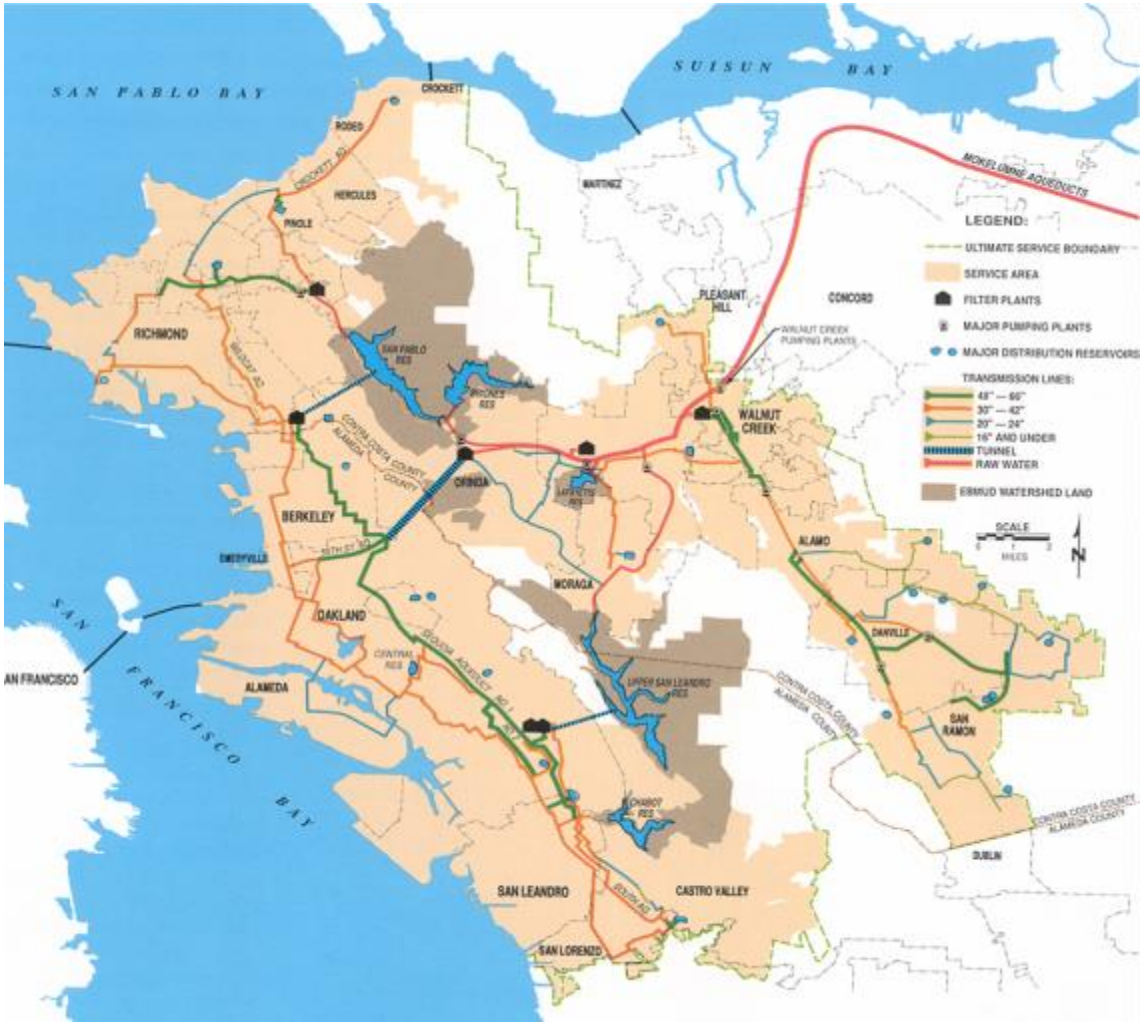
EAST BAY MUNICIPAL UTILITY DISTRICT

SPUR HayWired Forum

Preparing At-Risk Communities and More for the Next Earthquake

November 1, 2018

Overview of EBMUD's Water System



Raw Water System

- 7 reservoirs
- Aqueducts

Treatment System

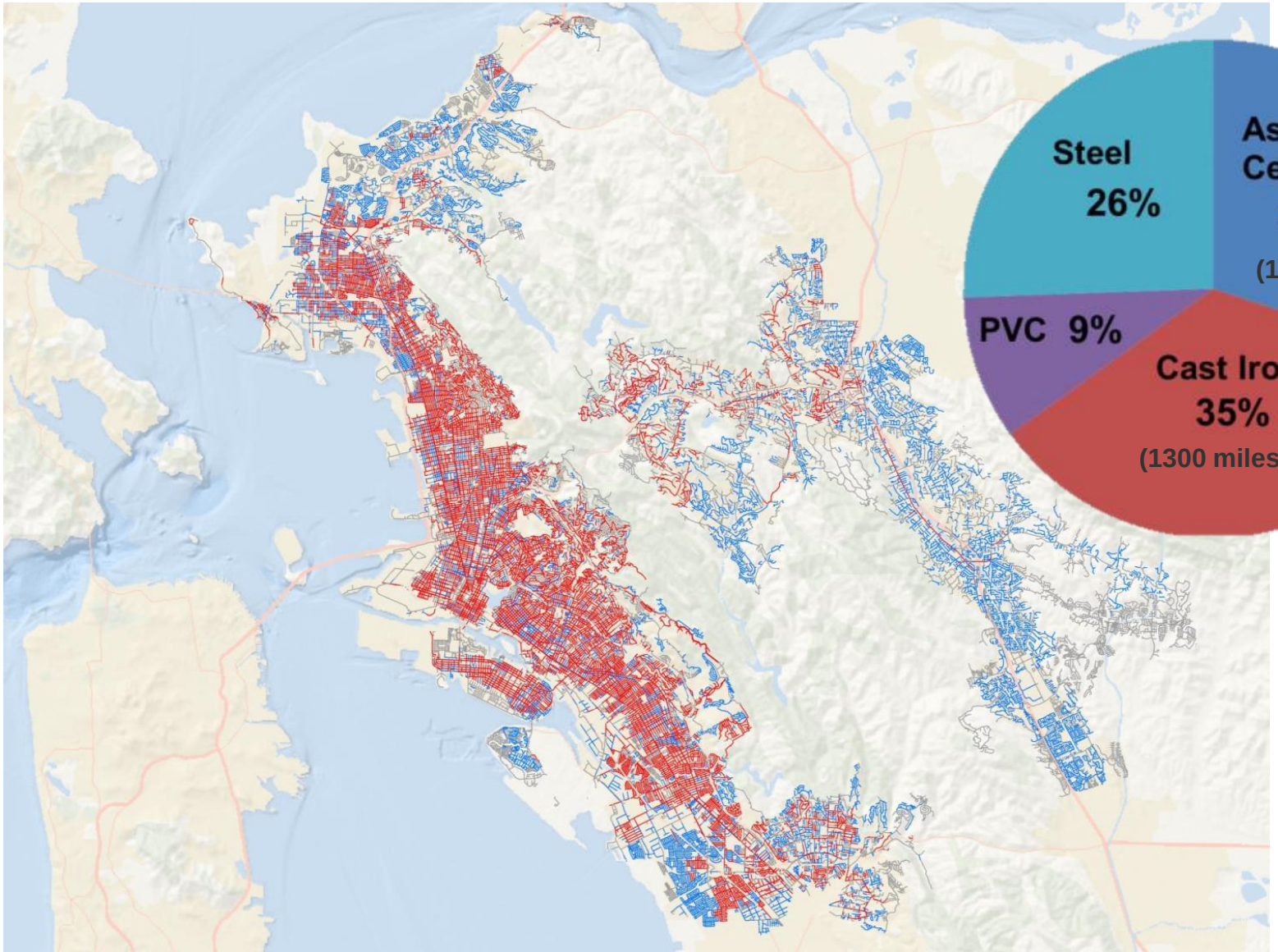
- 3 inline WTPs
- 3 conventional WTPs

Distribution System

- 4,200 miles of pipeline
- 122 pressure zones
- 164 reservoirs
- 135 pumping plants
- 100 regulators/RCS

