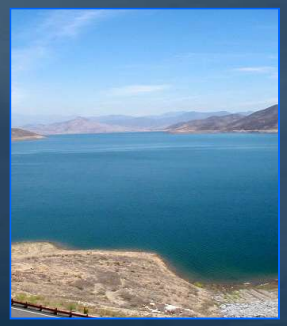
Metropolitan's Infrastructure Resilience – Seismic Resilience Update

MWDOC Board Presentation
February 2nd, 2022

Metropolitan's Comprehensive Reliability Approach

System Reliability Strategy

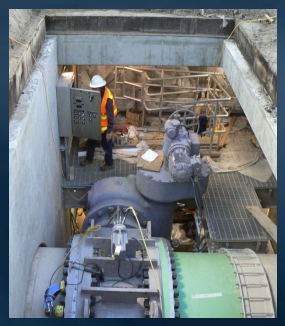
- **Water Supply**



- **System Capacity**

- **Infrastructure Reliability**

- **System Flexibility**



- **Emergency Response**

Metropolitan's Multi-faceted Approach to Resilience

Resilience Strategy

- **Planning**
- **Engineering**
- **Operations**
- **Agency Partnerships**
- **Reporting**

Resilience of Imported Water Supplies

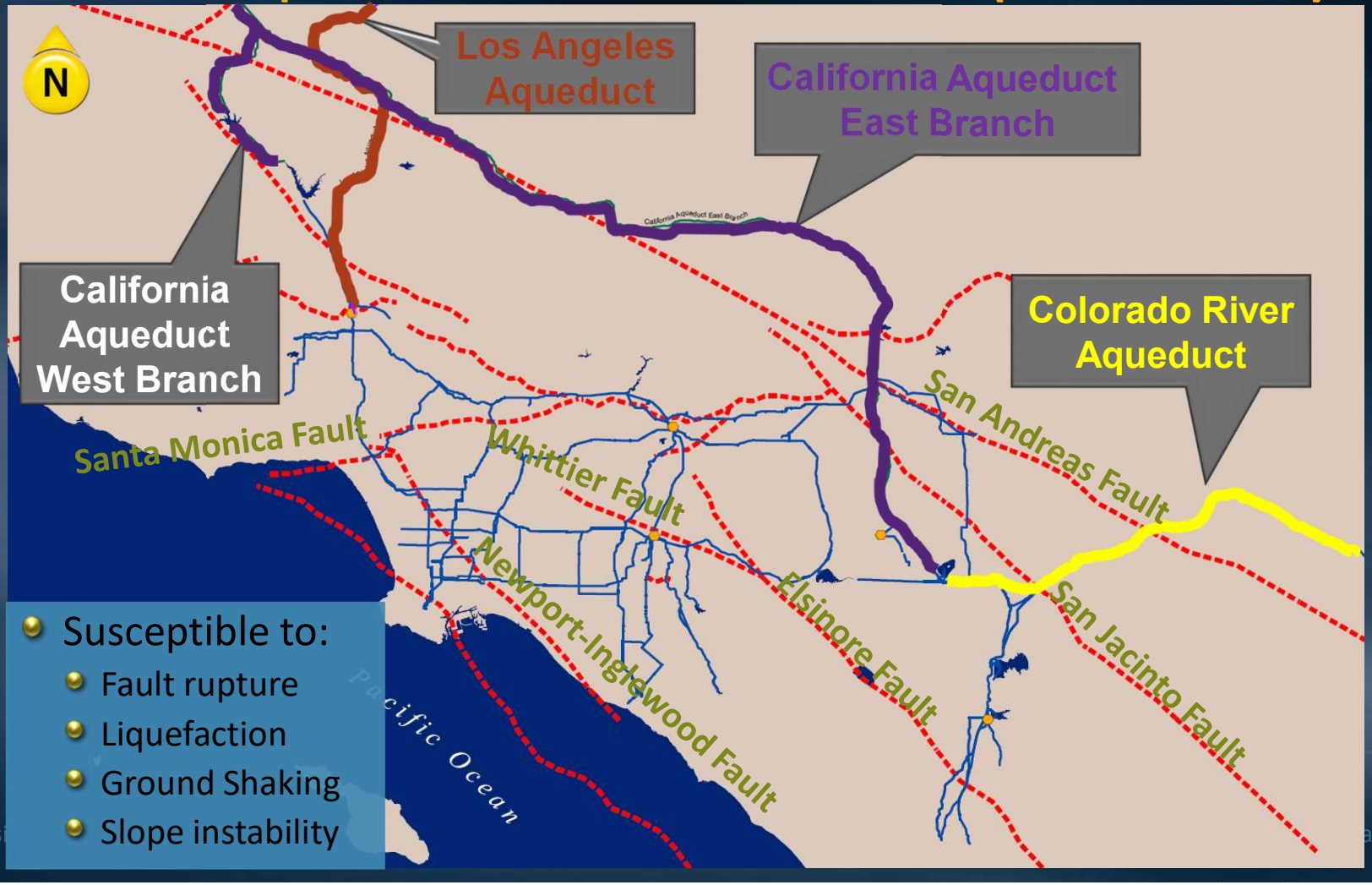
Washwater Tank Seismic Upgrade

Machine Shop

DWR-LADWP-MWD

Seismic Resilience Report

Major Earthquake Faults and Metropolitan's System



Development of Seismic Resilience Strategy

- Construction of Metropolitan's system was completed in phases from the 1930's through the 2000's
- Included few special provisions for seismic events

