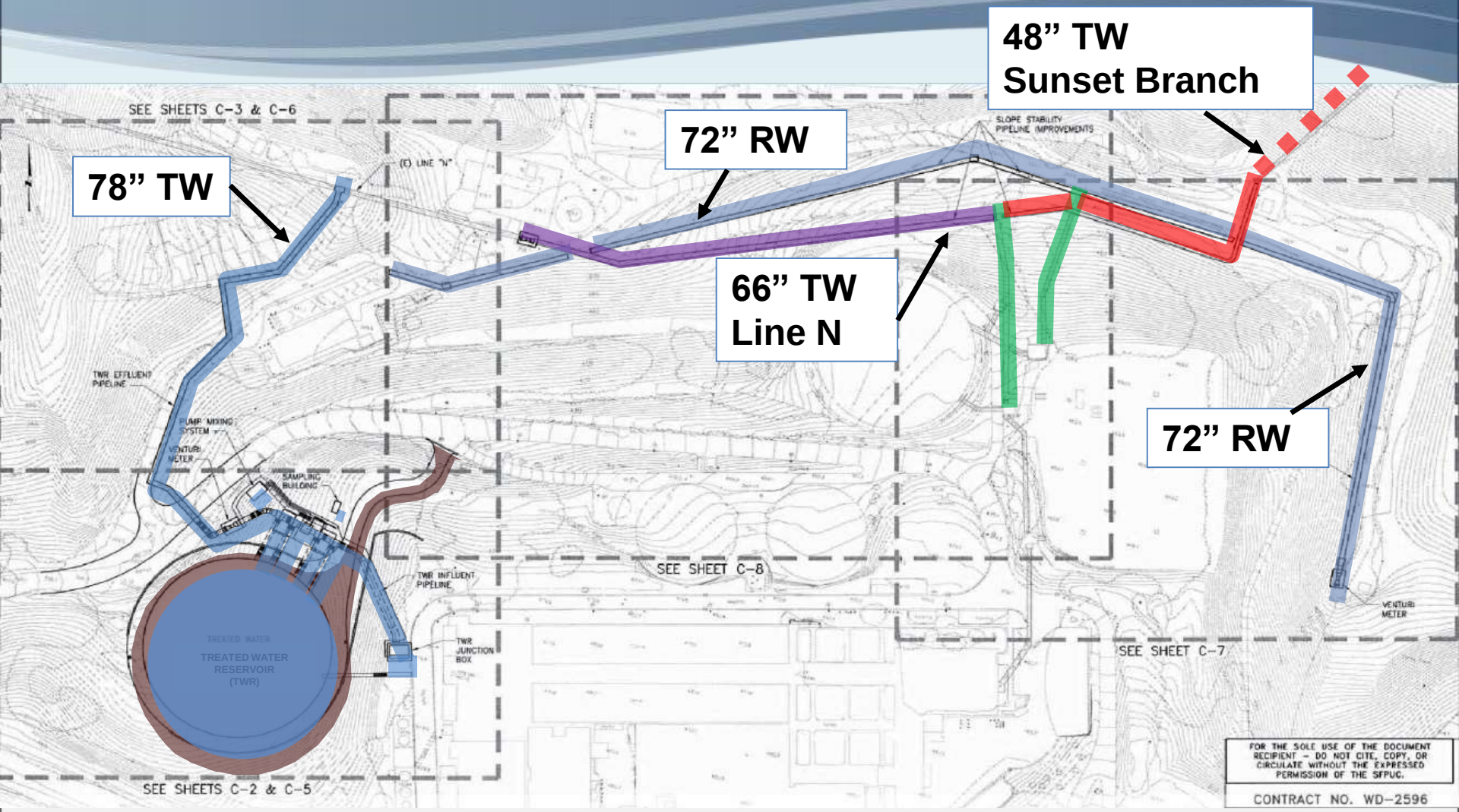
HTWTP Geologic Map



HTWTP Pipeline Improvements

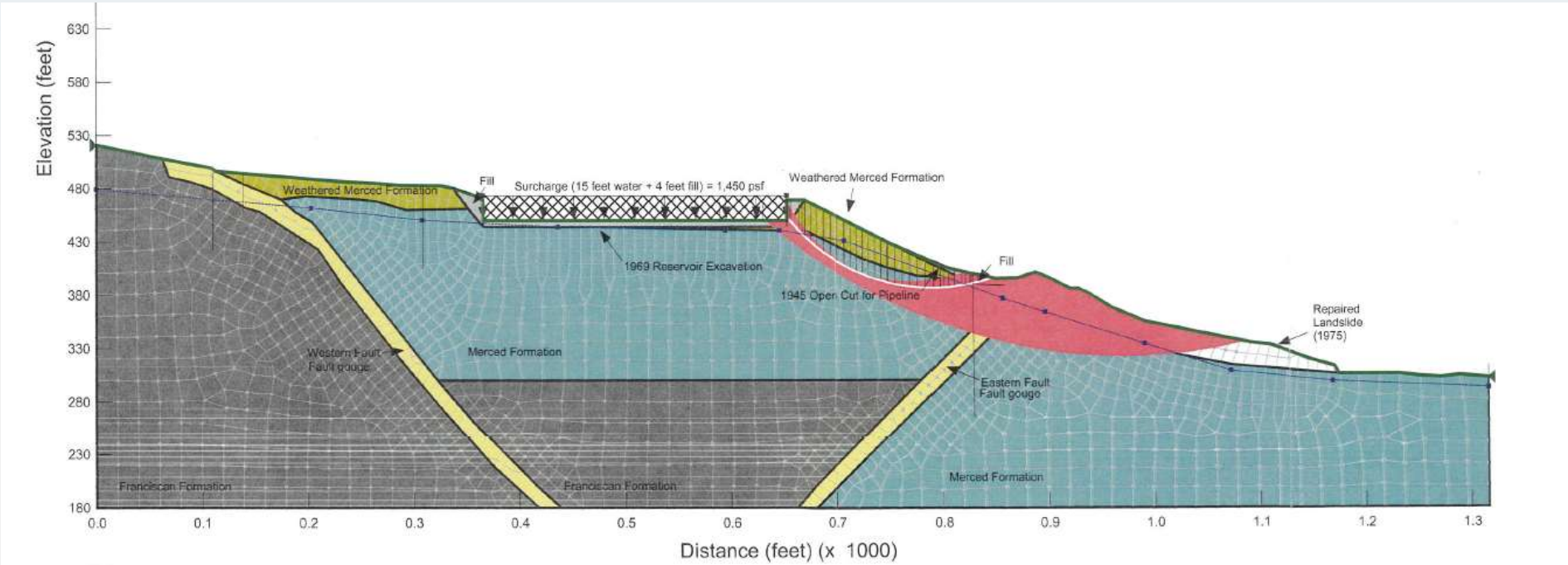
- Treated Water (TW)
  - Parallel to and crosses Western Fault
  - Abandon 78” TW (Line “N”) from existing reservoirs
  - New 78” TW pipe from new reservoir
  - Slipline 60” TW (Sunset Branch) with 48” pipe
- Raw Water (RW)
  - Crosses Eastern Fault then runs parallel to Western Fault
  - Abandon 60” RW (San Andreas No. 3 - SA#3)
  - New 72” RW
    - Above ground with piers
    - Buried

HTWTP Pipeline Improvements



Sliplining 60” Treated Water (Sunset Branch Pipeline)

