Airport and Infrastructure Resilience Project Overview

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Lifeline Committee Meeting

August 8, 2013

earthquake and hazards program

Association of Bay Area Governments

Objectives for Our Study

Objective

- Gain a comprehensive understanding of the role Bay Area airports can play in long-term social, economic, and physical recovery from a disaster, given their vulnerabilities, interdependencies on regional infrastructure, and capacity for functioning following a disaster.

Project Overview

Four Interrelated Projects

- Airport Liquefaction Susceptibility Analysis
- Role of Airports in Regional Disaster Response and Recovery
- ***Regional Infrastructure Vulnerabilities and Interdependencies***
- *Oakland Airport Focus Area Shoreline Resilience Planning (in partnership with BCDC)*

http://quake.abag.ca.gov/airport_resilience/

Regional Infrastructure Vulnerabilities and Interdependencies

- Infrastructure Seismic Vulnerabilities
- Infrastructure Interdependency Vulnerabilities

Project Timeline

Airport Liquefaction Susceptibility Analysis

June 2012 – May 2013

Role of Airports in Regional Disaster Response and Recovery

June 2012 – May 2013

Regional Infrastructure Vulnerabilities and Interdependencies *and* Oakland Airport Focus Area Shoreline Resilience Planning (in partnership with BCDC)