- *"It was desirable that faults be crossed at right angles to minimize damage in the event of movement, and that some flexible type of conduit on or near the surface be used so that if repairs become necessary they will be as simple as may be…"*
  - - Julian B. Hinds, Nov. 24, 1938

Development of Seismic Resilience Strategy

Steps Toward Seismic Resilience




1930's
Construction of Colorado River Aqueduct

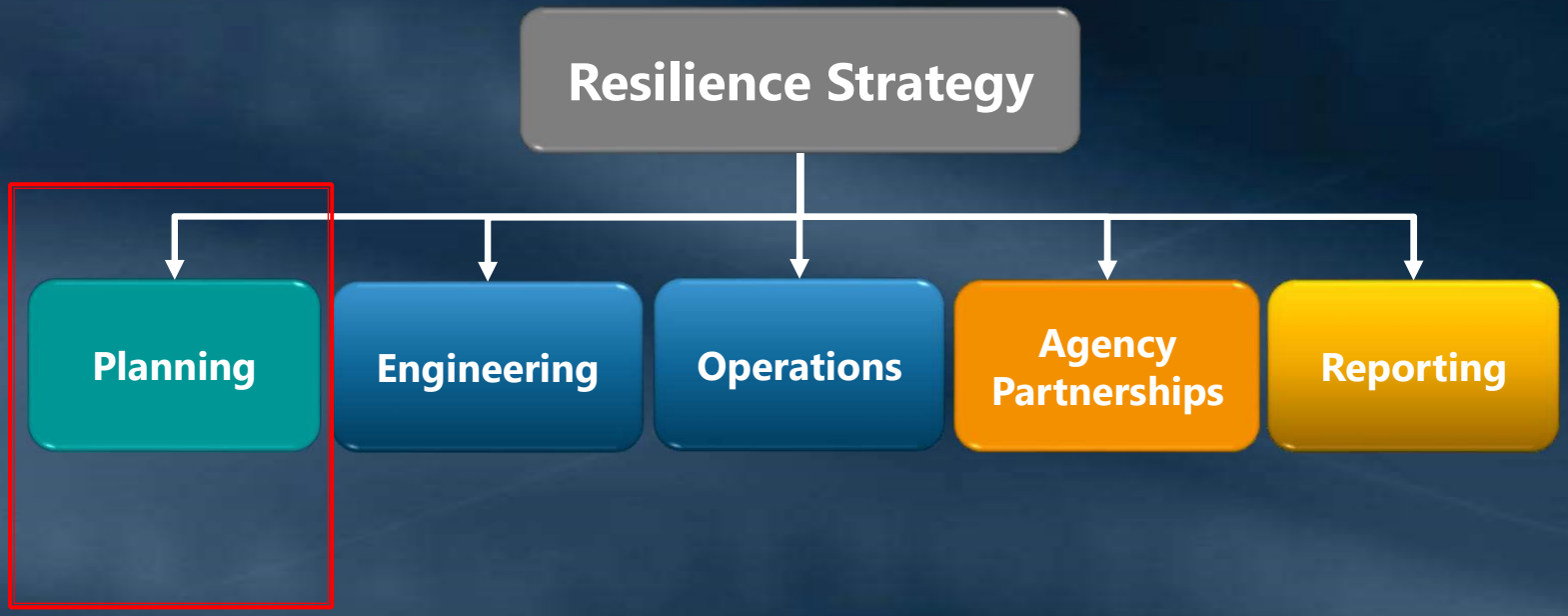
1971
San Fernando Earthquake

1994
Northridge Earthquake

2011
Christchurch Earthquake

Metropolitan's Multi-faceted Approach to Resilience

Metropolitan's Multi-faceted Approach to Resilience

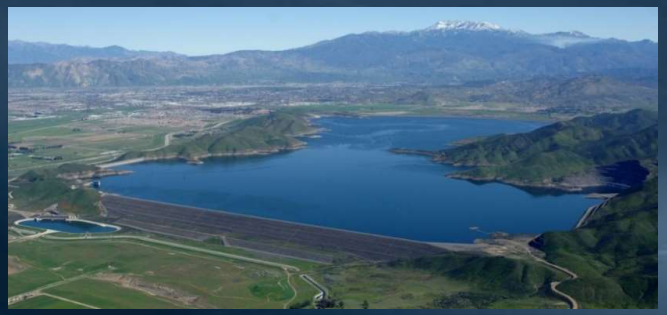


Planning

- Increased emergency water storage in Southern California
  - Constructed DVL
    - Nearly doubled the surface storage capacity in Southern California
    - Constructed on coastal side of the San Andreas Fault
    - Can directly supply 4 of 5 treatment plants

