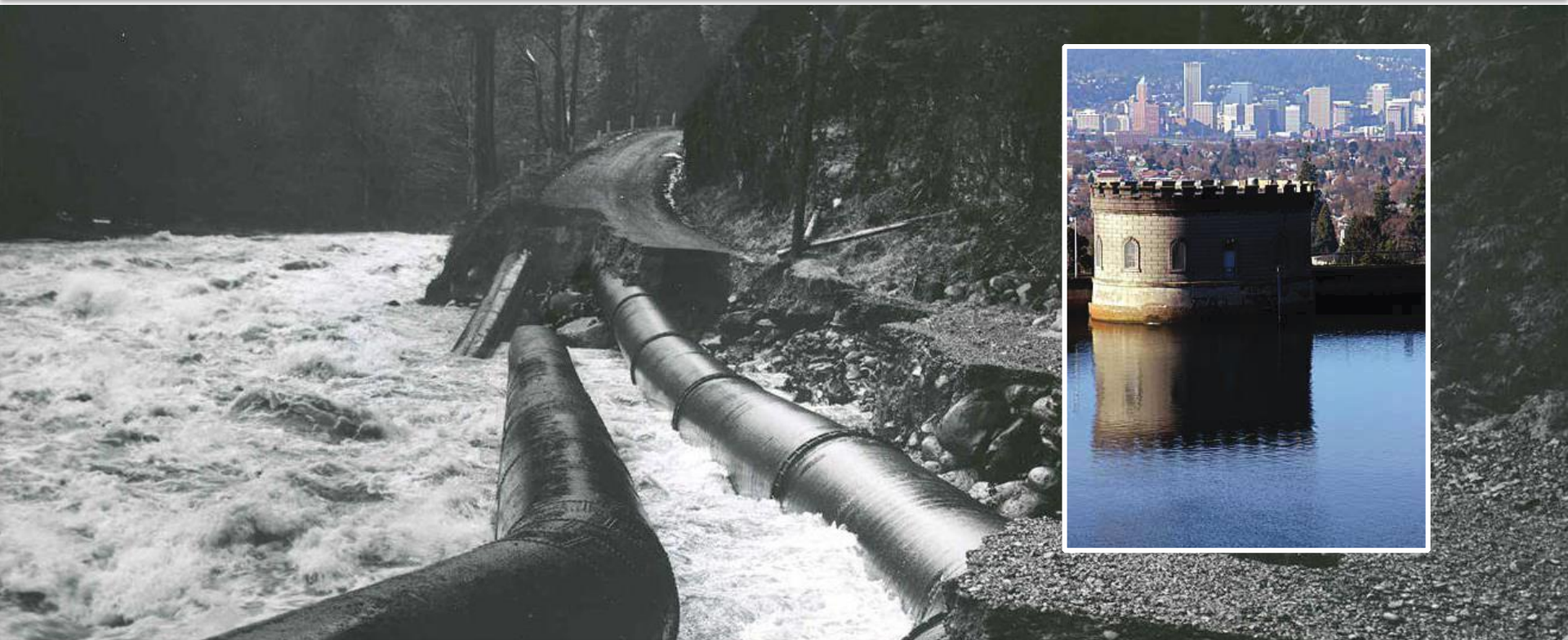


City of Portland Water Bureau

Water System Resilience



Michael Stuhr, P.E.
PNWER Annual Summit
July 2017





Themes

Building Code – life safety

- City code – rules that provide life safety, protect health, address typical circumstances or hazards
- City policy – direction from City leaders, can provide resilience against unusual hazards or events