January 2013 – June 2014

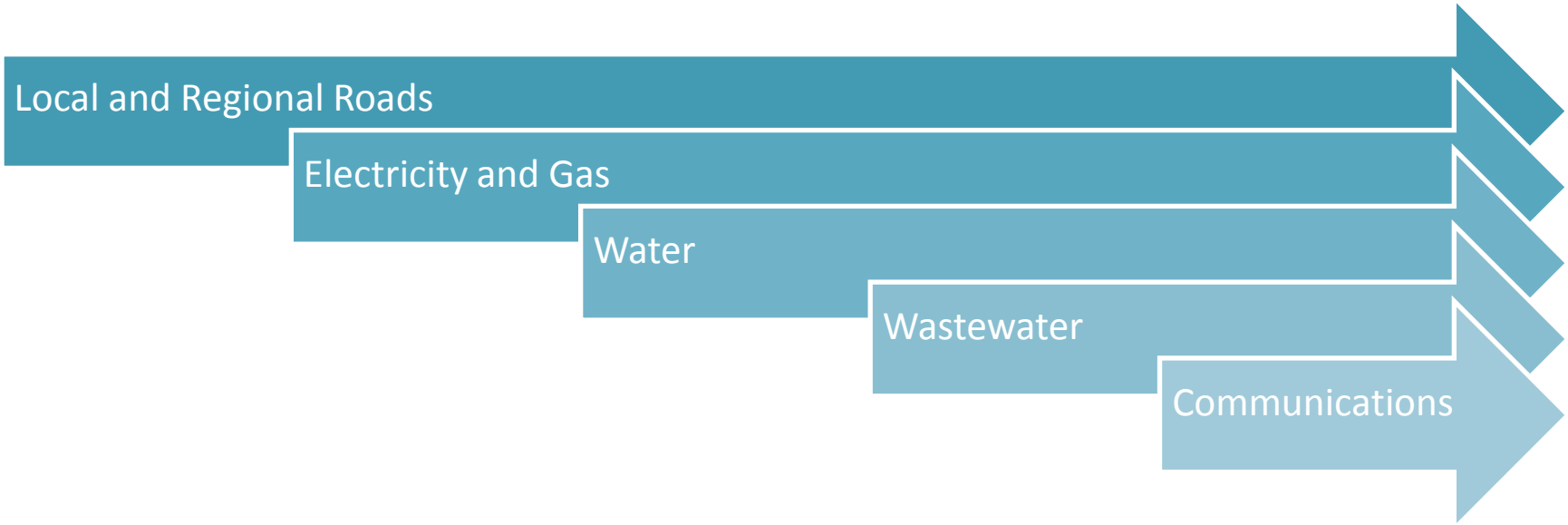
Overview of Our Study

- Questions to Address
  - What is the state of the vulnerabilities and interdependencies of our regional and sub-regional infrastructure systems?
- Goals
  - Provide a general understanding of infrastructure hazard vulnerability and impacts of system interdependencies on restoration
  - Develop a regional infrastructure vulnerability assessment at transmission scale
  - Recognize the interdependencies in regional infrastructure systems and determine the organization capacity to restore services
- Outcome
  - Sub-Regional Infrastructure Interdependencies Findings and Recommendations Report