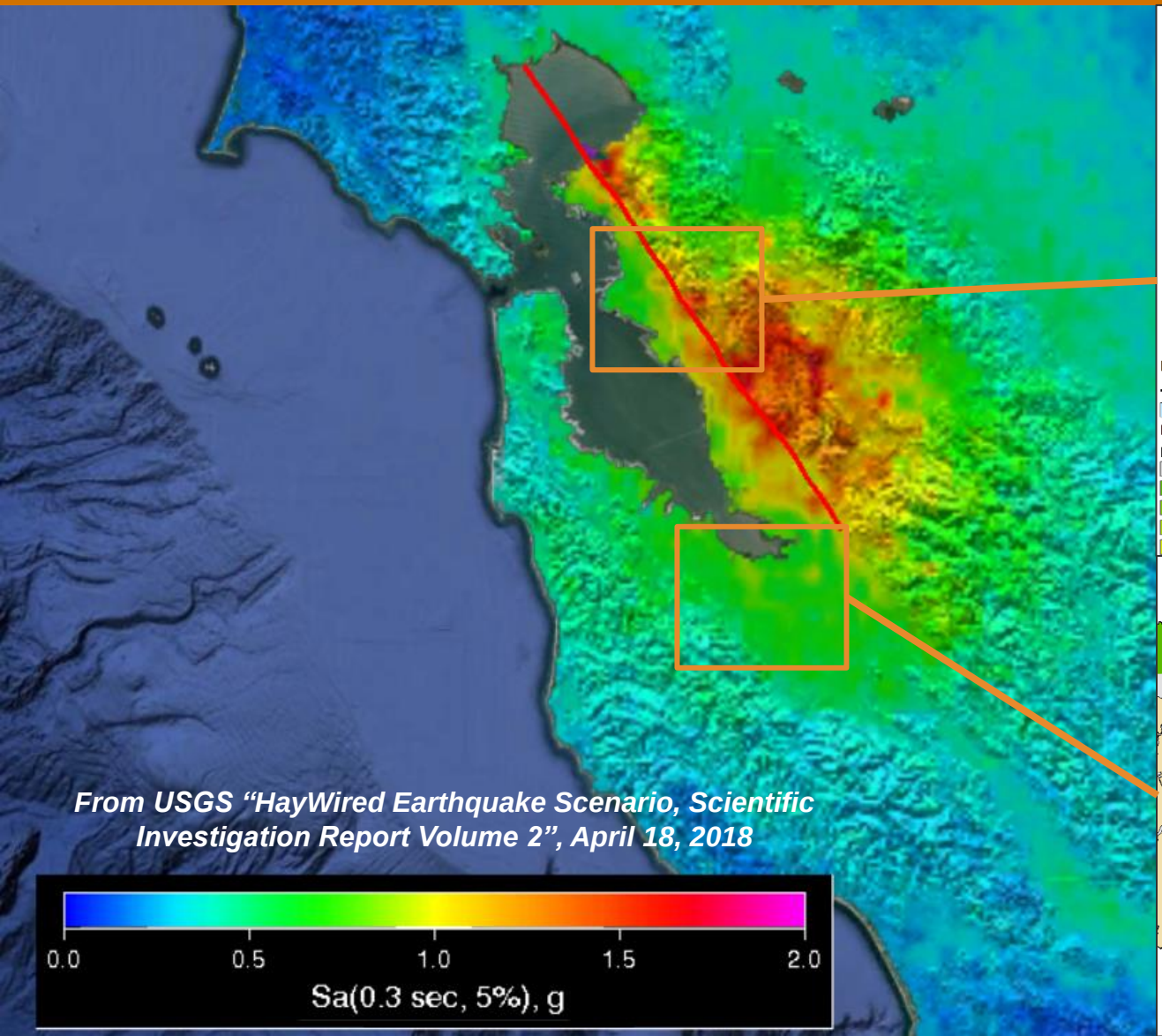
EBMUD Distribution System

Pipeline Inventory

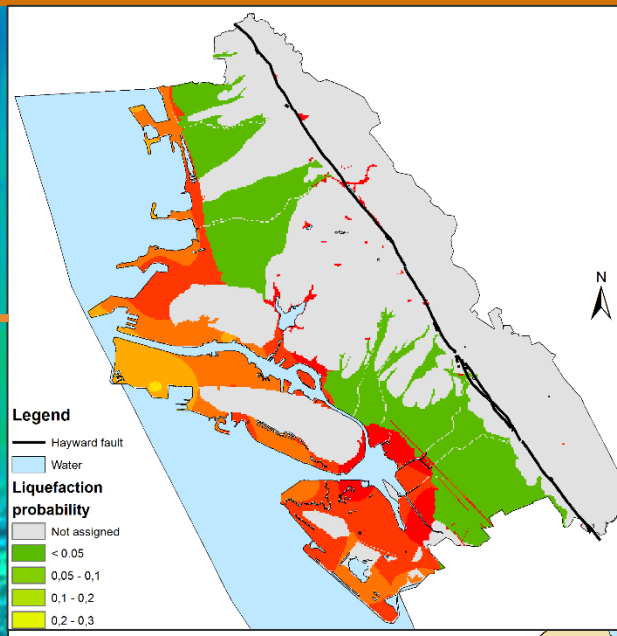


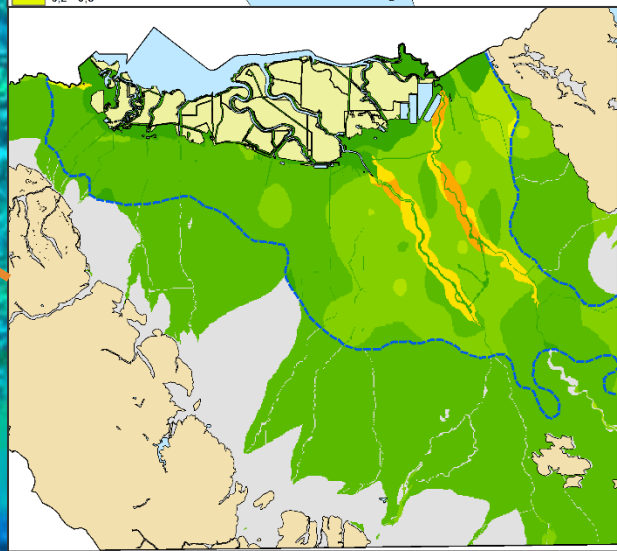
Univ Colo Water Network Resilience model (CUWNet) for USGS M7.0 HayWired Scenario

EBMUD

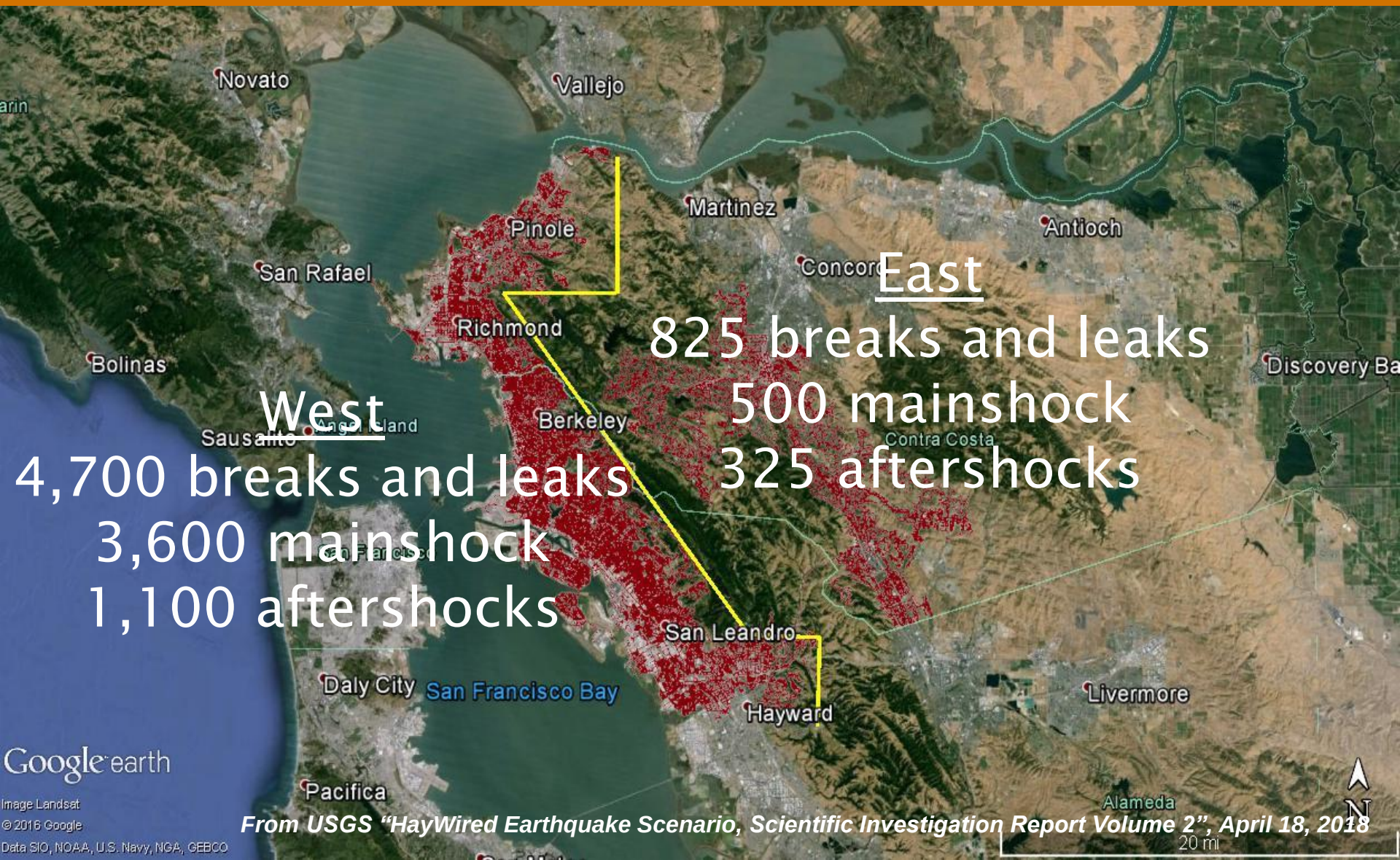


From USGS "HayWired Earthquake Scenario, Scientific Investigation Report Volume 2", April 18, 2018