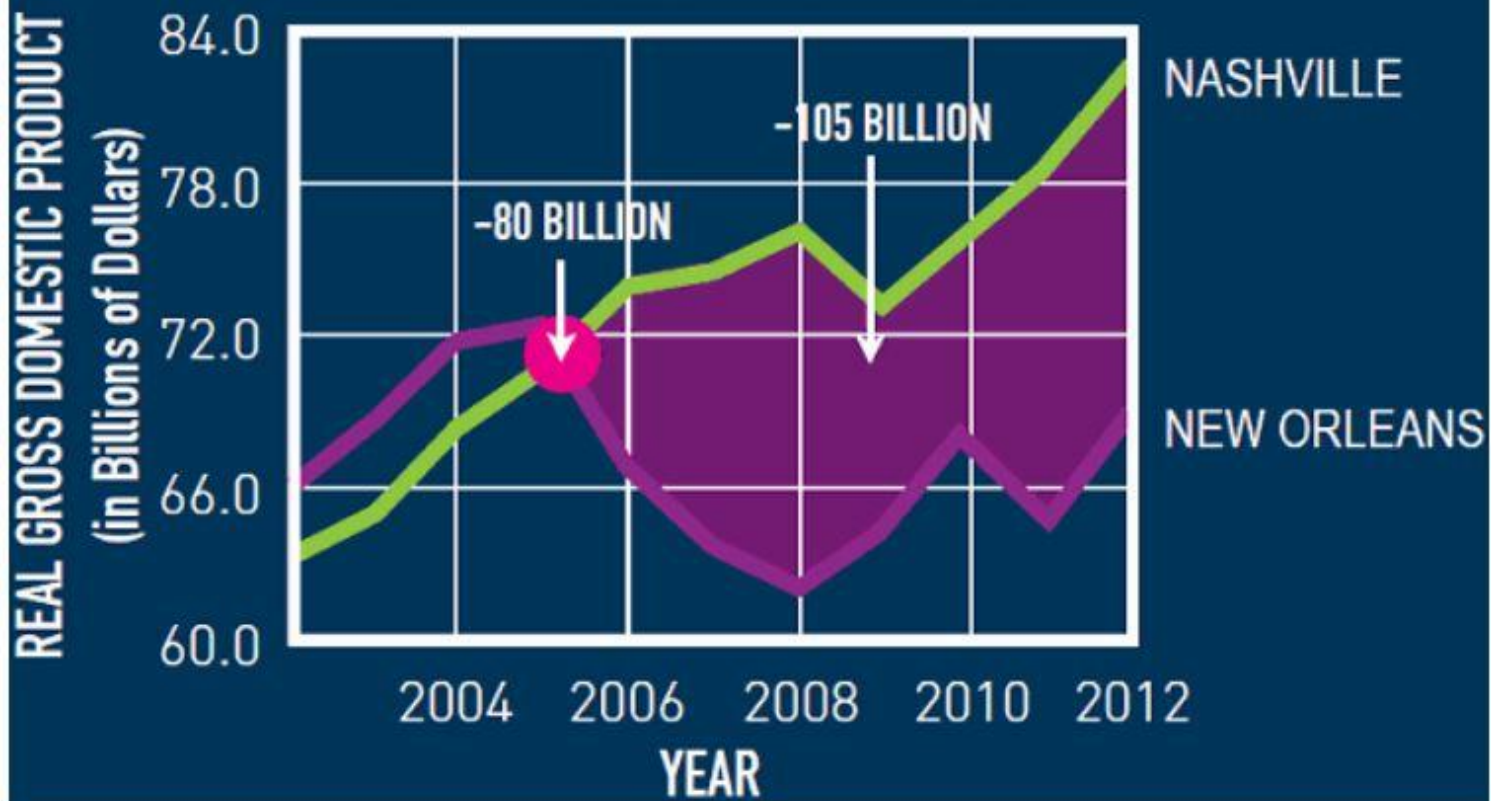
Themes

Funding Sources

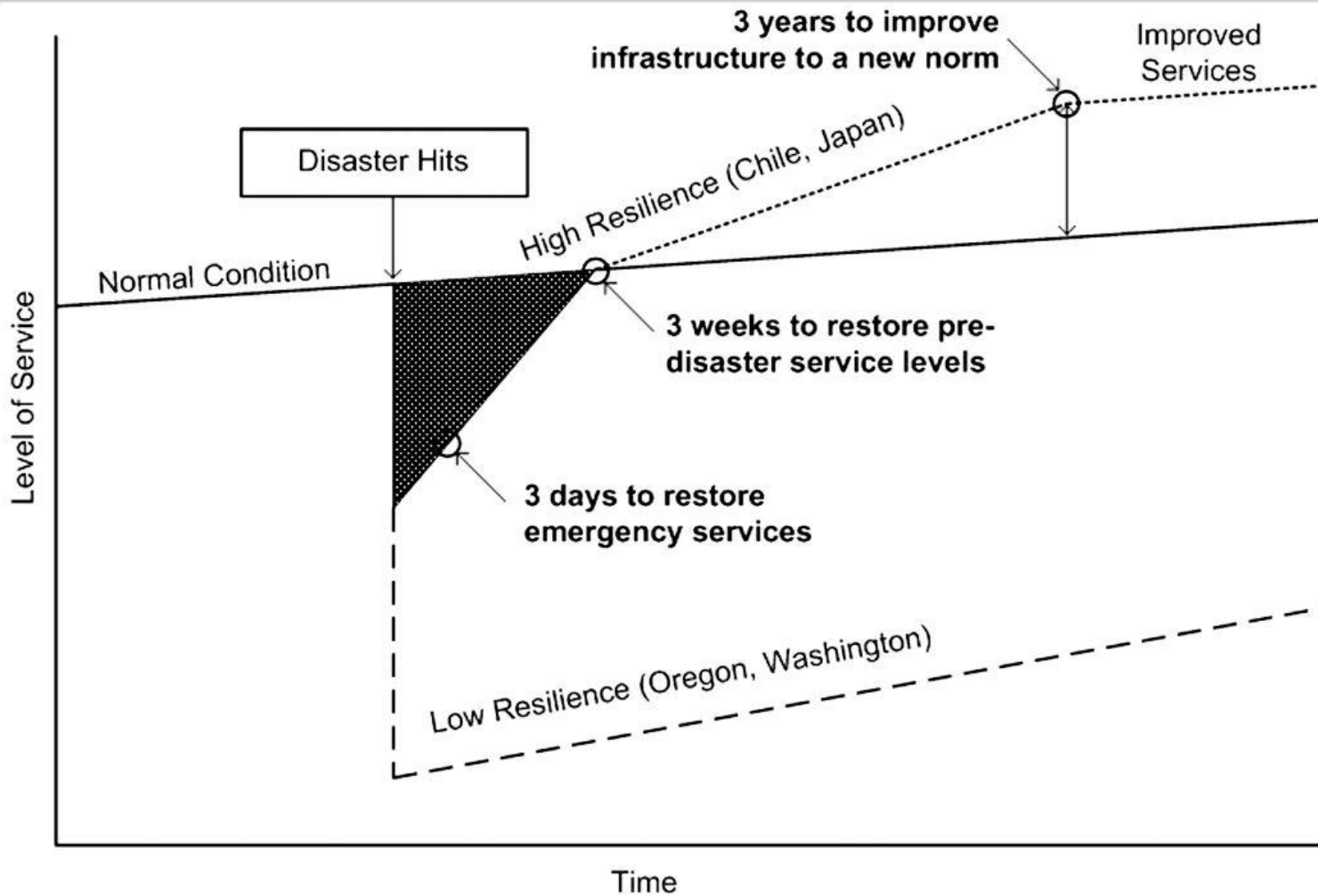
- Need to move from rewarding restoration after event
- To support more resilient building practices