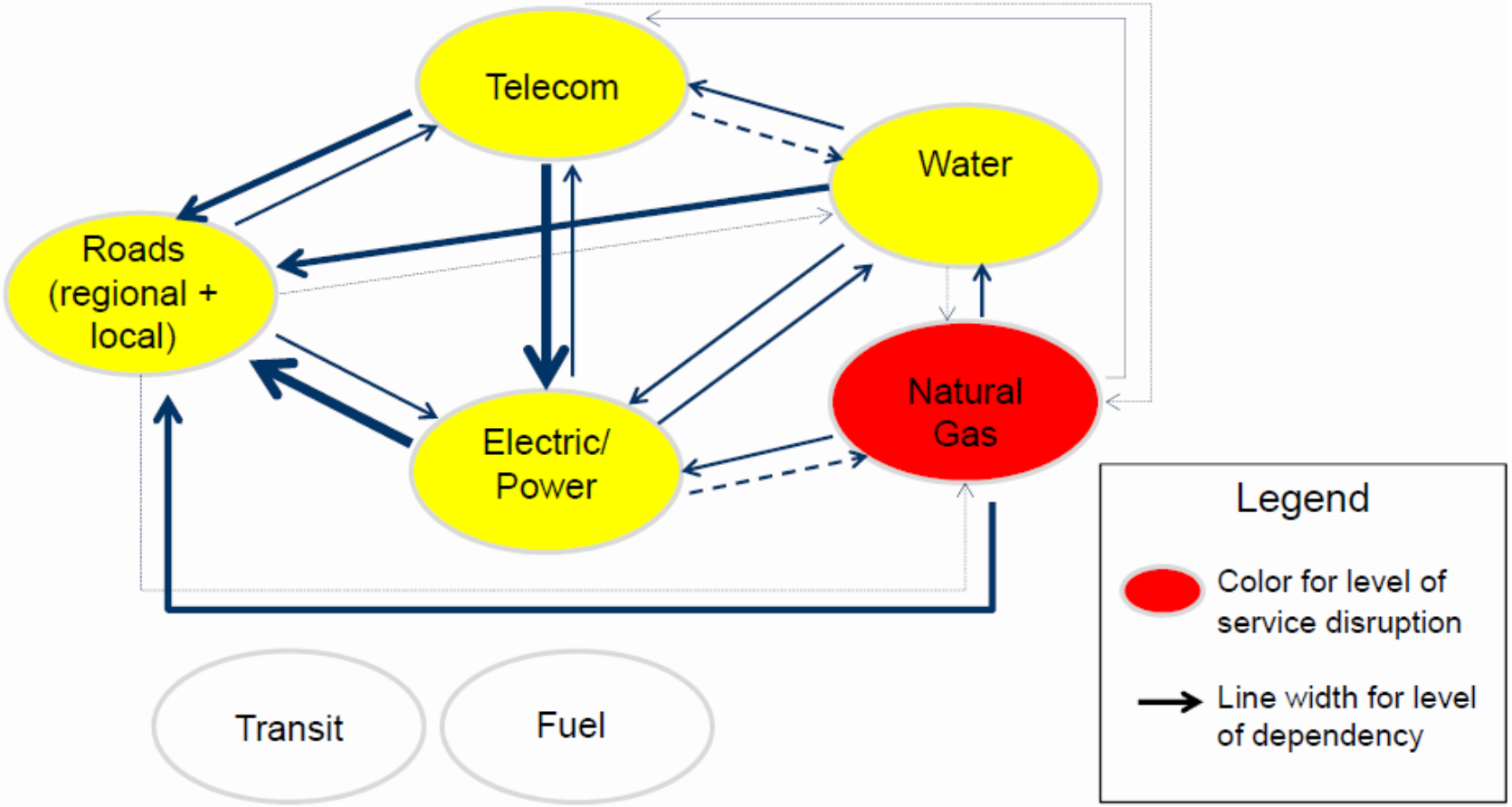
Scope of Our Study

- Asset Categories
  - Energy (electricity, natural gas, and fuel)
  - Water and Wastewater
  - Communications
  - Ground Transportation
  - Ports and Airports
- Asset Components
  - Nodes: Key built assets such as pump stations, treatment plants, or substations
  - Links: Distribution and transmission lines such as pipes, wires, or cables
  - Interdependencies: Resources necessary for basic operation of the system, such as electricity, gas, or fuel
  - People: Personnel who run, make decisions about, and oversee the built systems
  - Information: data on systems and their performance

Preliminary Hierarchy – High Level



Lifeline Interdependencies in San Francisco
(Progress Report ; September 2012)



Anticipated Products

Service Disruption Level
No loss
Slight Disruption
Moderate Disruption
Severe Disruption
Uncertain

Sector	Time After Event				
	0 hours		72 hours		2 weeks
Power					
Transportation					
Water					
Wastewater					
Natural Gas					
Healthcare					
Solid Waste					

Anticipated Products

TARGET STATES OF RECOVERY FOR SAN FRANCISCO'S BUILDINGS AND INFRASTRUCTURE

INFRASTRUCTURE CLUSTER FACILITIES	Event occurs	Phase 1 Hours			Phase 2 Days		Phase 3 Months		
		4	24	72	30	60	4	36	36+
CRITICAL RESPONSE FACILITIES AND SUPPORT SYSTEMS									
Hospitals								X	
Police and fire stations			X						
Emergency Operations Center									
Related utilities						X			
Roads and ports for emergency				X					
CalTrain for emergency traffic					X				
Airport for emergency traffic				X					
EMERGENCY HOUSING AND SUPPORT SYSTEMS									
95% residence shelter-in-place								X	
Emergency responder housing				X					
Public shelters							X		
90% related utilities								X	
90% roads, port facilities and public transit							X		
90% Muni and BART capacity						X			
HOUSING AND NEIGBORHOOD INFRASTRUCTURE									
Essential city service facilities							X		
Schools							X		
Medical provider offices								X	
90% reighborhood retail services									X
95% of all utilities								X	
90% roads and highways						X			
90% transit						X			
90% railroads							X		
Airport for commercial traffic					X				
95% transit							X		
COMMUNITY RECOVERY									
All residences repaired, replaced or relocated									X
95% neighboorhood retail businesses open								X	
50% offices and workplaces open									X
Non-emergency city service facilities								X	
All businesses open									X
100% utilities									X
100% roads and highways									X
100% travel									X