Damage predictions: pipeline distribution system



East

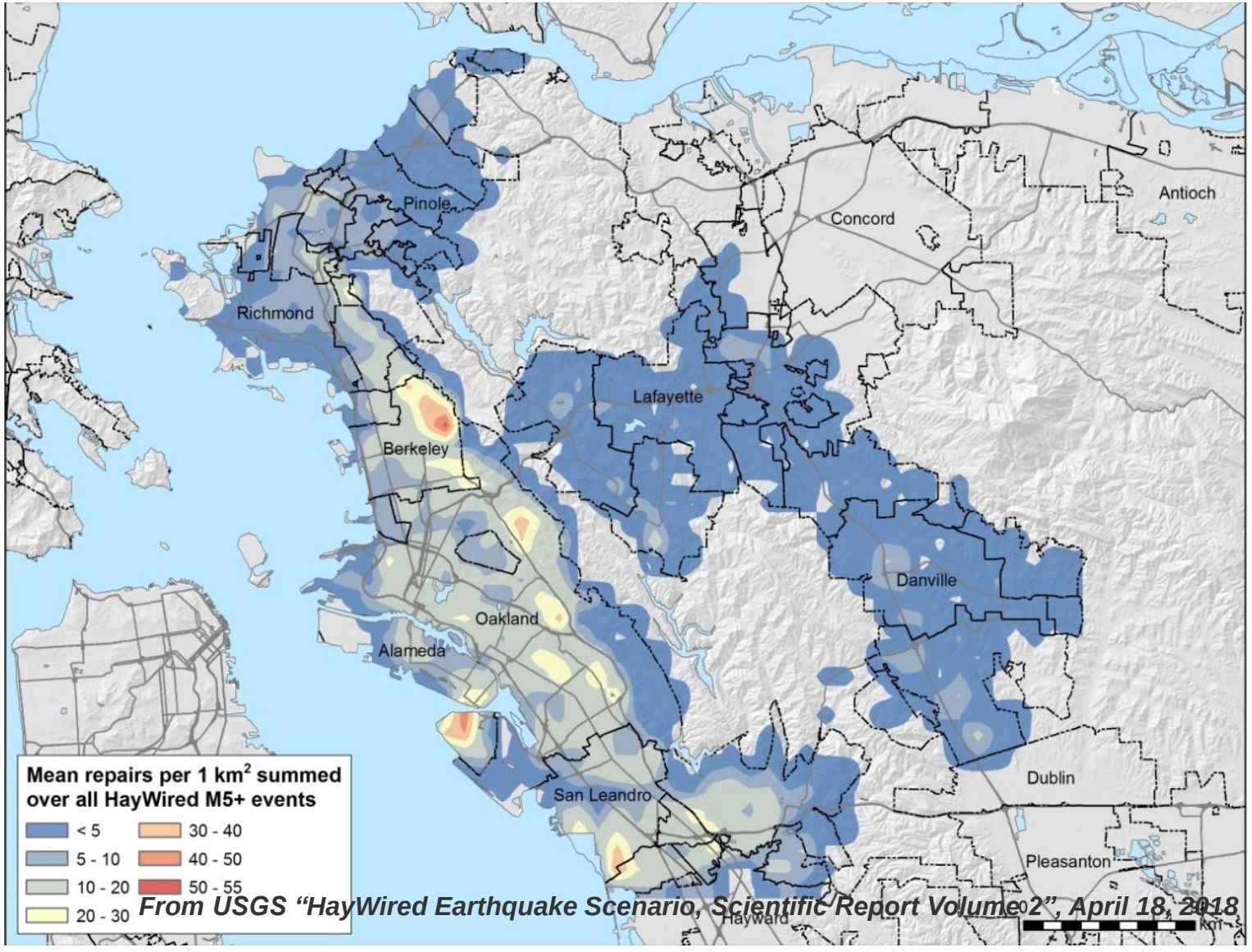
825 breaks and leaks
500 mainshock
325 aftershocks

West

4,700 breaks and leaks
3,600 mainshock
1,100 aftershocks

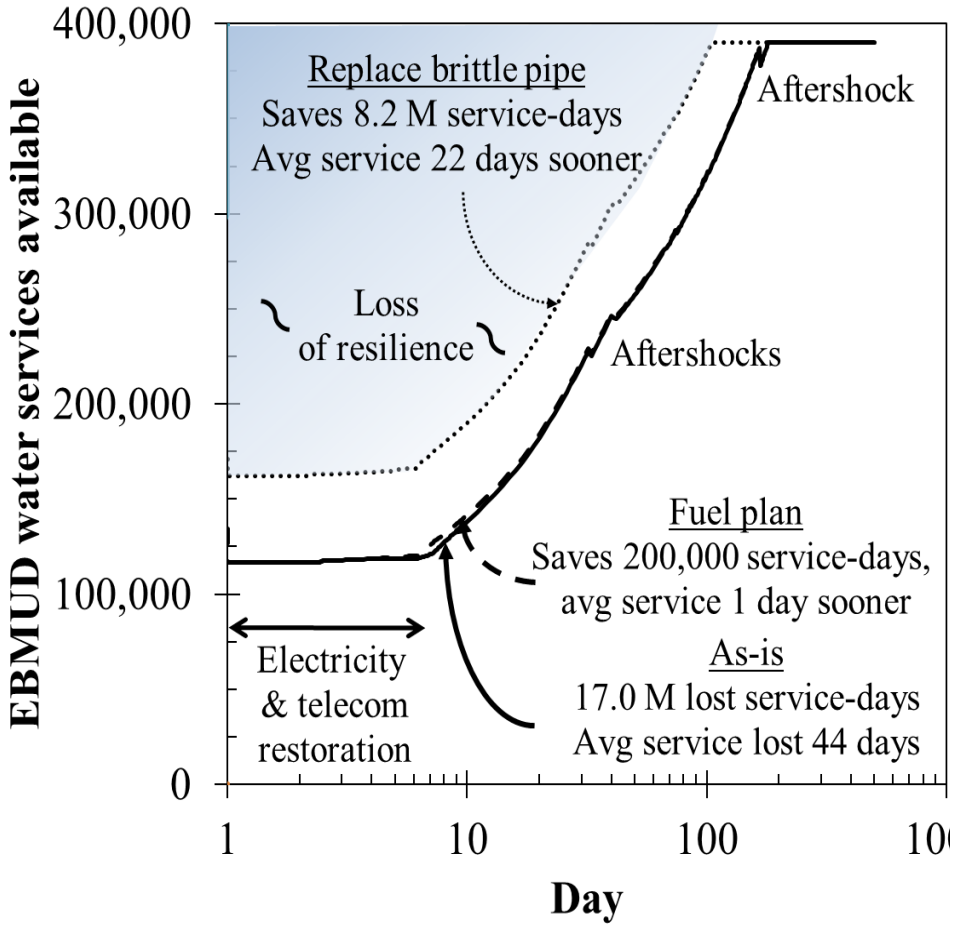
From USGS "HayWired Earthquake Scenario, Scientific Investigation Report Volume 2", April 18, 2018

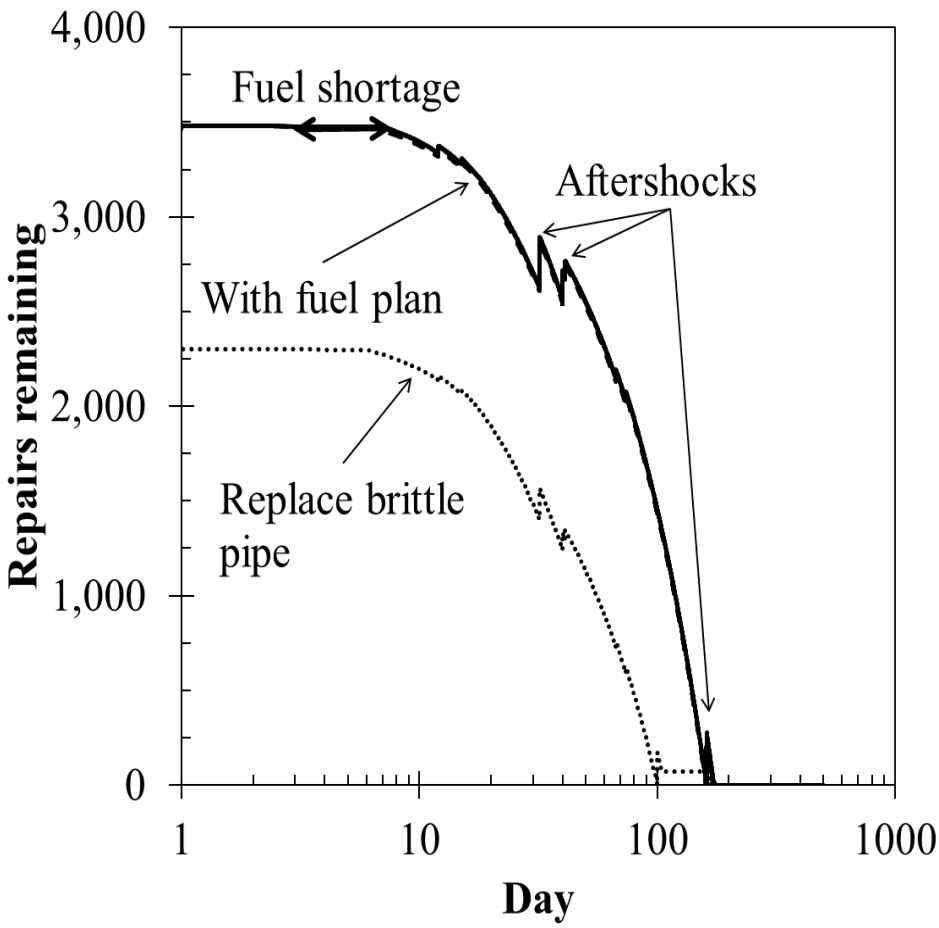
Predicted damage from main-shock and aftershocks



From USGS "HayWired Earthquake Scenario, Scientific Report Volume 2", April 18, 2018

HayWired Response, Restoration & Repairs





From USGS "HayWired Earthquake Scenario, Scientific Investigation Report Volume 2", April 18, 2018