NEW ORLEANS VS NASHVILLE ECONOMIC GROWTH

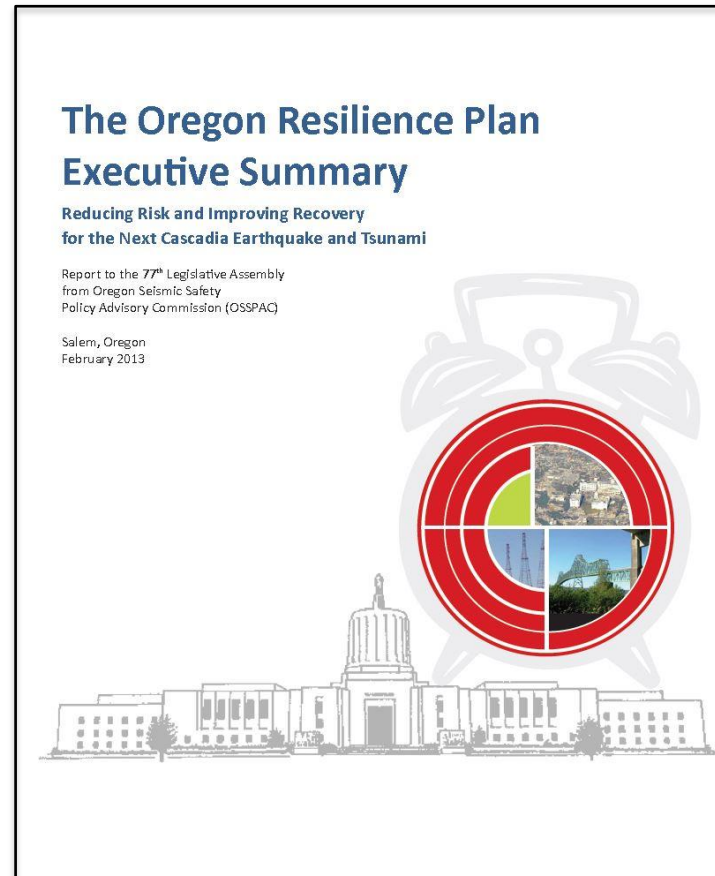


SAFRR – Science Application for Risk Reduction (Lucy Jones, USGS)

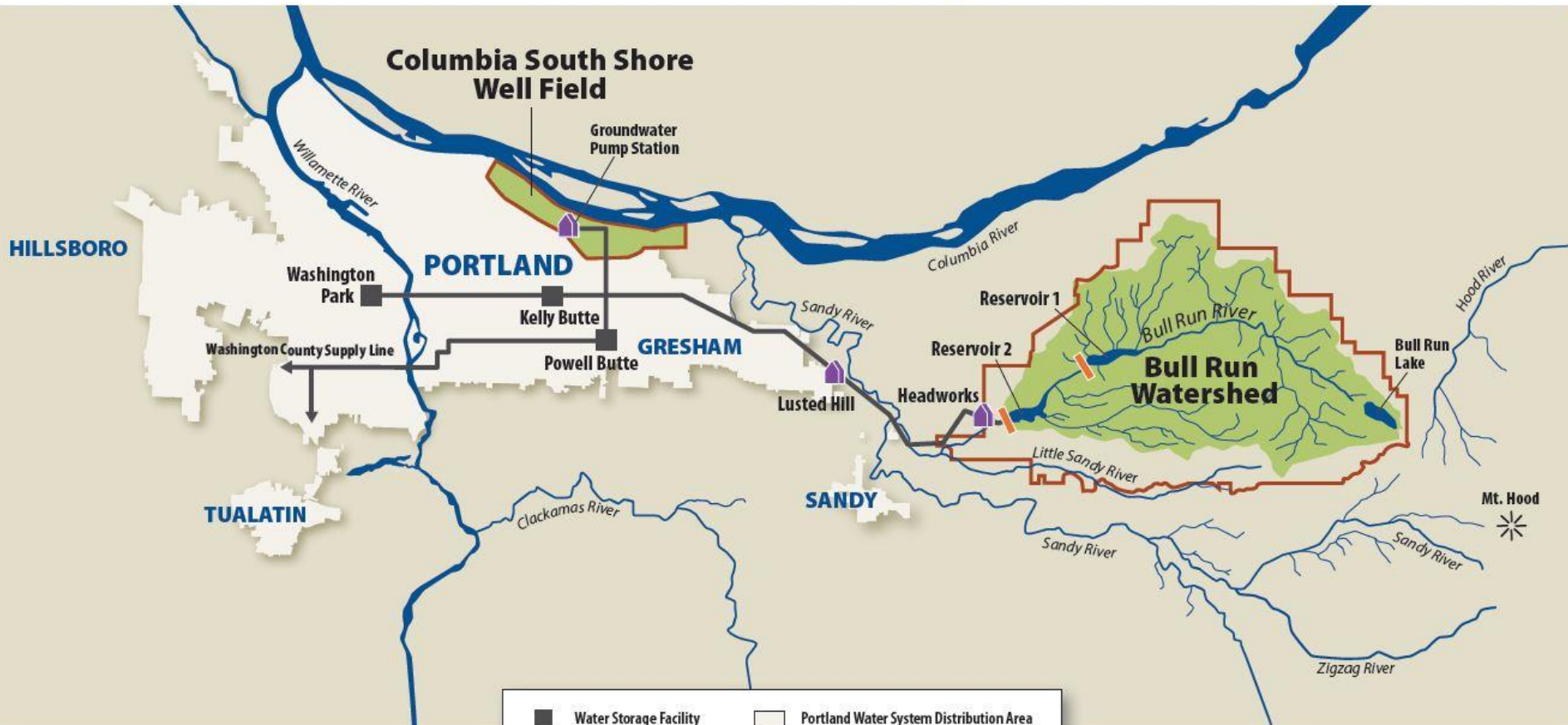









Oregon Resilience Plan (ORP)