Source: SPUR analysis

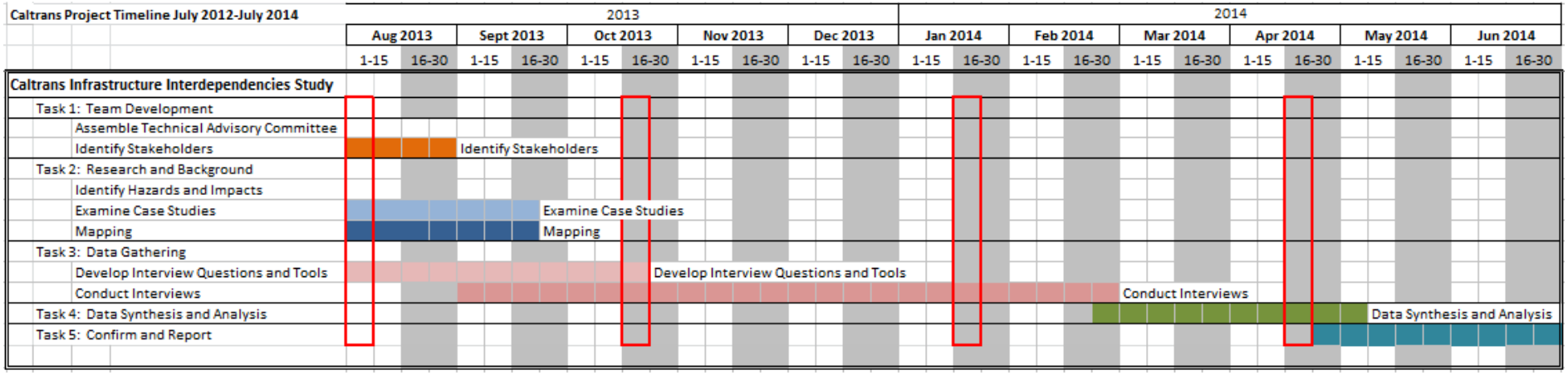
TARGET STATES OF RECOVERY

Performance measure	Description of usability after expected event	BUILDINGS	LIFELINES
	Category A: Safe and operational		
	Category B: Safe and usable during repairs	100% restored in 4 hours	
	Category C: Safe and usable after moderate repairs	100% restored in 4 months	
X	Expected current status		

Implementation Steps

Phase 1: Research and Background	Phase 2: Data Gathering	Phase 3: Data Synthesis and Analysis	Phase 4: Confirm and Report
• Refine Infrastructure and Hazard Categories • Assemble data wish list • *Examine Earthquake and Regional Case Studies* • *Identify potential interviewees*	• *Develop Interview Questions and Tools* • *Generate GIS Maps* • *Collect Data on Infrastructure* • Conduct Interviews	• Synthesize Interview responses • Develop Diagrams, Tables and Charts • Develop Vulnerability Inventory • Write Interdependencies Findings Report	• Check findings with stakeholders • Craft Mitigation Recommendations • Finalize Report