Planning

- Emergency storage to withstand a six-month disruption to imported supplies to the region
  - Surface storage
  - Groundwater storage
  - Local production & conservation
- Emergency storage requirements are reviewed periodically



Planning

- Delta Conveyance

Seismic Resilience Strategy

Seismic Resilience Strategy

- **Planning**
- **Engineering**
  1. Assessment
  2. Prioritization
  3. Mitigation
- **Operations**
- **Agency Partnerships**
- **Reporting**

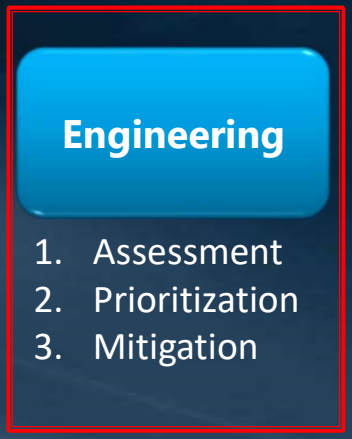
Earthquake-resistant ductile iron pipes

Engineering & Infrastructure Upgrades

- Metropolitan established an ongoing seismic assessment and upgrade effort
  - Periodically reassess the seismic risk to infrastructure
  - Addresses key vulnerabilities
- Facility Assessments
  - Prioritized based on importance to water deliveries
  - Periodic reviews to reflect new knowledge
  - Goal is to have the ability to withstand a major earthquake
- Assessments are based on:
  - Most recent seismic codes and standards
  - Up-to-date, site-specific geotechnical information
  - Most up-to-date earthquake magnitude projections
- In addition Metropolitan considers seismic risk in all rehabilitation and replacement projects

Infrastructure Seismic Upgrades

- Three-step process
  - Assessing the overall seismic risk of the infrastructure
  - Prioritizing the deficient structures based on their risk
  - Mitigating identified vulnerabilities starting from the most critical structures



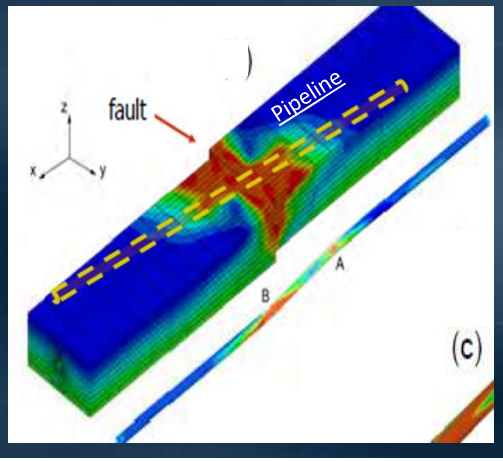
1. Comprehensive Assessment

- Primary seismic hazards to Metropolitan's infrastructure
  - Intense ground shaking (IGS)
  - Permanent ground displacement (PGD)
- Components of Infrastructure
  - Dams & reservoirs – IGS
  - Aboveground facilities – IGS & PGD
  - Underground structures - PGD
  - Lifelines (CRA & C&D) - PGD