- **Specifies likely impacts of a magnitude 9.0 Cascadia earthquake.**
- Defines target states of recovery goals to be met within 50 years.
- Recommends changes in practice and policy.
- [http://www.oregon.gov/OMD/OEM/ospac/docs/Oregon Resilience Plan Final.pdf](http://www.oregon.gov/OMD/OEM/ospac/docs/Oregon%20Resilience%20Plan%20Final.pdf)



Portland's Water System

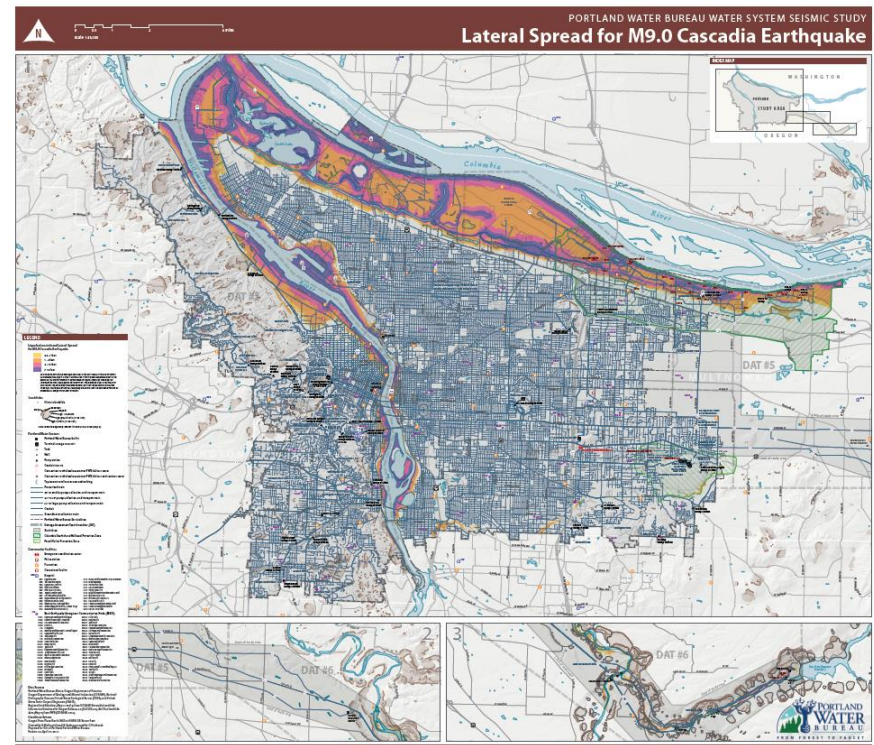


	Water Storage Facility		Portland Water System Distribution Area
	Water Supply Pipes		Water Source
	Water Treatment Facility		Protected Area
	Dam		



Deliverables

- Worked with Oregon Dept of Geology & Mineral Industries (DOGAMI) and 1000s of bore logs
- Four (4) PDF Maps along with four new ArcGIS layers in the City's GIS mapping system
 - Liquefaction Hazard
 - Lateral Spread
 - Ground Settlement
 - Landslide Deformation





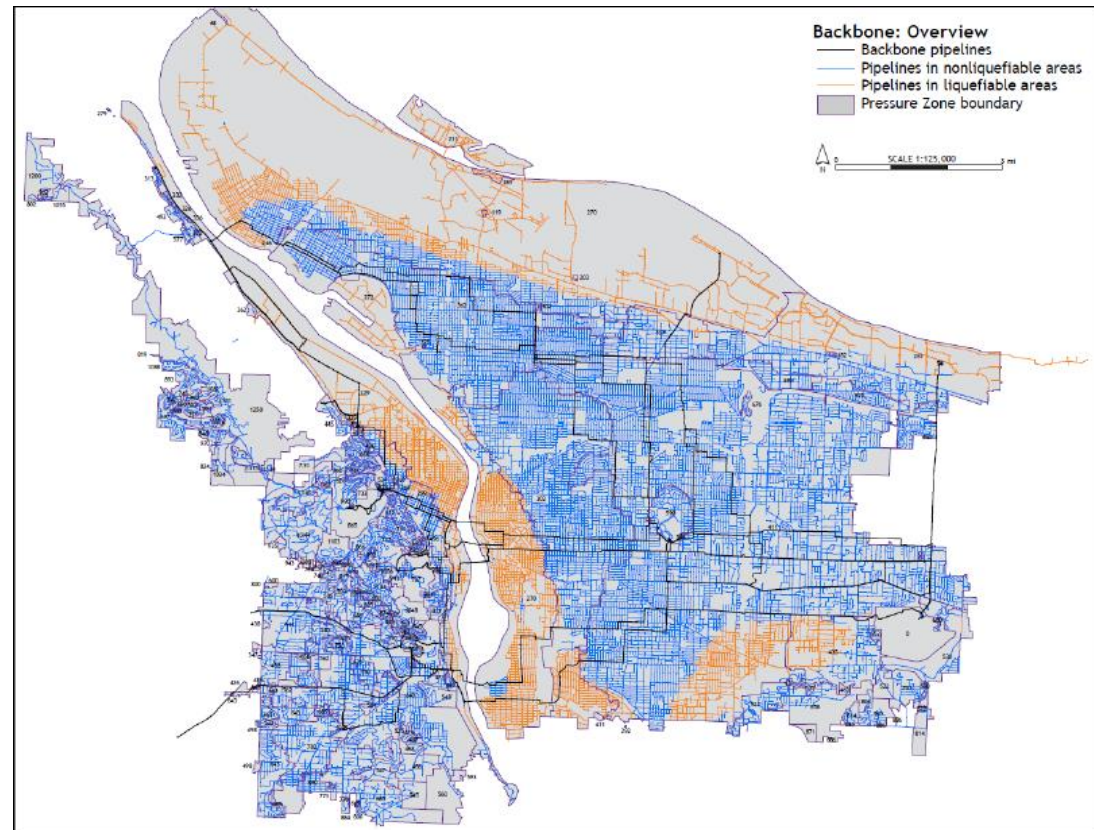
Pipeline Failures

- TGD

- 1 failure every 16 miles (1 break every 80 miles and 1 leak every 20 miles)