Project Timeline



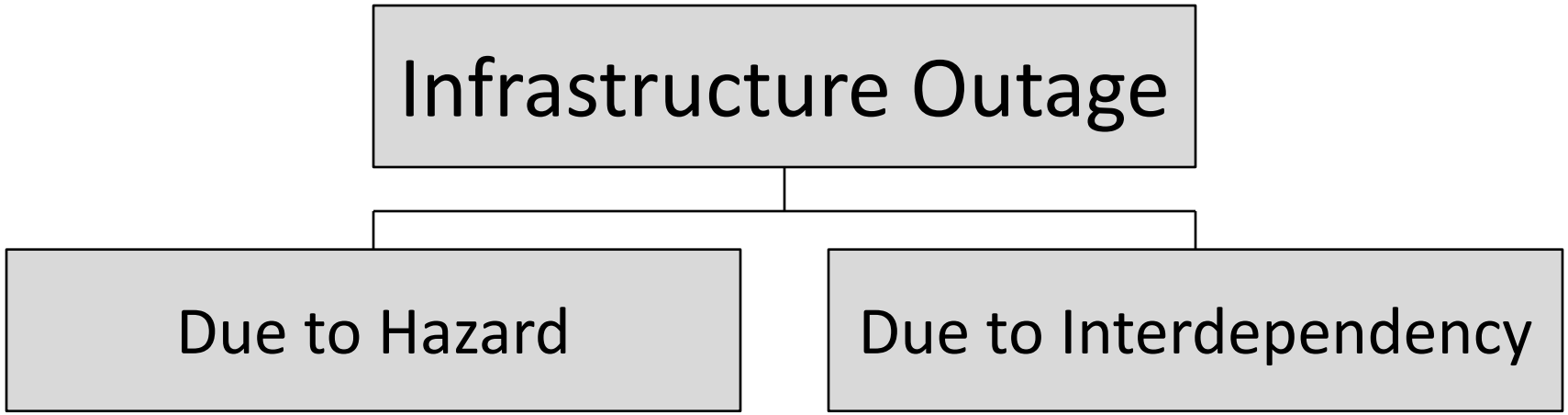
Interview Questions Review

- Overview questions:
  - Are these questions answerable?
  - Are these questions getting at what we want to know?
  - Who is the right person to answer them?
    - Identify department: owners, operators, planners?
    - Champion?
    - Data manager/GIS person?

Bay Area Infrastructure Seismic Vulnerability Study

Michael Germeraad
ABAG Resilience Intern

This portion of the study examines the interaction between hazards and infrastructure



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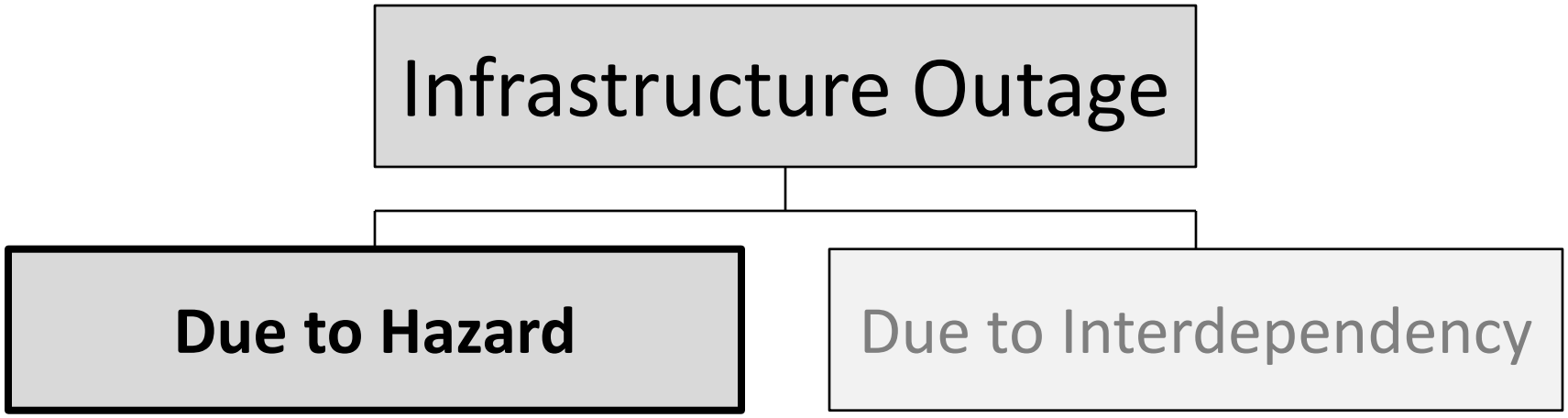


What will this look like?