Engineering

1. Assessment
2. Prioritization
3. Mitigation

Damage caused by ground shaking



Simulated pipe displacement cause by fault rupture

2. Risk-Based Prioritization

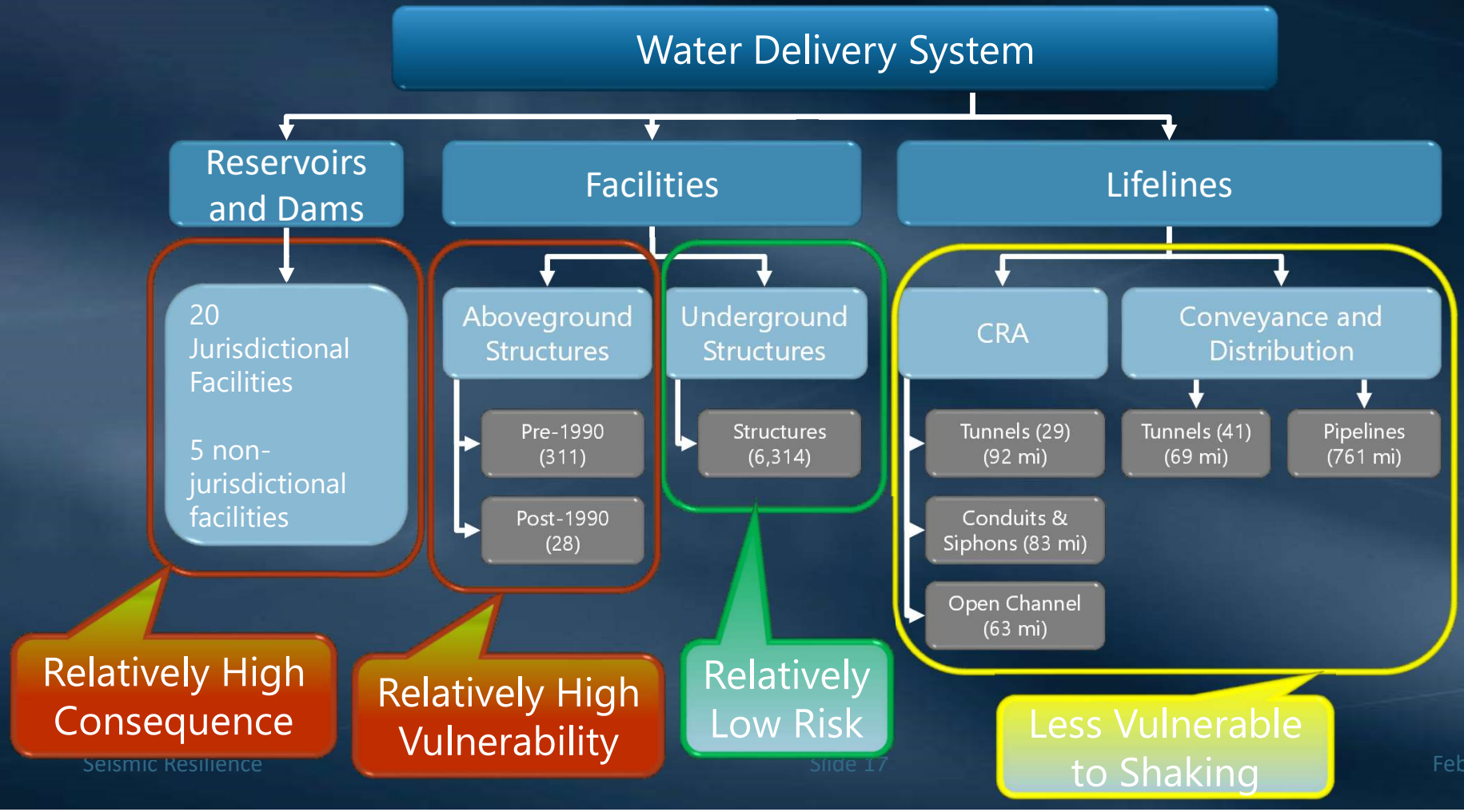
Engineering

1. Assessment
2. Prioritization
3. Mitigation

- Risk is the combination of likelihood of damage and its consequences
- Prioritization by risk level of each component

Component	Likelihood of Damage	Consequences
Aboveground facilities	Relative high	Medium
Underground structures	Relative low	Relatively low
Lifelines	Relatively low except under PGD	Medium
Dams & reservoirs	Relatively low	Relative high

Main Components of Water Delivery System



3. Effective Mitigation

- Develop component-specific mitigation strategies/measures
- Apply resilient tools including flexibility & redundancy
- Improve cost/benefit with multi-purpose projects
- Continue refining mitigation measures to take advantages of latest technologies