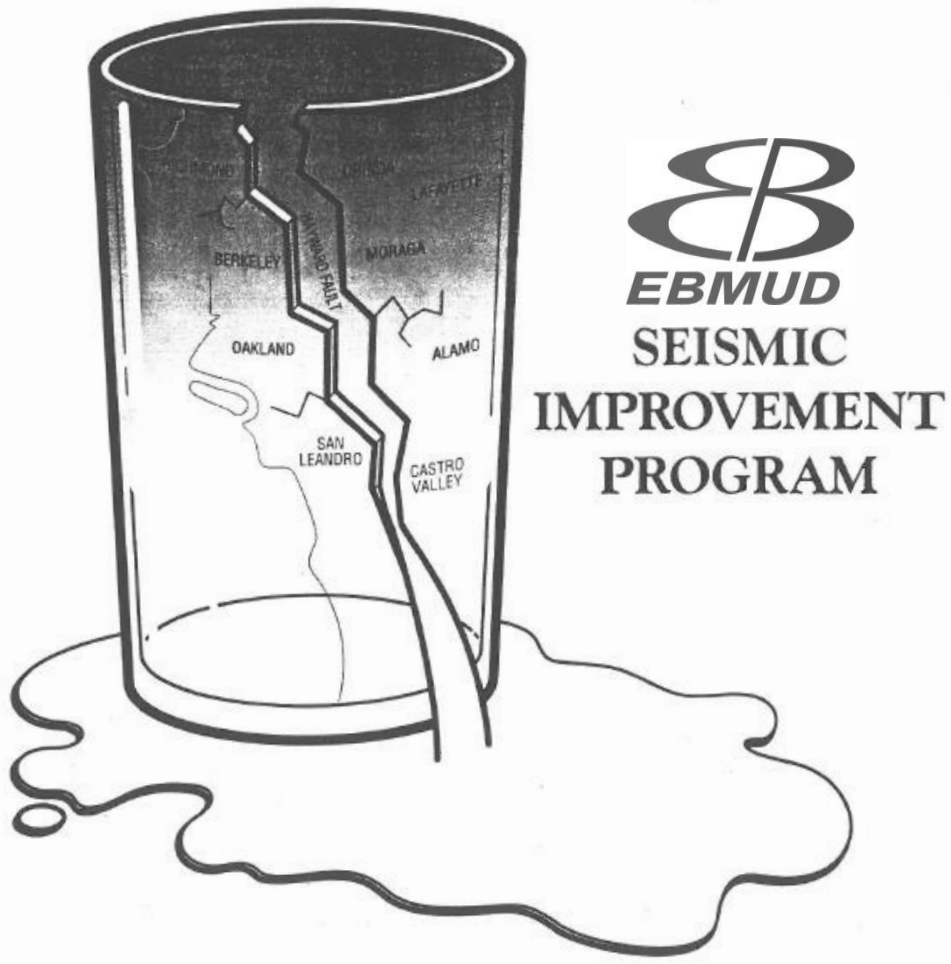
Post-Earthquake Water System Restoration Priorities

Priority		Strategy or Plan
1	Maintain System Pressure	Keep water flowing at a positive pressure to preserve as much access to clean drinking water as possible.
2	Address Consumption Needs for Drinking Water and Firefighting	Focus on providing service to as many critical customers and fire hydrants as possible.
3	Reserve Water Storage in System	Automatically actuated valves have already been installed to preserve some water in storage while still letting some water flow to meet immediate needs.
4	Isolate Damaged Areas	Isolate severely damaged sections of pipeline, to maintain system pressure and reduce water loss after an earthquake event.
5	Address Essential Needs	To maintain operations in the aftermath of an emergency, EBMUD will rely on several resources that have been acquired beforehand.

Highlights of EBMUD Programs & Initiatives to Improve Resiliency

- EBMUD's Seismic Improvement Program
- EBMUD's Pipeline Replacement Programs
  - Large Diameter Pipelines
  - Pipeline Rebuild
- Initiatives and studies to enhance reliability and resilience of EBMUD's water system:
  - Use of seismic resilient pipelines
  - Efforts to create a seismic resilient network of pipes

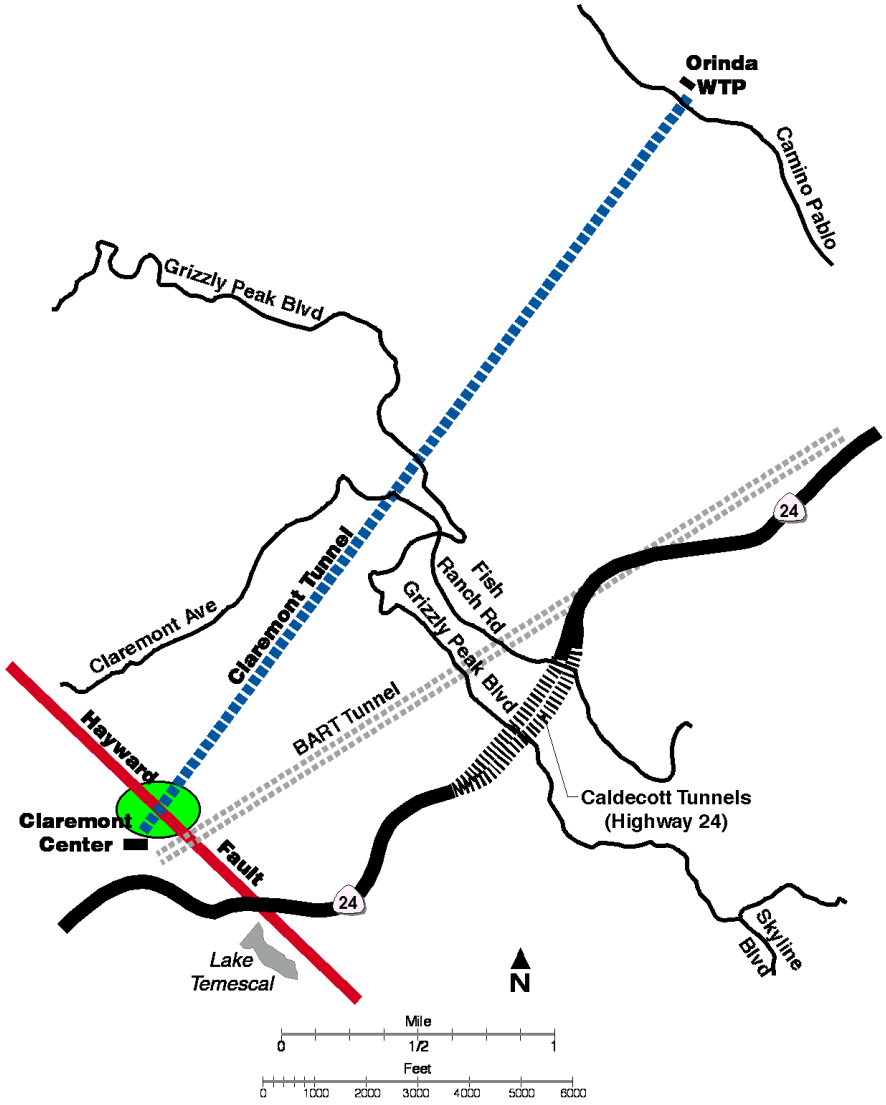
Programs to Improve Resiliency
SIP: 1995 – 2005

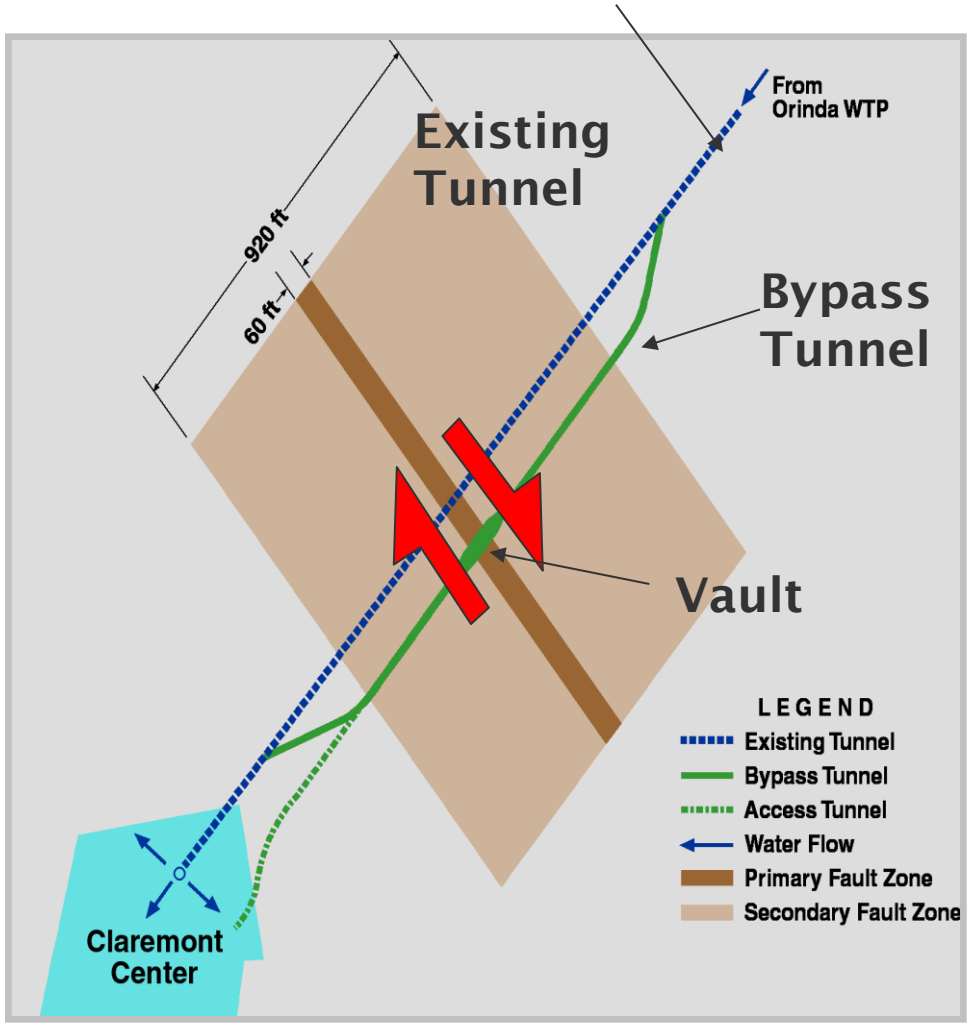


Program Scope – In 1995 Dollars ($)