- PGD

- 12 to 16 failures each mile





Seismic Study Recommendations

- CIP Improvements
 - Supply (Conduits, Groundwater)
 - Backbone (river crossings, terminal storage)
 - Distribution (liquefaction-susceptible piping)
 - Pump Stations (seismic retrofits)
 - Storage (tank anchorage, flexible piping connections)



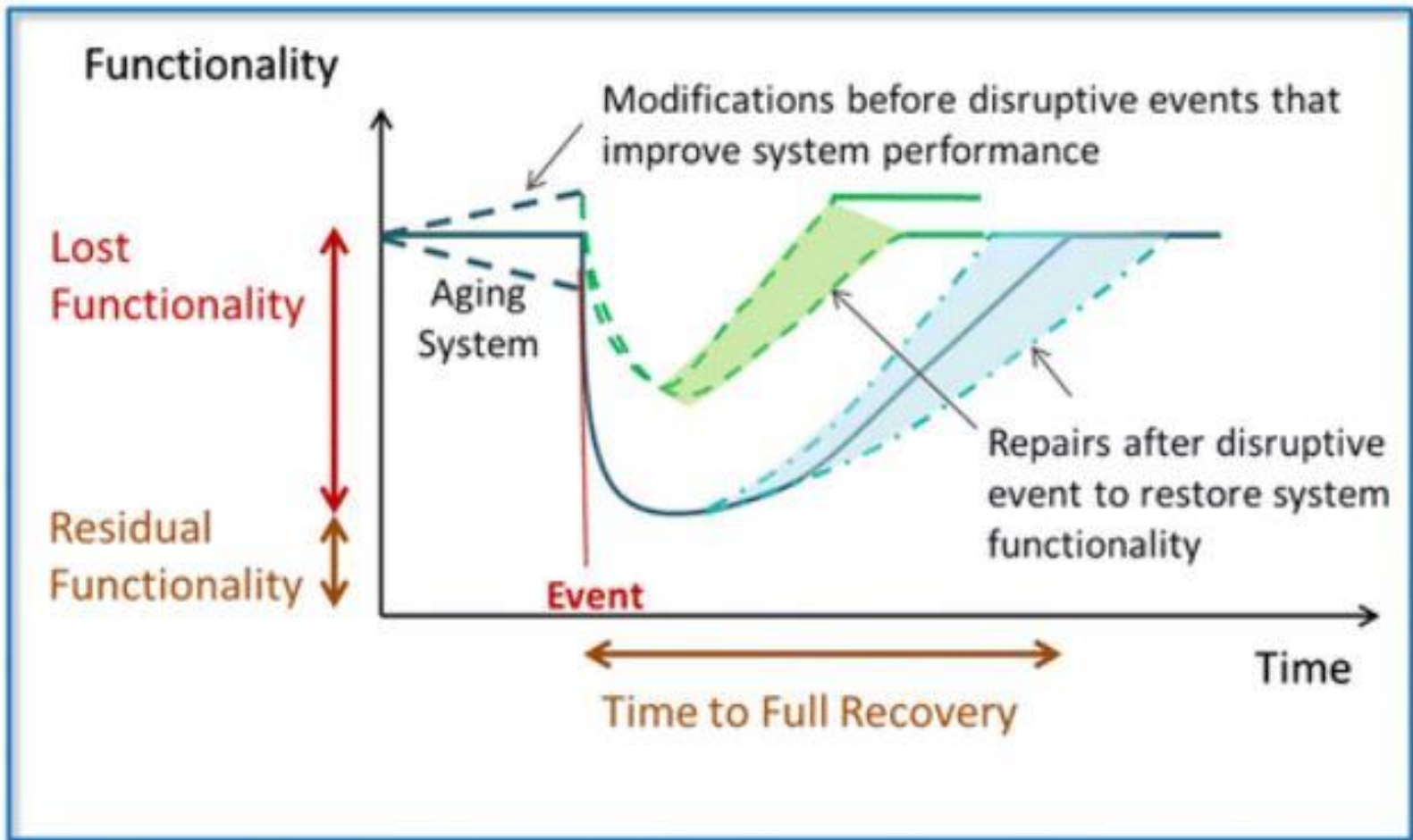
Seismic Study Recommendations

- Non-CIP projects
 - Pressure zone isolation plan to limit system leakage
 - Mutual aid agreements and on-call contracts
 - Additional seismic evaluation of Conduit bridges
 - Stockpile repair resources
 - Assess need for additional portable generators
 - Develop and maintain hard copy utility maps
 - Anchorage for electrical, mechanical, and communication equipment