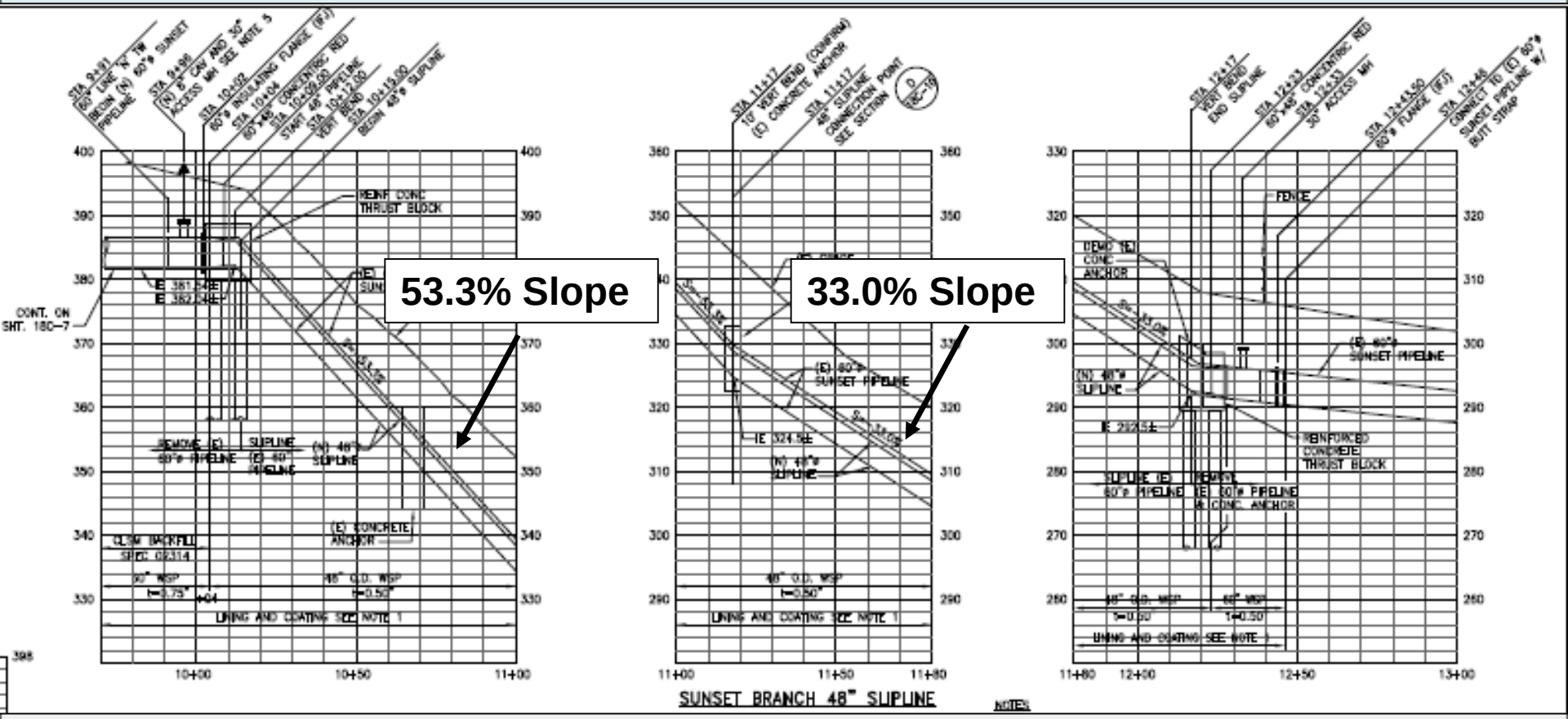
Geological Cross Section



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)



48” Treated Water (Sunset Branch)

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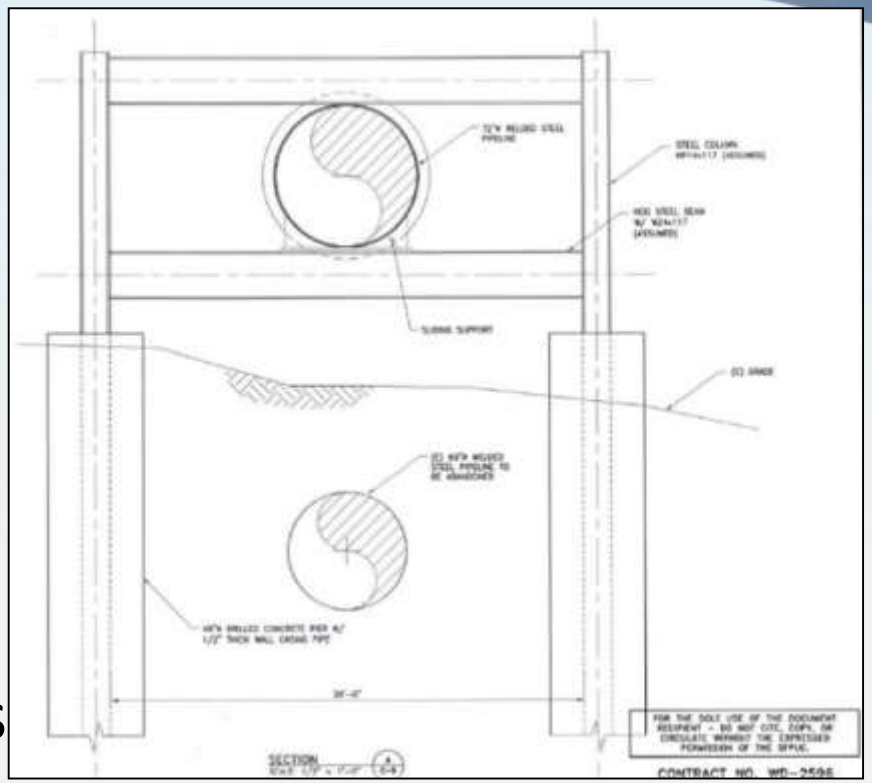
48” Treated Water (Sunset Branch)