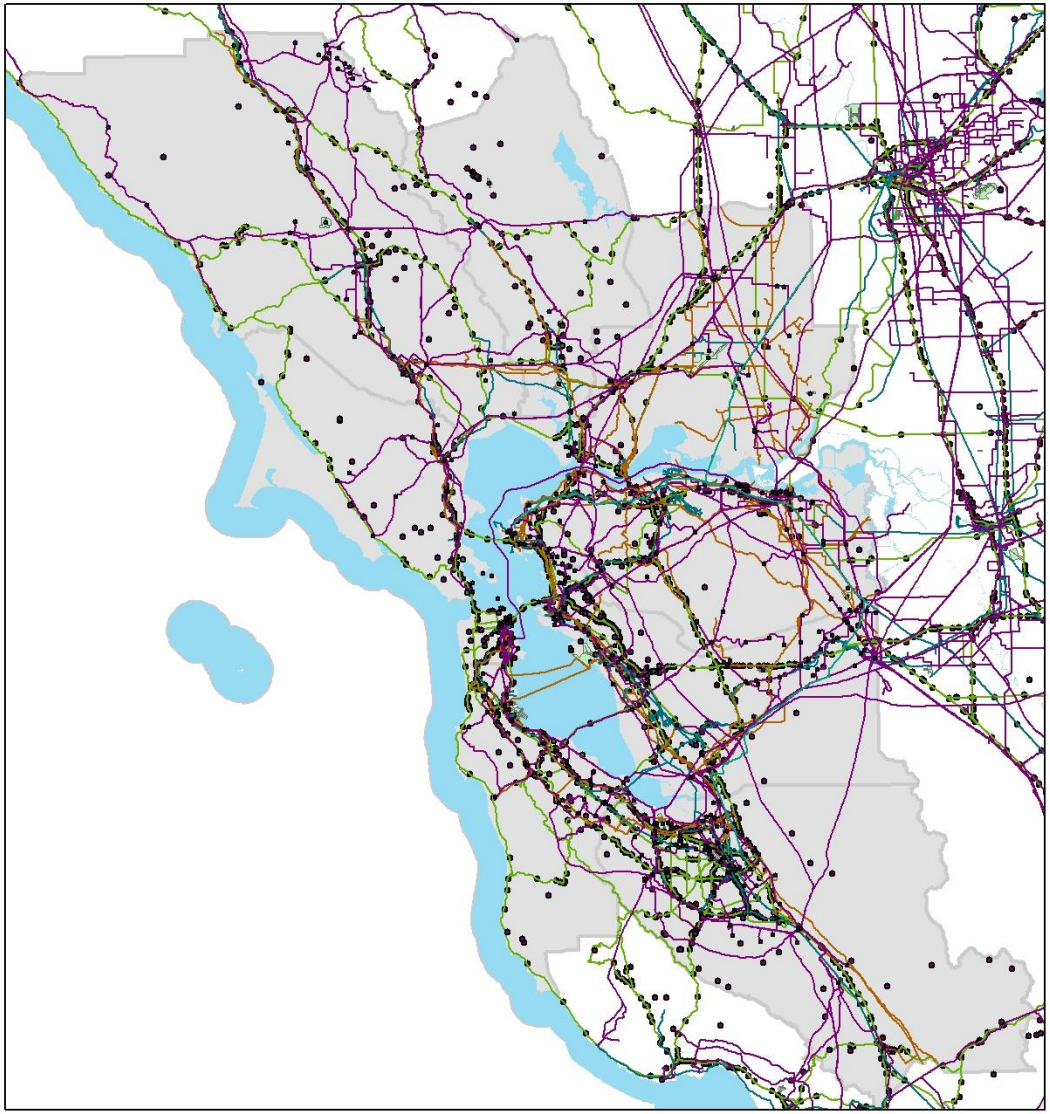
- Region-wide susceptibility assessment.
- When data is available there will be a pseudo-vulnerability assessment of system components and implicit discussion of systems.
- The consequences will often be measured by the number of users.
  - Have potential to include key facilities (ports, hospitals, etc.)

Three methods will drive analysis

- GIS Mapping
  - Geographic interaction between infrastructure and hazard
- Earthquake case studies & technical documents
  - Identify past vulnerabilities.
  - Determine general consequence and interdependencies of outages
- Local failures (not just earthquakes)
  - Determine regional consequences and interdependencies of outages.