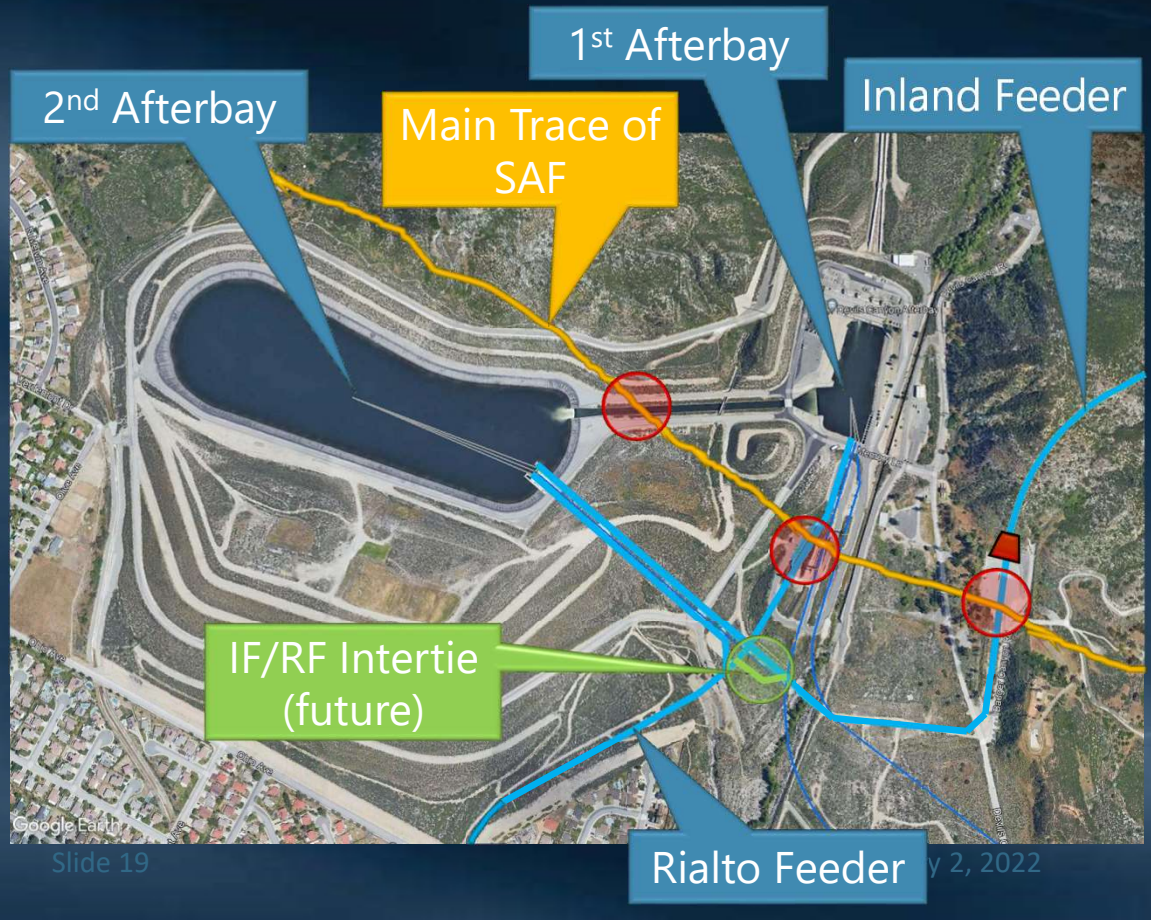
Engineering

1. Assessment
2. Prioritization
3. Mitigation

Example of Effective Mitigation

Devil Canyon Facility

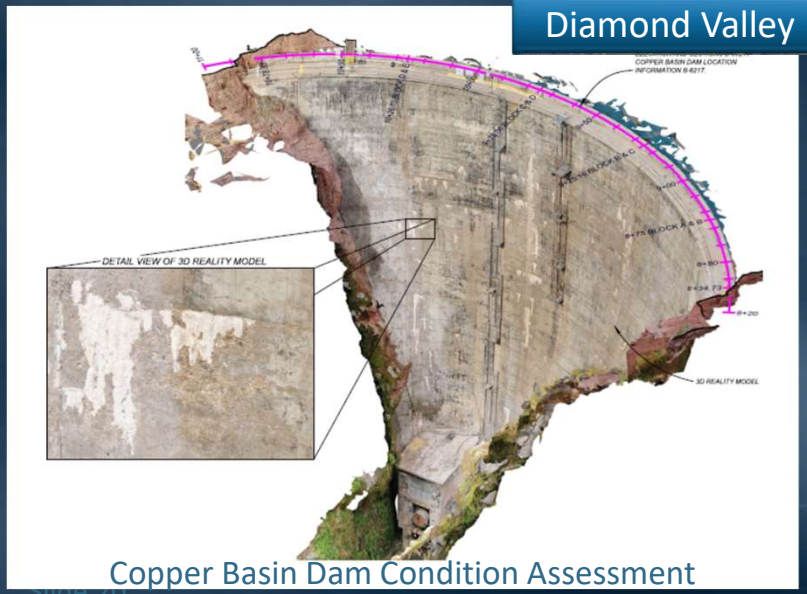
- Crossed by San Andreas Fault
  Mitigation measures
  - Design structures to meet state-of-the-practice seismic design standards
  - Create “fuses” in the system to isolate affected areas, protect crucial components and facilitate restoration
  - Prepare for post-event repair and restoration
  - Develop alternative supplies to further mitigate the risk



Status Update
1. Dams & Reservoirs

- Mitigation measures
  - Continuous monitoring by instrumentation
  - Regular inspections
  - Periodical review & assessment
  - As-needed upgrade
- Examples of ongoing projects
  - DVL monitoring system upgrade
  - Copper Basin Dam assessment
- Planned improvements
  - Real-time monitoring
  - Scenario-based risk assessment

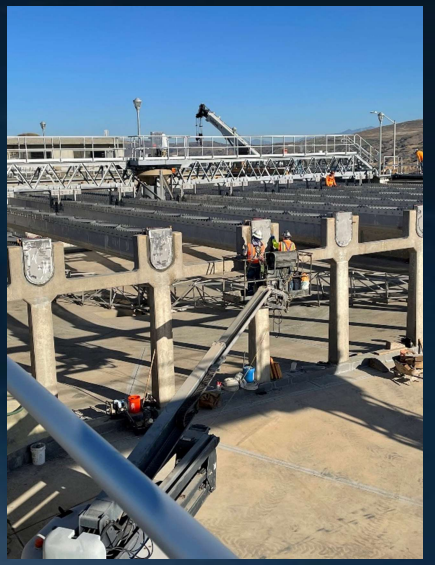
Diamond Valley Lake – West Dam



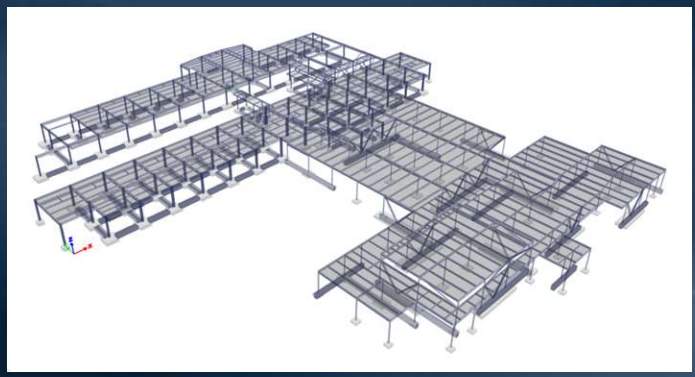
Copper Basin Dam Condition Assessment

Status Update
2. Aboveground Facilities

- Current status
  - Of 311 pre-1990 aboveground structures:
    - 195 are seismically sufficient
    - 75 have been upgraded
    - 41 under evaluation, design, or construction
  - Of 28 post-1990 aboveground structures
    - 10 have been evaluated and confirmed to be adequate
    - 1 has been upgrade
    - 5 under evaluation or design
    - 12 to be evaluated over the next 2 years
- Examples of ongoing projects
  - Construction: Diemer W. Basins & Filter Bldg.
  - Design: La Verne WQL, Weymouth Headhouse Bldg., Foothill PCS, etc.