- Storage Reservoirs
  - ***$66.5M***
- Pumping Plants
  - ***$4.9M***
- *Claremont Tunnel Improvements*
  - ***$24.5M***
- *Southern Loop Installation*
  - ***$30.6M***
- *Fault Crossing Improvements*
  - ***$49.5M***
- Buildings/Equipment Anchorages
  - ***$8.5M***
- Water Treatment Plants
  - ***$3.8M***

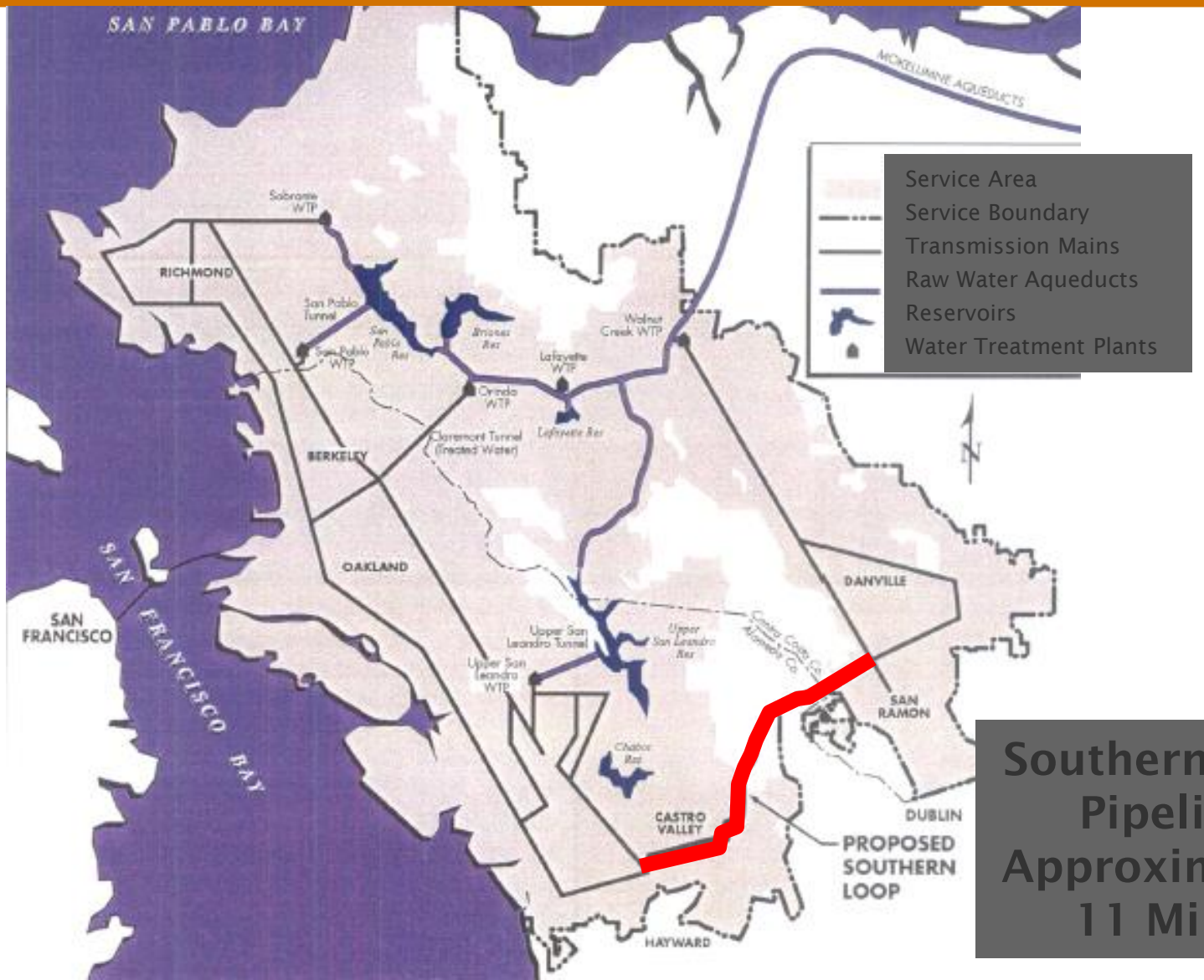
SIP Highlights: Claremont Tunnel Improvements





Total Offset = 8.5 feet horizontal

SIP Highlights: Southern Loop Pipeline



Southern Loop Pipeline Approximately 11 Miles

SIP Highlights: Fault Crossing Improvements

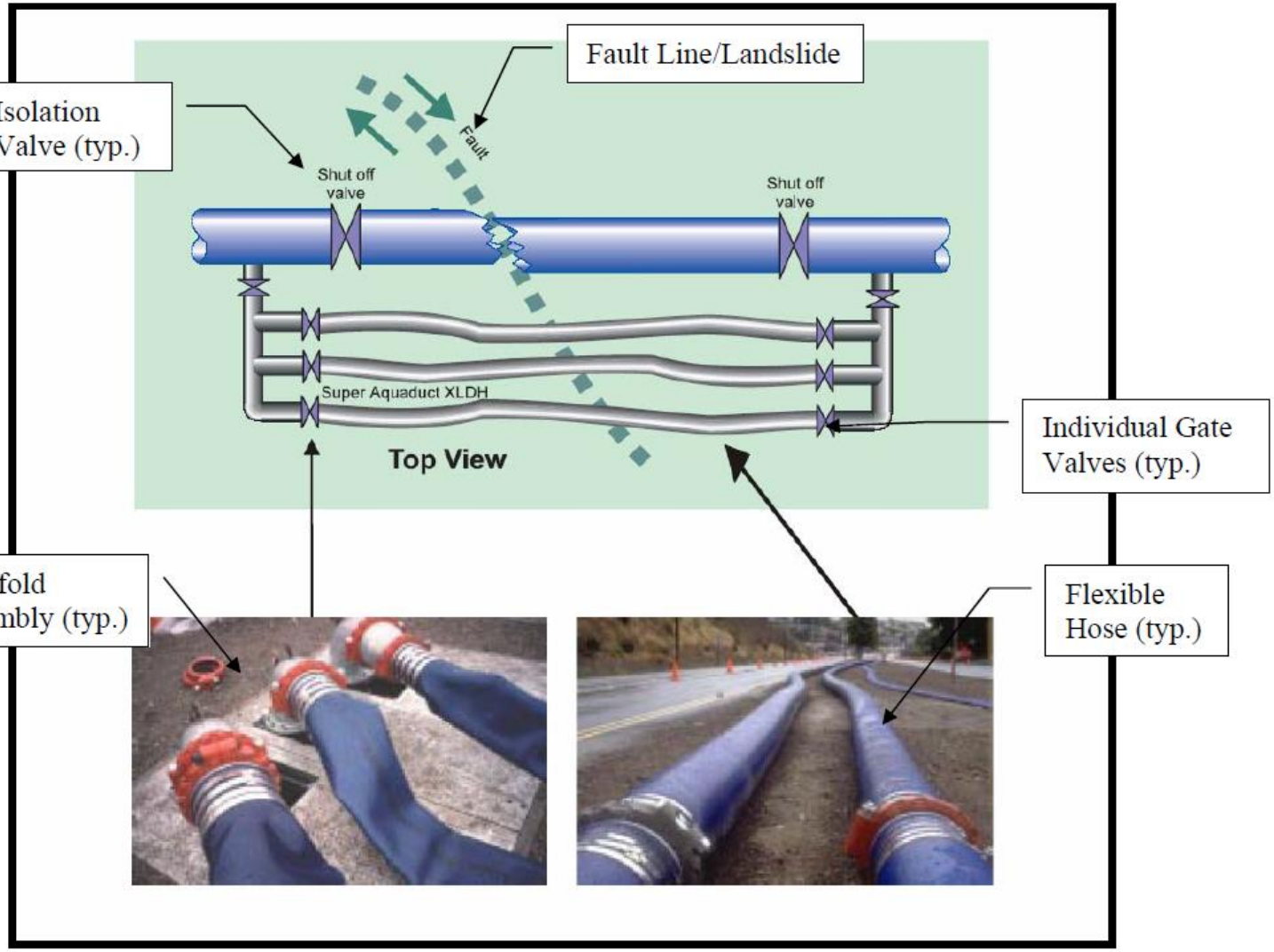
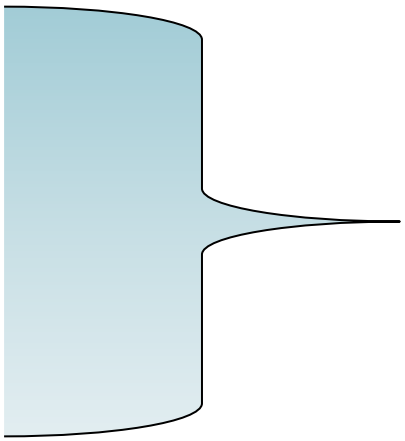
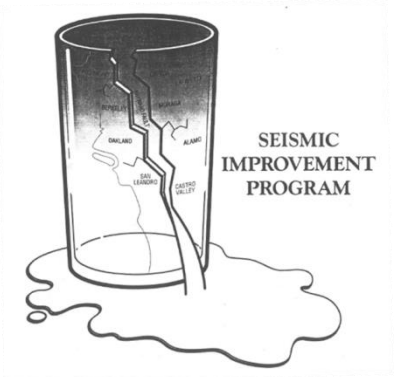