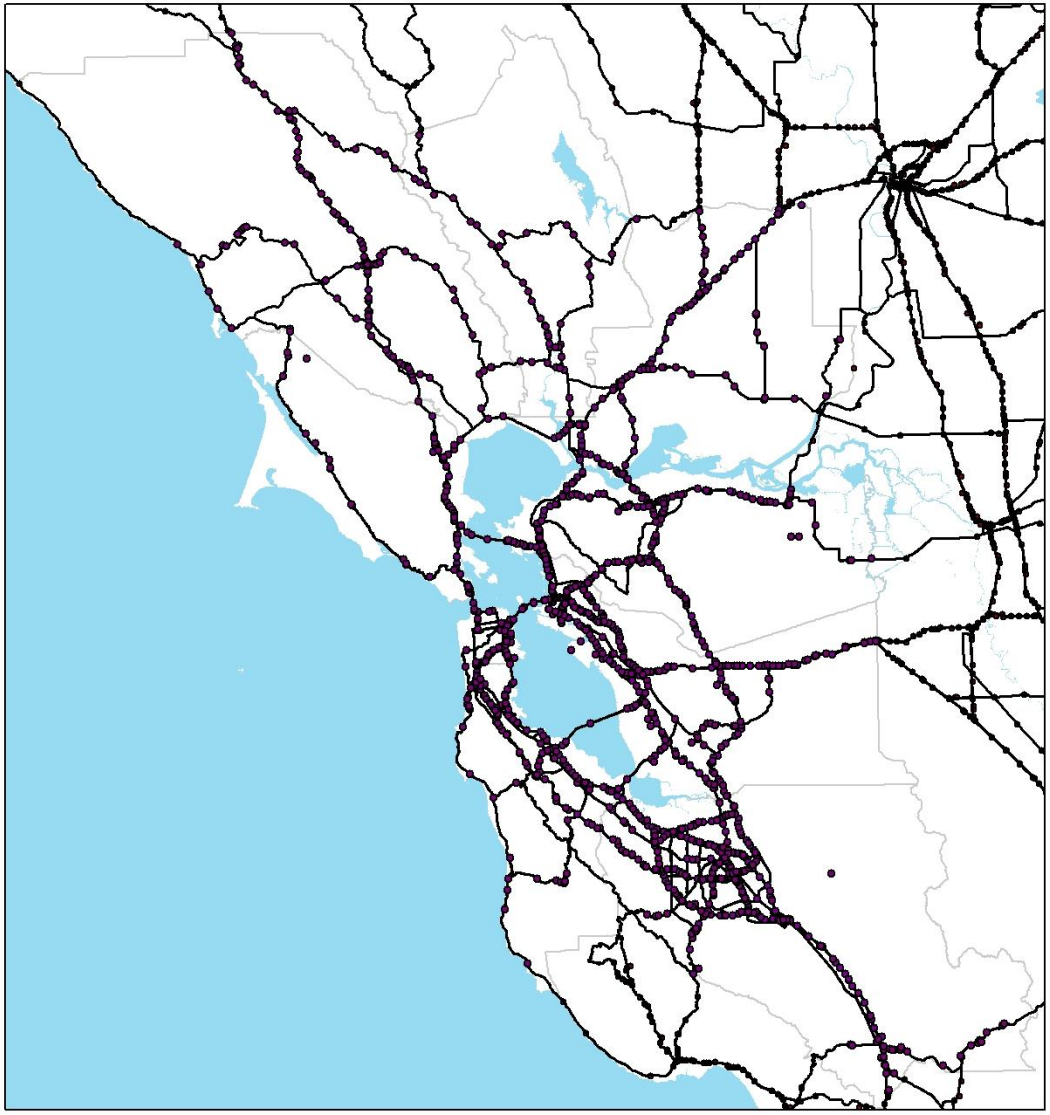
Infrastructure is spatially distributed and comprised of thousands of links and nodes each with unique properties.

- Need to simplify system for feasible analysis.