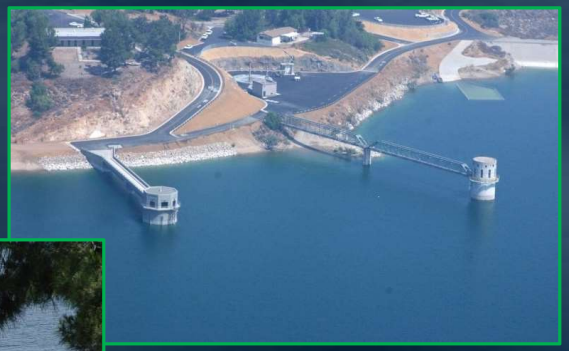
Diemer West Basins and Filter Building Rehabilitation Project



La Verne WQL

Above Ground Facilities Upgrade Examples

- Most Notable Upgrades:
  - CRA pumping plant buildings and penstocks
  - Lake Mathews outlet tower
  - Water treatment plant seismic upgrades



Diemer Plant Seismic Upgrades

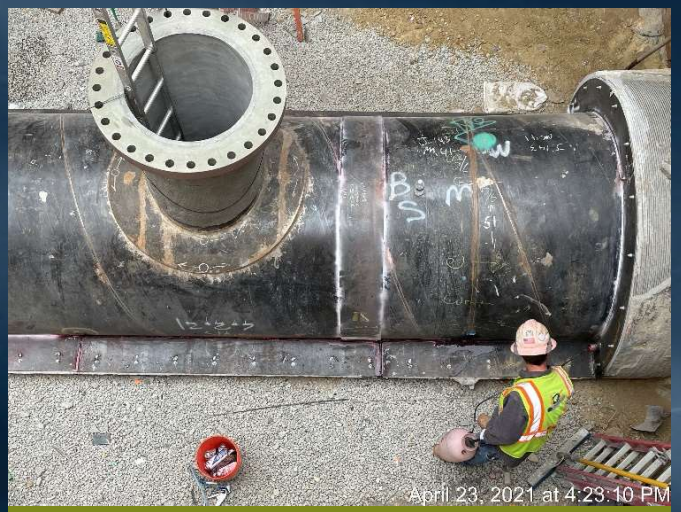
Completed

Underway

Status Update
3. Lifelines

- Mitigation strategies
  - Identify high-risk segments with large potential PGD
  - Incorporate seismic improvement into rehabilitation projects
  - Improve flexibility to enhance resilience
- Examples of ongoing projects
  - Casa Loma Siphon No. 1
  - PCCP Rehabilitation
  - DVL to Rialto Flexibility Improvement
- Planned tasks
  - Update Tunnel risk assessment
  - Update pipeline vulnerability assessment