Figure 2-1. A typical Emergency Bypass System Assembly

Tools to Further Enhance Reliability, Robustness & Resilience in a Water System

1. Enhance component reliability, particularly where reparability is poor
2. Provide redundancy where we don't have it (e.g., Transmission Mains, Major Facilities)
3. Valve Spacing in Transmission Mains
4. Valve Spacing in Distribution Mains
5. Resilient Distribution Grid - Coarseness





$200M invested 1995-2005:

- Hardened dozens of major facilities
- Added a key transmission pipe for redundancy

Highlights of *Post-SIP* Mitigation Programs: *LDP Projects*

Completed Pipeline Replacements

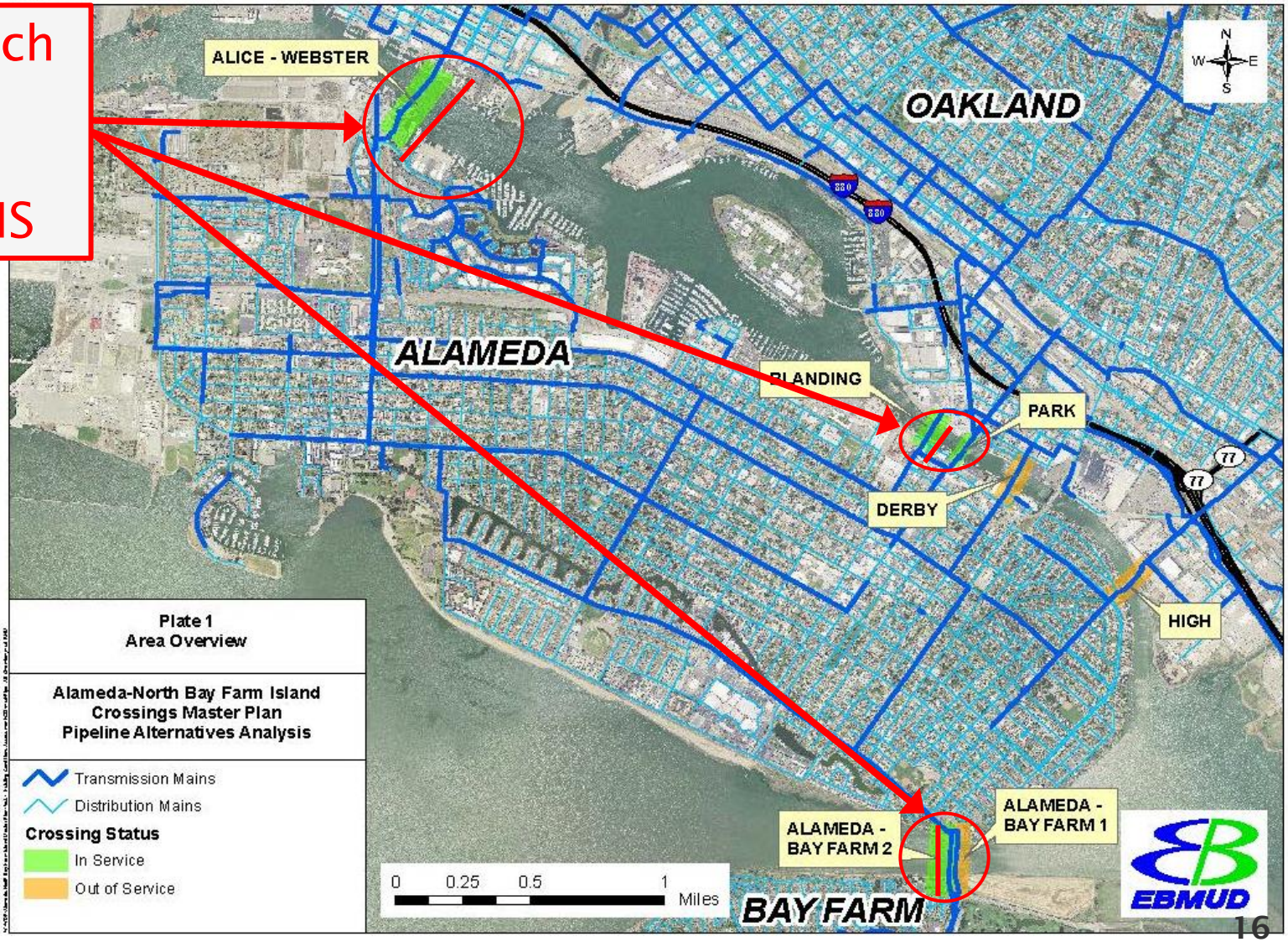
- Lincoln Avenue Pipeline, Alameda
- Dingee Pipeline, Oakland
- Claremont Center, Oakland

Future Pipeline Replacements FY18-22

- MacArthur-Davenport, Oakland *(in progress)*
- Alameda Estuary Crossing, Oakland and Alameda
- Summit Pressure Zone Transmission, Berkeley
- Grand Ave, Oakland
- Wildcat Aqueduct, Berkeley *(parallel transmission line)*
- International Blvd, Oakland
- Judy Lane, Lafayette

Large Diameter Pipeline Replacement Program: Alameda Crossings

NEW 24-inch Diameter CROSSING LOCATIONS



Alameda Crossing No. 1

- Install 1,780 feet of 24-inch HDD pipeline under estuary
- Install 5,000 feet of connecting 24-inch pipeline on each side in Oakland and Alameda
- Total cost $15M
- EIR complete
- Design underway

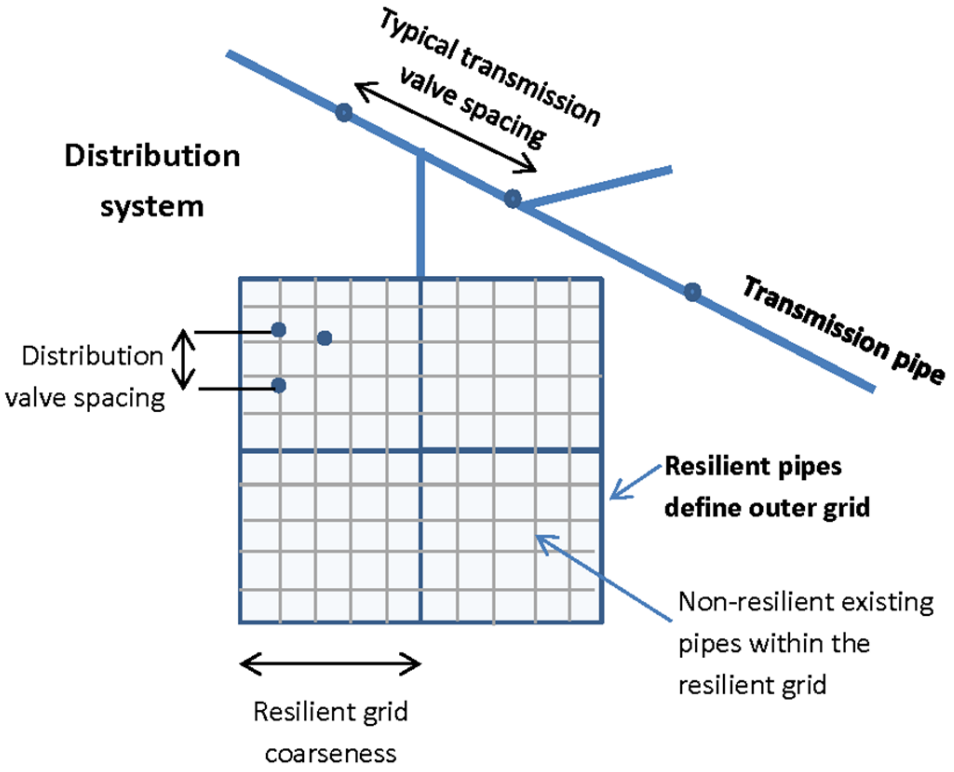
Highlights of *Post-SIP* Mitigation Programs: *Pipeline Rebuild*

Challenge: *Leverage EBMUD's Pipeline Rebuild Program to Incrementally Strengthen Reliability, Robustness, and Resilience*

- EBMUD ramping up replacement rate
- Piloting innovative methods to achieve lower costs, higher reliability
- Golden opportunity to further improve our:
  - Reliability
  - Robustness
  - Resilience

Current & Future Work to Enhance Reliability, Robustness & Resilience in a Water System

1. Enhance component reliability, particularly where reparability is poor
2. Provide redundancy where we don't have it (e.g., Transmission Mains, Major Facilities)
3. ***Valve Spacing in Transmission Mains***
4. ***Valve Spacing in Distribution Mains***
5. ***Resilient Distribution Grid - Coarseness***