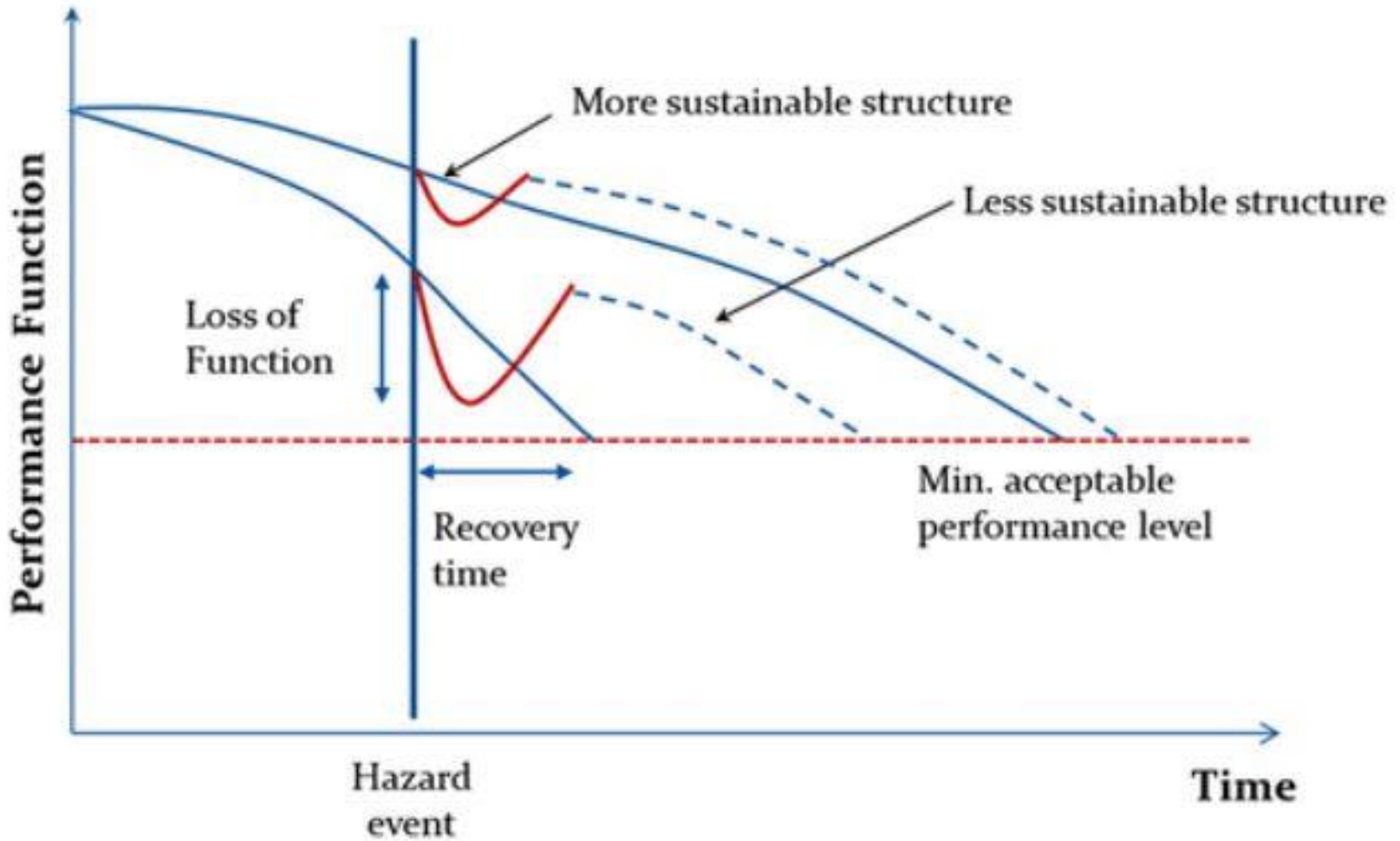
Next Steps

- Develop an implementation plan
- Implement recommendations
 - Examples:
 - Specific size and location for new pipelines
 - When to use alternate materials for small pipelines
 - How to keep backbone system in service
 - Alternatives analysis for CIP projects
- Budget for future projects



Risk-Based Decision Making for Sustainable and Resilient Infrastructure Systems

Journal of Structural Engineering / Vol 142 Issue 9 – September 2016



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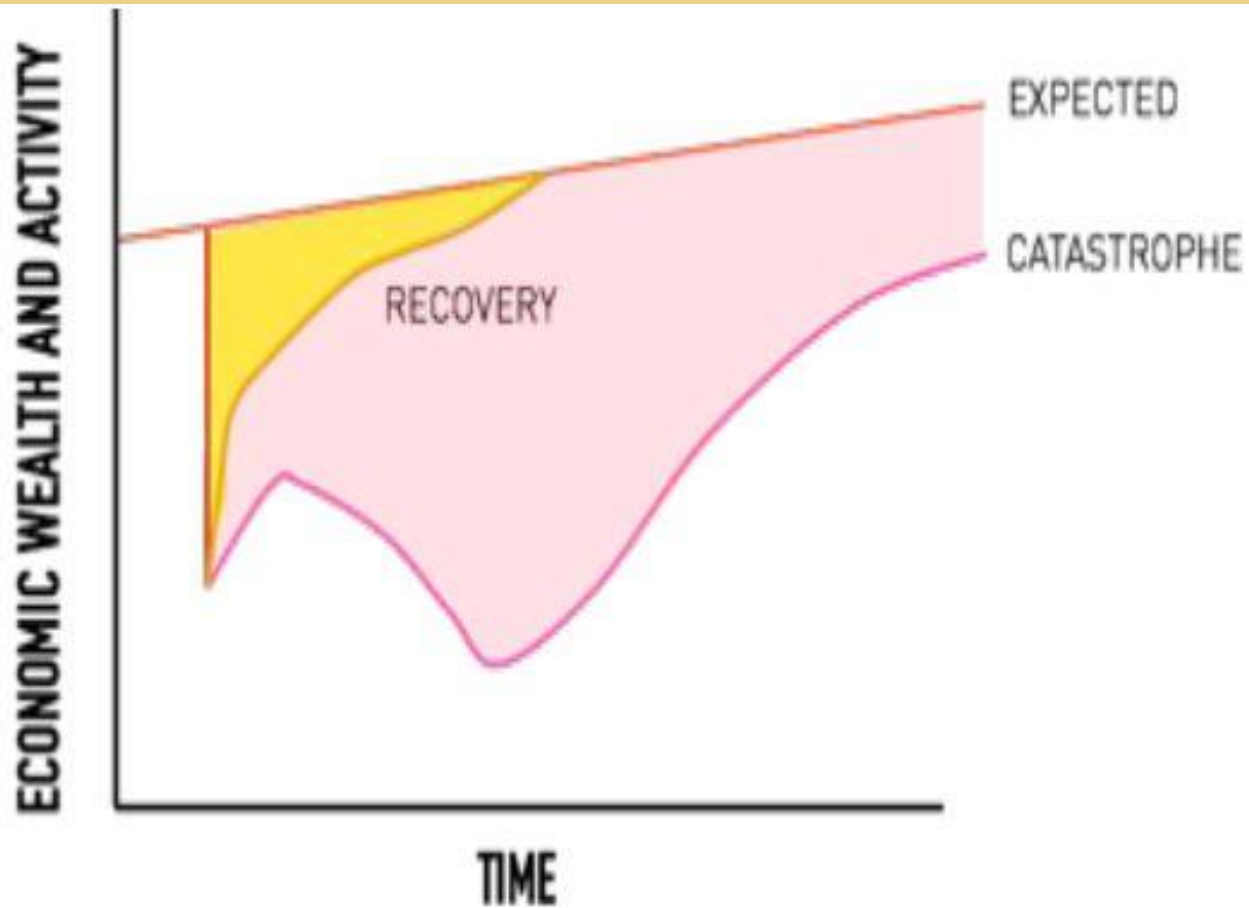