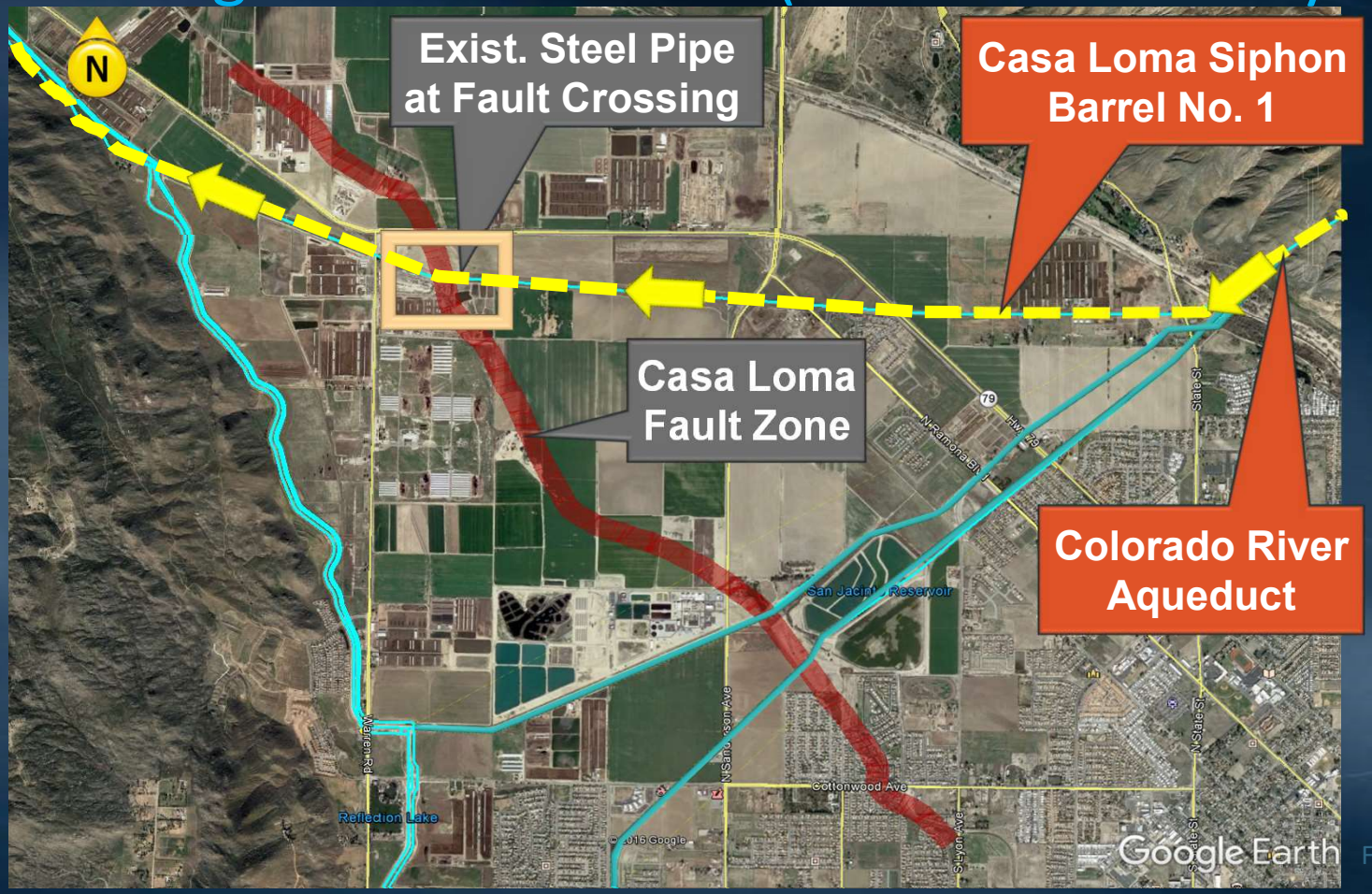
Casa Loma Siphon Improvement



PCCP Rehabilitation

Example: Casa Loma Siphon

Fault Crossing – Casa Loma Fault (San Jacinto Fault System)



Example: Casa Loma Siphon

Casa Loma Siphon No. 1 Fault Crossing Mitigation

Full Scale Joint Test

Earthquake-Resistant Pipes (104" Dia.)

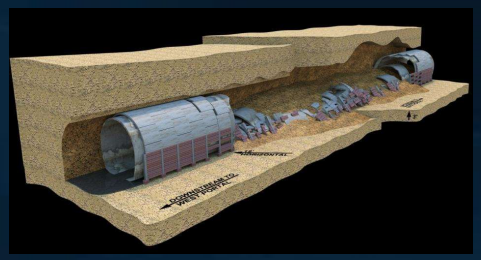
Existing 148" Dia. Steel Pipe

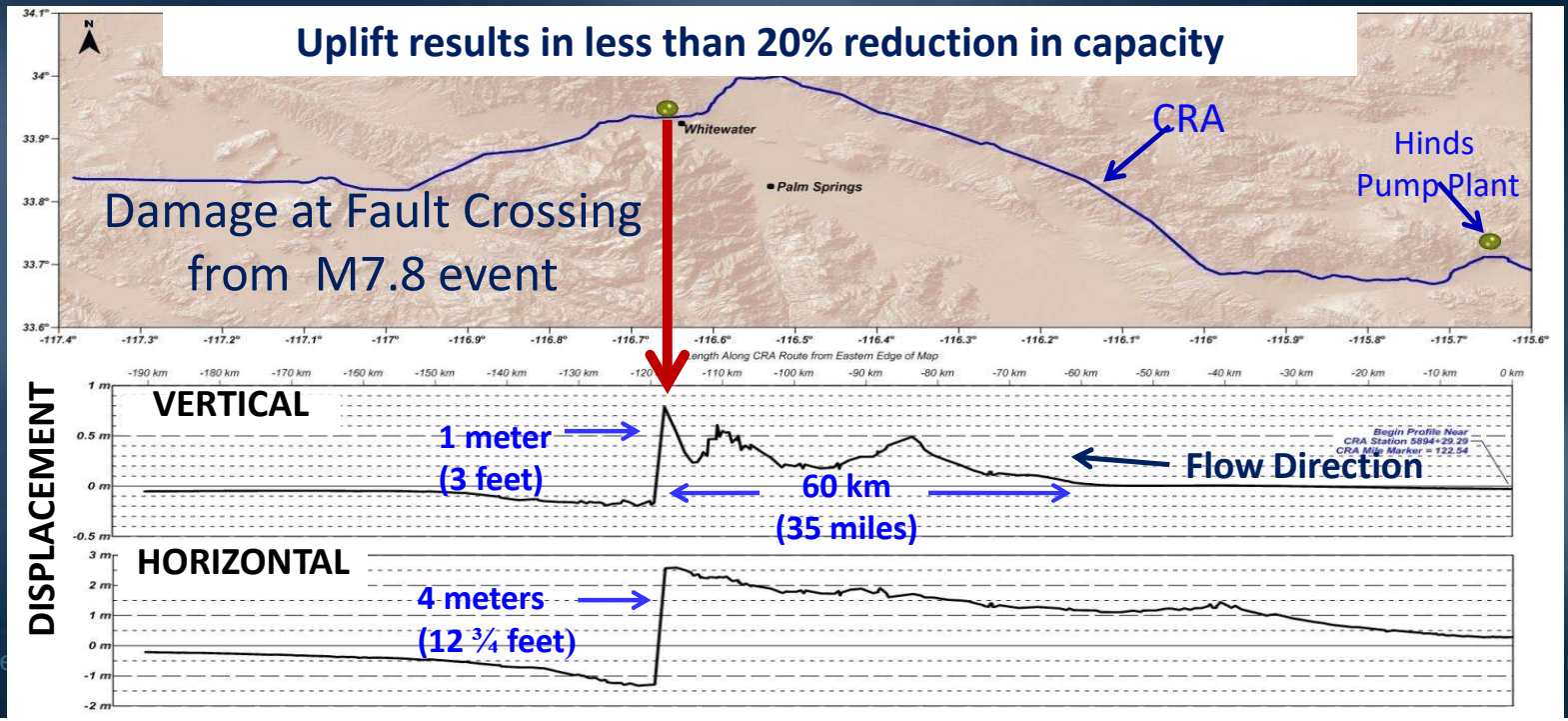
Earthquake Resistant Ductile Iron Pipe (ERDIP)