Resilient Network Includes Reliable Backbone & Critical Pipelines

EBMUD

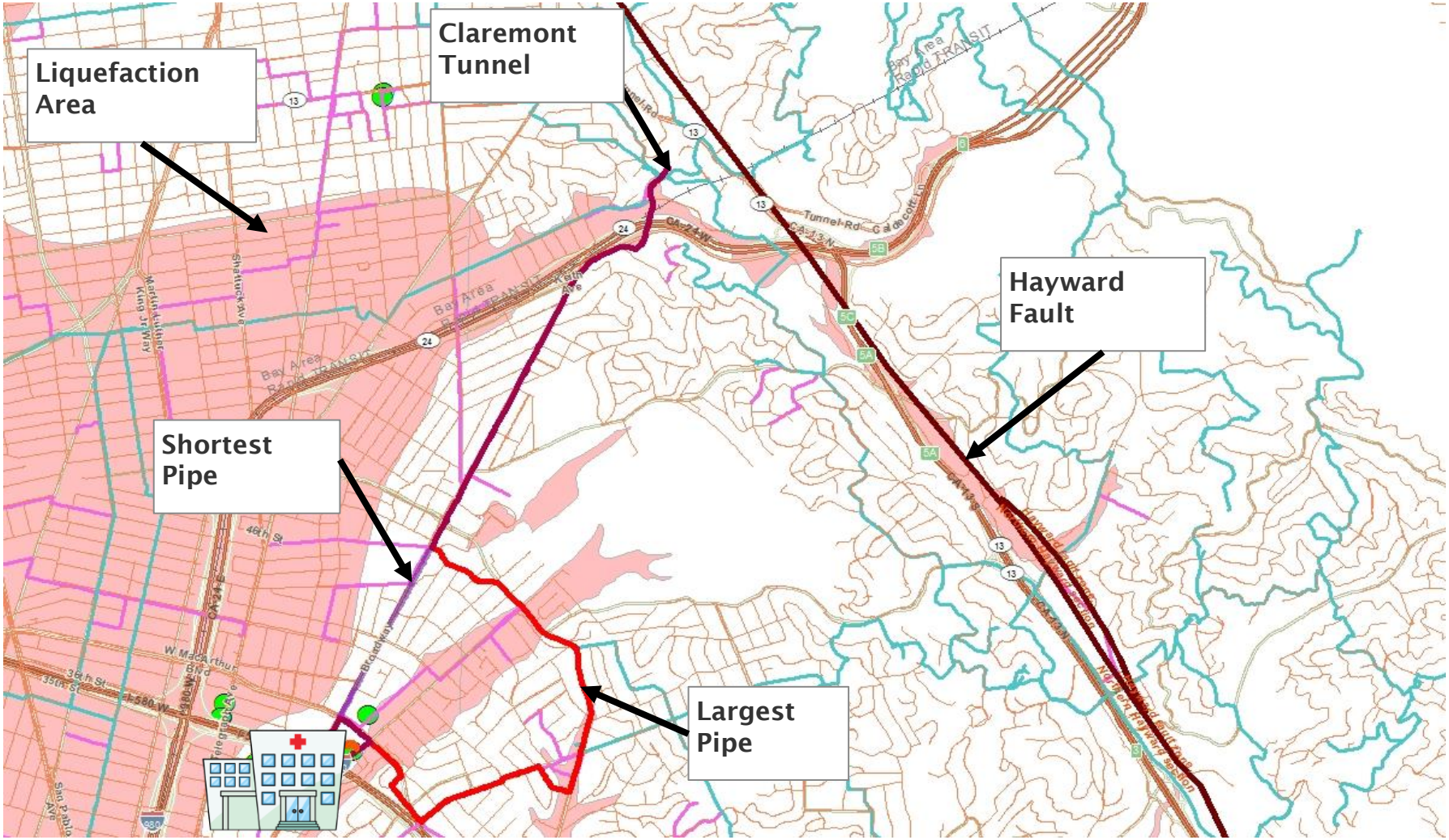
Backbone pipelines:

- Generally large, necessary to maintain storage in system

Critical pipelines:

- Feed health services, schools, jails/detention centers, EOTs, oil refineries, regional communication facilities, biotech firms

Resilient Network Alignment Considerations



Enhancing Component Reliability for Geohazards

48-inch flexible expansion joint construction
on 48-inch transmission pipeline
at Fontaine Street, Oakland

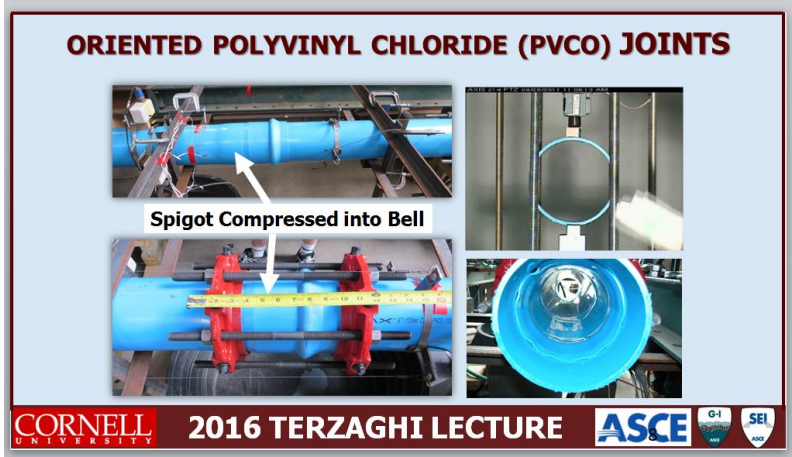
48-inch flexible expansion joint construction on
60-inch transmission pipeline at El Portal Drive, San Pablo

18-inch flexible expansion joint
with ball marker on connecting ML&PCS pipe at
Keith Avenue / Euclid Ave, Berkeley

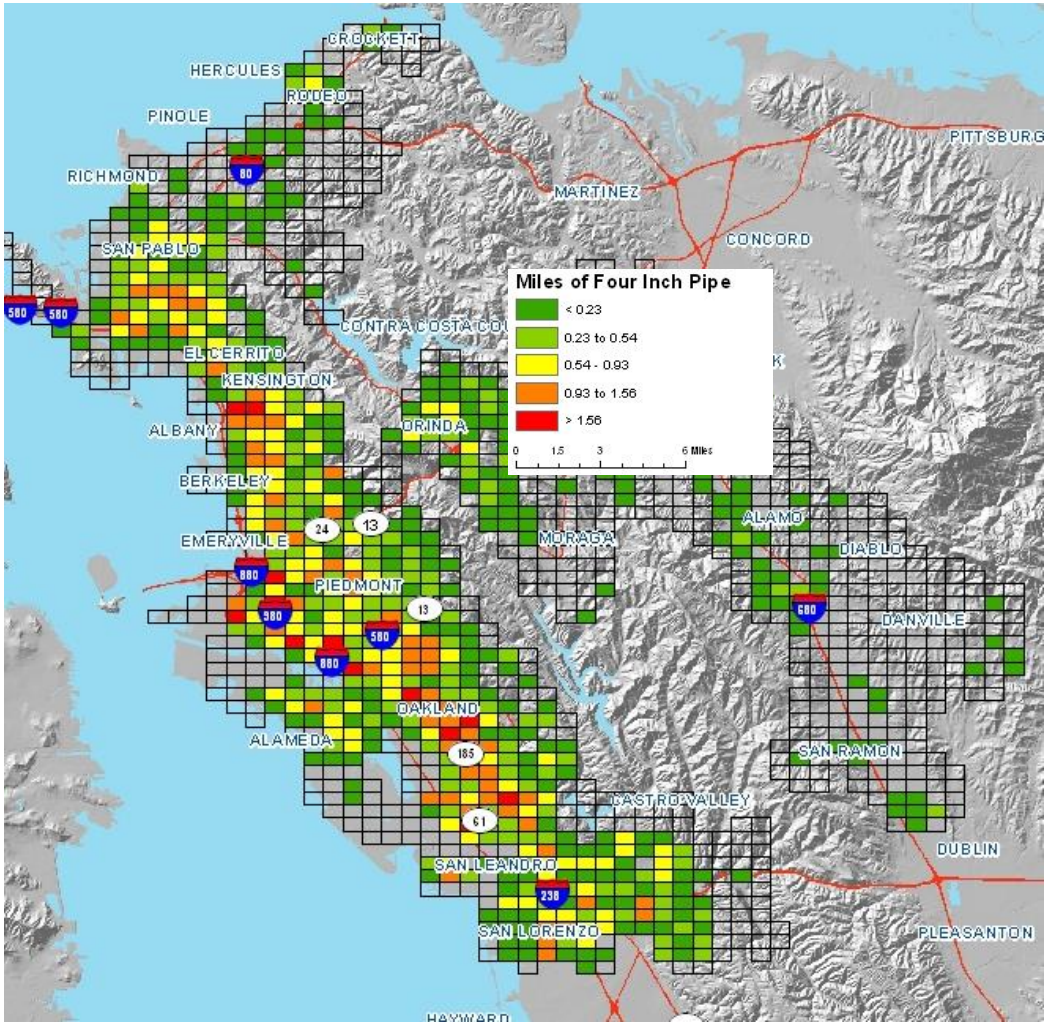
8-inch HDPE pipeline butt fusion at El Portal Drive, San Pablo