72” Raw Water (SA#3)

	Pros	Cons
Above Ground	• Less impact to existing pipelines	• Higher Cost • Higher security risk • Will need to coordinate with PG&E to reroute existing overhead electrical • Change aesthetics of plant (would look like an oil refinery!)
Buried	• Lower cost • Lower security risk • Not visible	• More extensive maintenance • More impact to SA3 during construction

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)

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

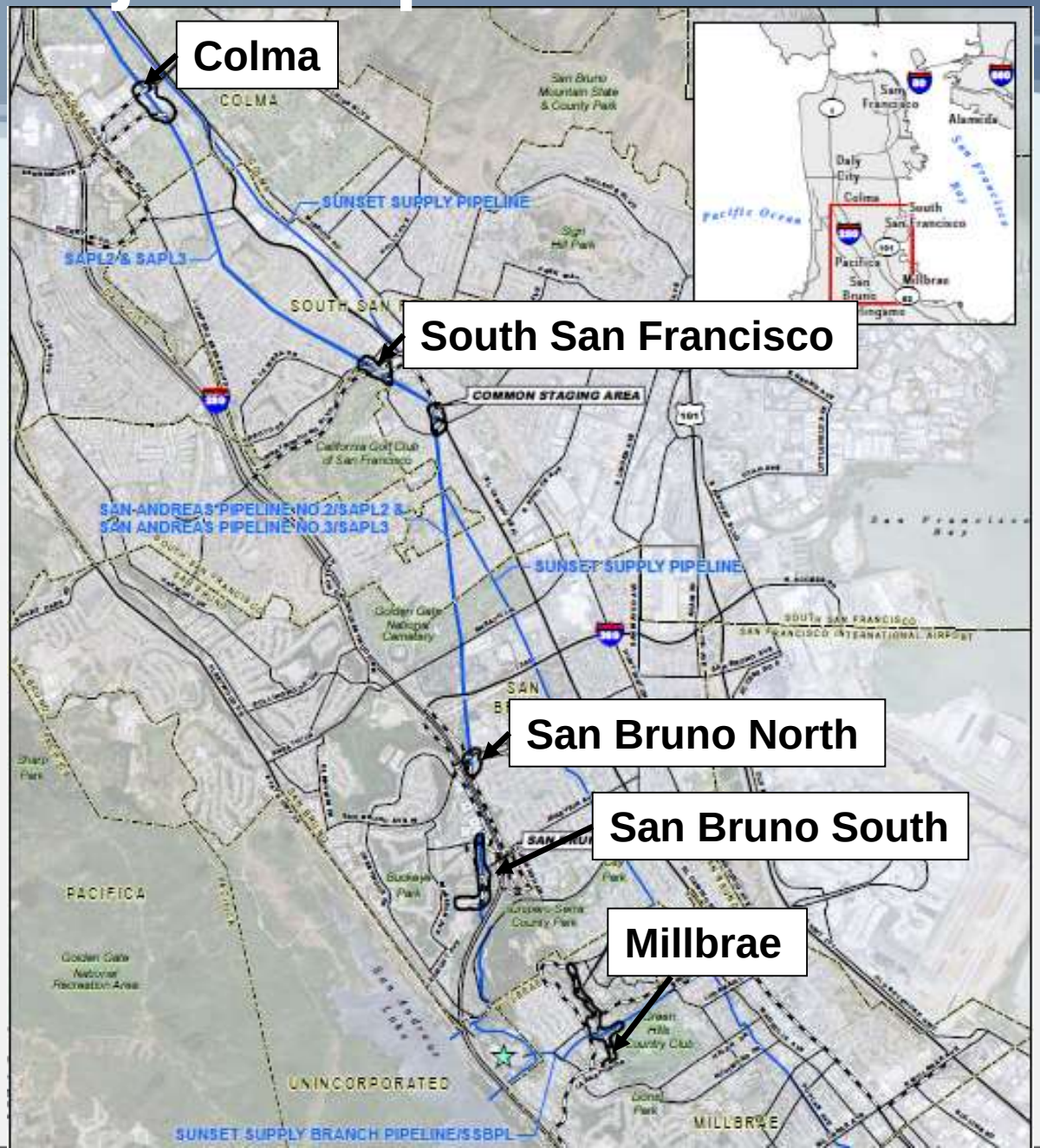
- Complete slipline of pipeline before installation of connection points
- Consider crotch plate sizing during design, to avoid conflict with appurtenances
- Confirm existing grade/cover prior to installation