- Proprietary technology developed by Kubota Corp.
  - Accommodates large displacements & allows pipeline to maintain water containment, even as individual segments move

Example of Tunnel Risk Mitigation

- In Final Design:
  - Strengthening of the CRA's Whitewater Tunnel portal
  - Pre-event design of a bypass tunnel to expedite repairs
  - Stockpiling key materials to expedite repairs at the fault crossings





Status Update

4. Underground structures

- Current status
  - A comprehensive inventory (more than 6300 underground structure) has been created
  - In the process of categorizing them based on functions and seismic risk
- Examples of high-risk structures
  - Bifurcation structures
  - Vault structures in liquefaction zone
- Planned tasks
  - Conduct initial screening for high-risk structures
  - Develop mitigation measures for high-risk structures identified as seismically deficient

Bifurcation Structure

Vault Structure

Metropolitan's Multi-faceted Approach to Resilience

Operations & Emergency Response

- Metropolitan maintains its own manufacturing shop facilities to fabricate and repair equipment and roll steel pipe
- The capability of these facilities has recently been upgraded substantially in order to expedite urgent repairs
  - Has the ability to repair at least two large diameter pipe breaks simultaneously
- Maintain ability to repair at least two major pipeline failures or respond to two system disruptions simultaneously

Structural Supplies

Fabrication Equipment

Heavy Equipment

Operations & Emergency Response

- Emergency Response
  - Workshops and exercises are conducted regularly, including simulations of major seismic events
  - For example, in 2019, Metropolitan conducted 75 emergency response exercises, many of them with member agencies and other critical utility partners including:
    - SCE
    - CalOES
    - DWR
    - Other agencies throughout California

Metropolitan's Multi-faceted Approach to Resilience

Partnerships

- Seismic Resilience Water Supply Task Force
  - Joint task force with LADWP and DWR
- Goal
  - Enhance the resilience of imported water supplies

Partnerships

- This multi-agency collaboration seeks to
  - Understand the impacts of a major seismic event on the imported water supplies
  - Develop a coordinated emergency response and recovery plan
    - Discuss and develop earthquake response strategies
    - Expedite repairs of imported water supply infrastructure
  - Investigate and develop mitigation options

Duration of an Outage

- The Task Force contemplated the potential damage to each agency's aqueducts from a Magnitude 7.8 earthquake on the southern San Andreas Fault system
  - DWR estimated
    - It could take 12 to 24 months to restore service to the California Aqueduct East Branch
    - 6 to 12 months to restore service to the West Branch under this scenario
  - Metropolitan estimated
    - It could take up to 6 months to restore service to the CRA

DWR Seismic Resilience Efforts for the State Water Project

- The DWR has in place a Seismic Resilience Strategy
  - Tabletop and Functional Emergency Response Exercises
  - Workshops
  - Inspections and Assessments
  - Upgrade Projects
  - Collaborations

- DWR's seismic upgrade projects currently include:
  - Perris Dam Remediation
  - Outlet Towers Seismic Improvements (e.g. Castaic)
  - Sisk Dam Remediation
  - Delta Seismic Study
  - Bridge Seismic Retrofits
  - Seismic Monitoring System Upgrades
  - San Bernardino Intake Tunnel Gate Seismic Triggers
  - Pyramid Dam Modernization Program
  - Lower Quail Canal Gas Pipeline Seismic Retrofit


THE METROPOLITAN WATER DISTRICT OF
SOUTHERN CALIFORNIA
1928