Figure 1-2. A schematic of the impact of a disaster on a regional economy, from Perry et al. (2008).

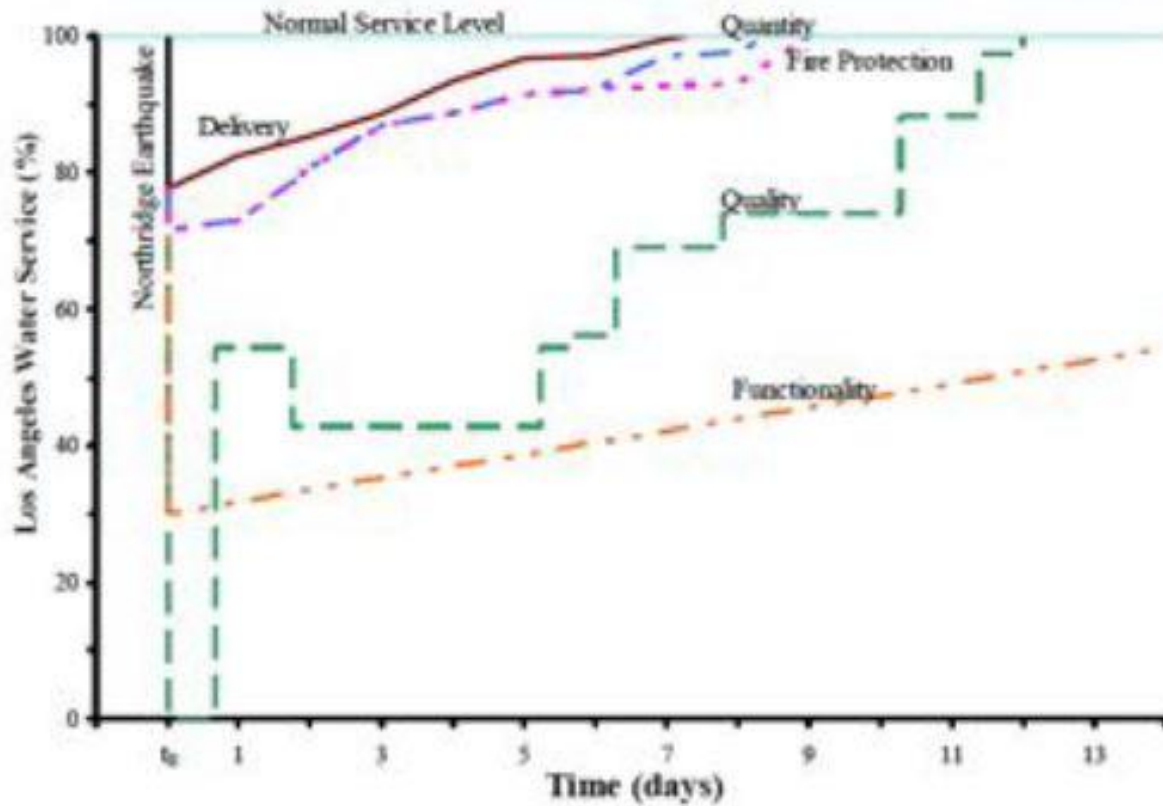


Figure 3-1. Los Angeles Water System service restorations following the 1994 Northridge earthquake (Davis et al, 2012).