Enhancing Component Reliability: Seismic Testing Laboratory

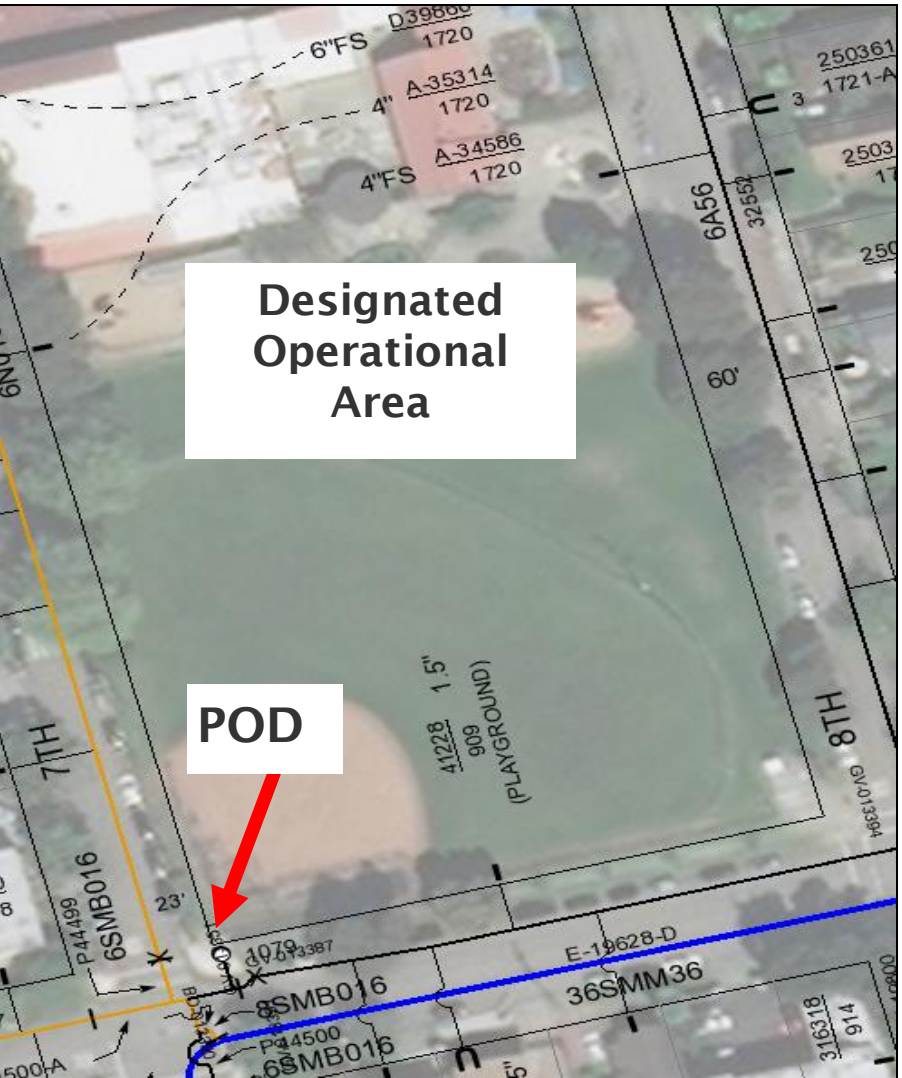
EBMUD

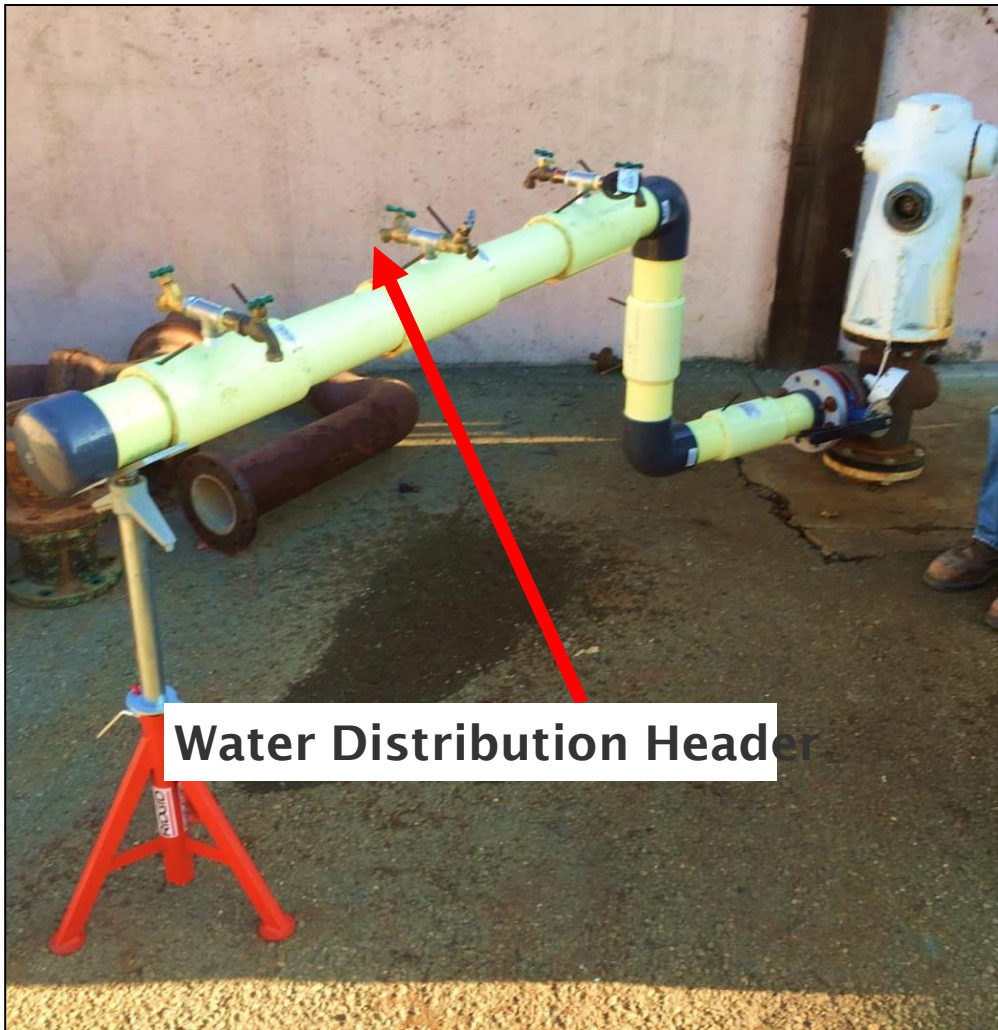


Example: Include social aspects when targeting pipe replacements



Enhancing Social Resilience

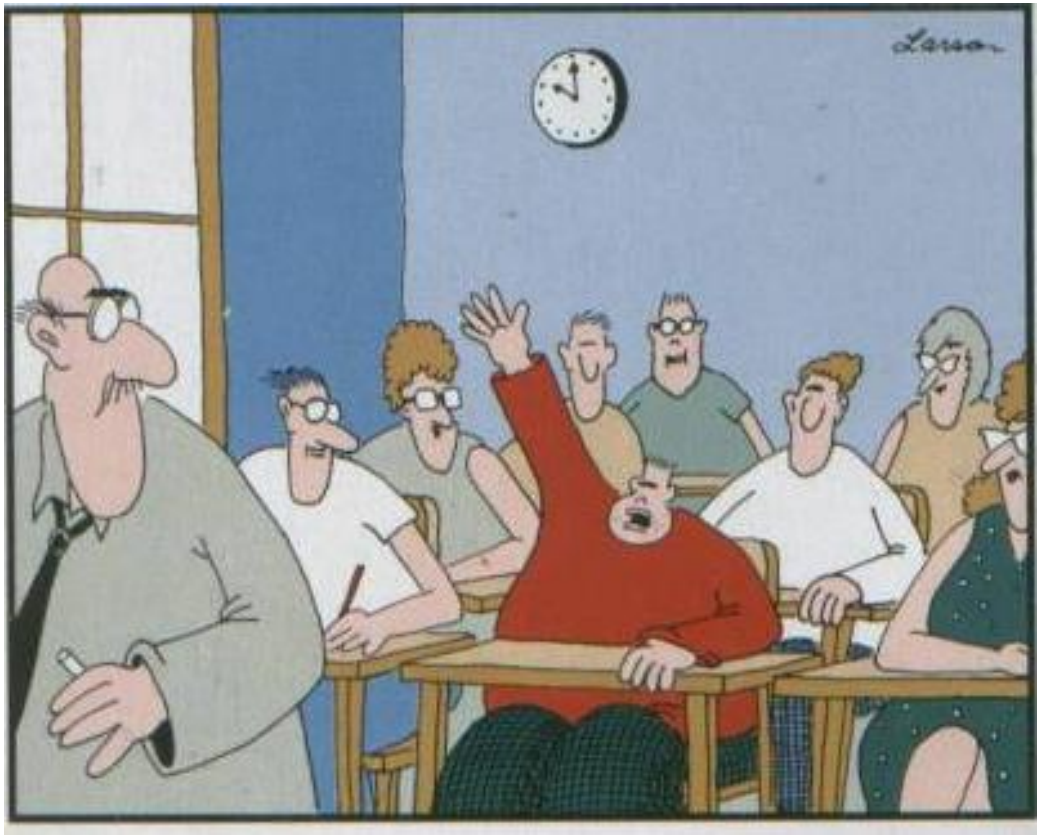




Summary: Next Steps to Advance
Reliability, Robustness, and Resilience

1. Further develop robust planning and resilient network concepts:
   - Mapping and consideration of geo-hazards
   - Planning/design criteria such as grid coarseness, valve spacing, pipeline material selection
   - Always consider role of judgments and bias
2. Continue to promote social resilience
   - Continued emergency preparedness & response
   - Consider social impacts for R&R priorities
   - Public information
3. Continue to leverage existing R&R programs to increase system resilience vs just component reliability

Questions?



Serge Terentieff