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 Map



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

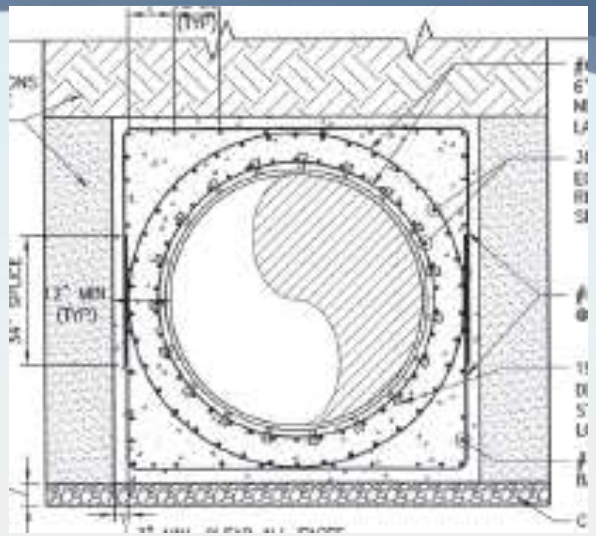
Residential Improvements over R.O.W.

Thick Eucalyptus Grove over R.O.W.

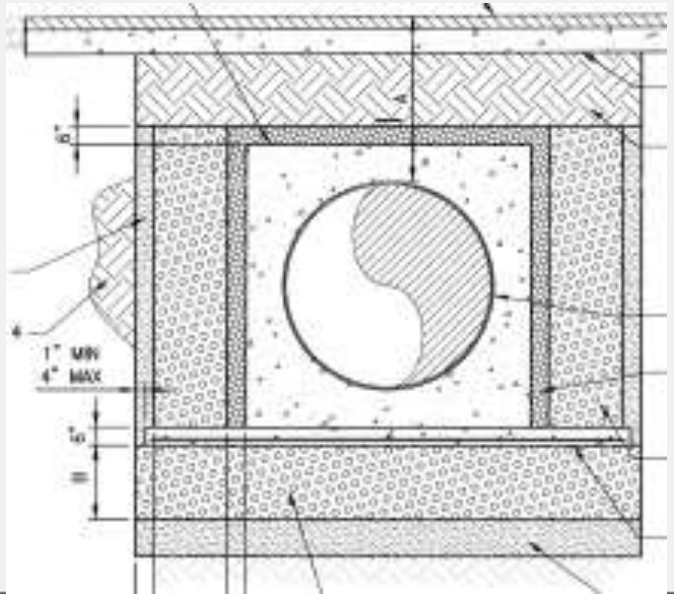
Golf Course over R.O.W.

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

Millbrae Site

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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