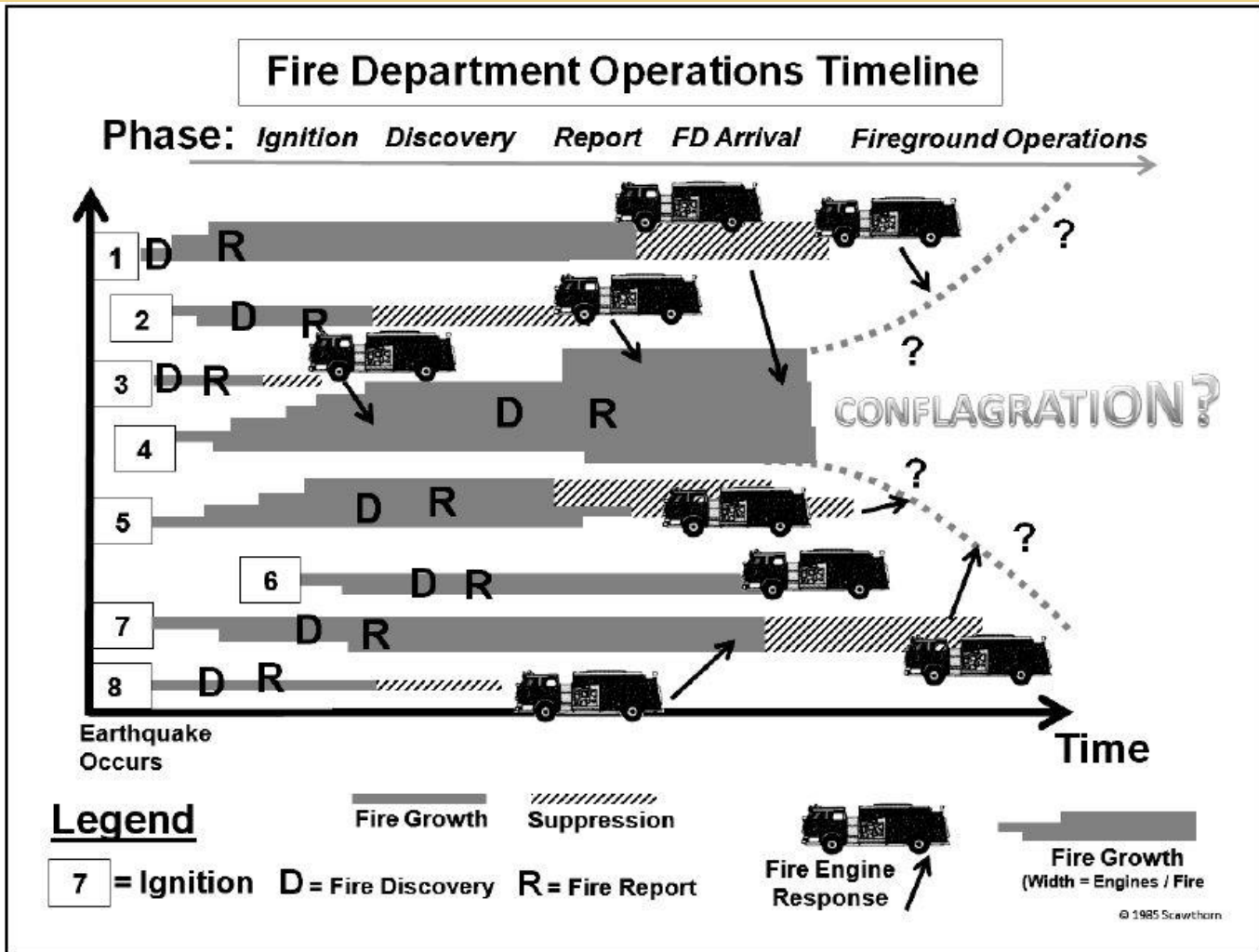
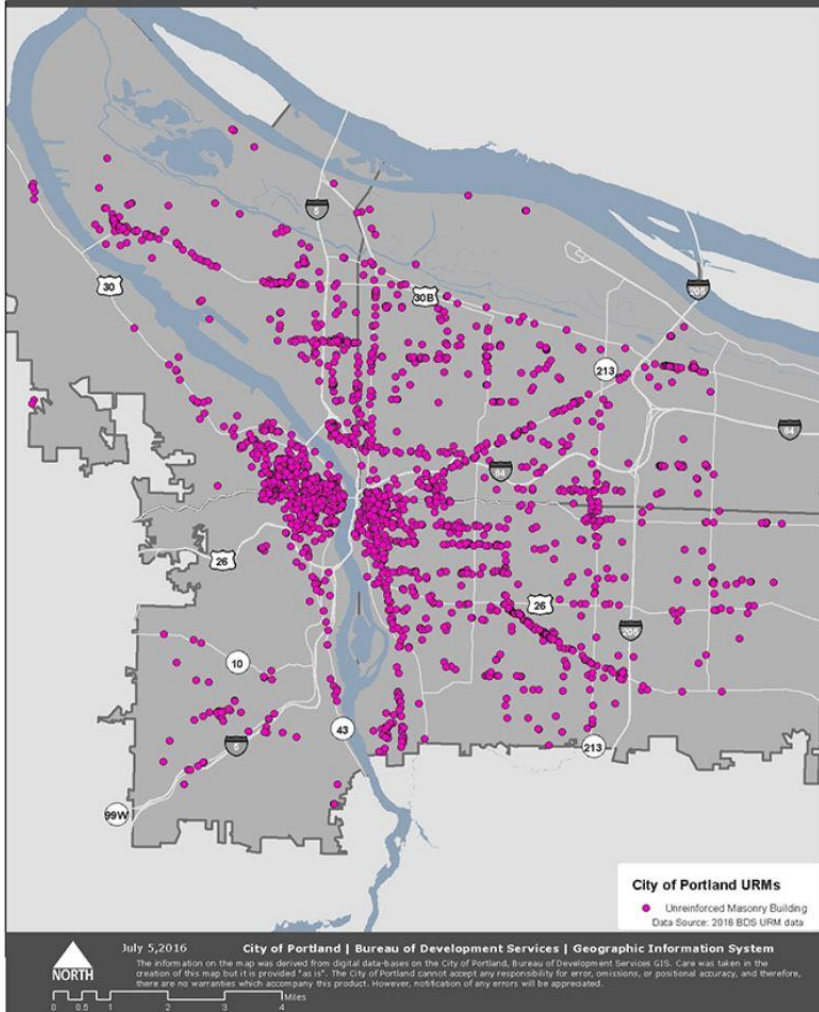


Figure 4 Analysis of fire following earthquake (TCLEE, 2005)



City of Portland
Unreinforced Masonry Buildings



- How to address unreinforced masonry structures in Portland