Thinning Methodology

1) Regional
2) Hierarchy/Importance
3) Historic Performance



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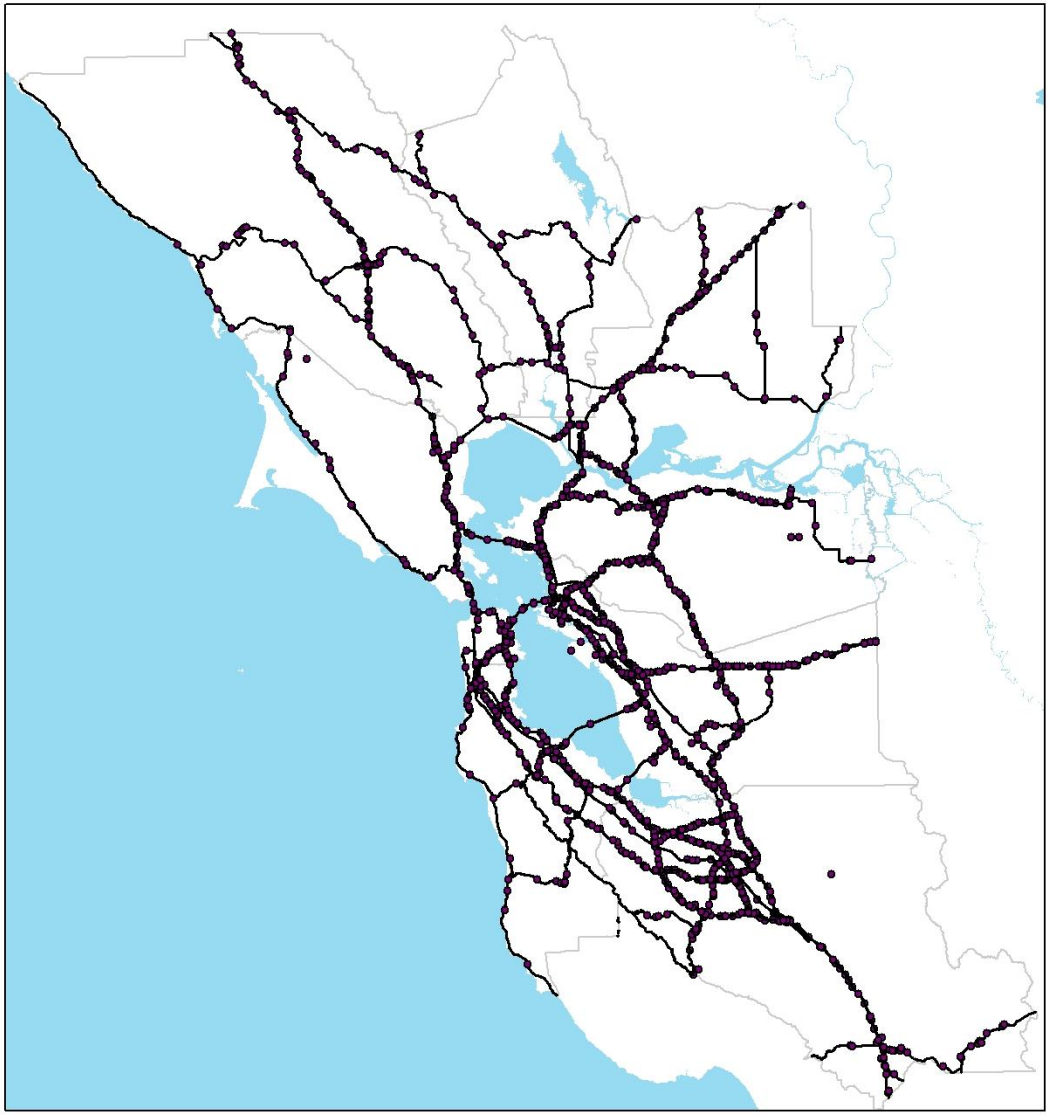

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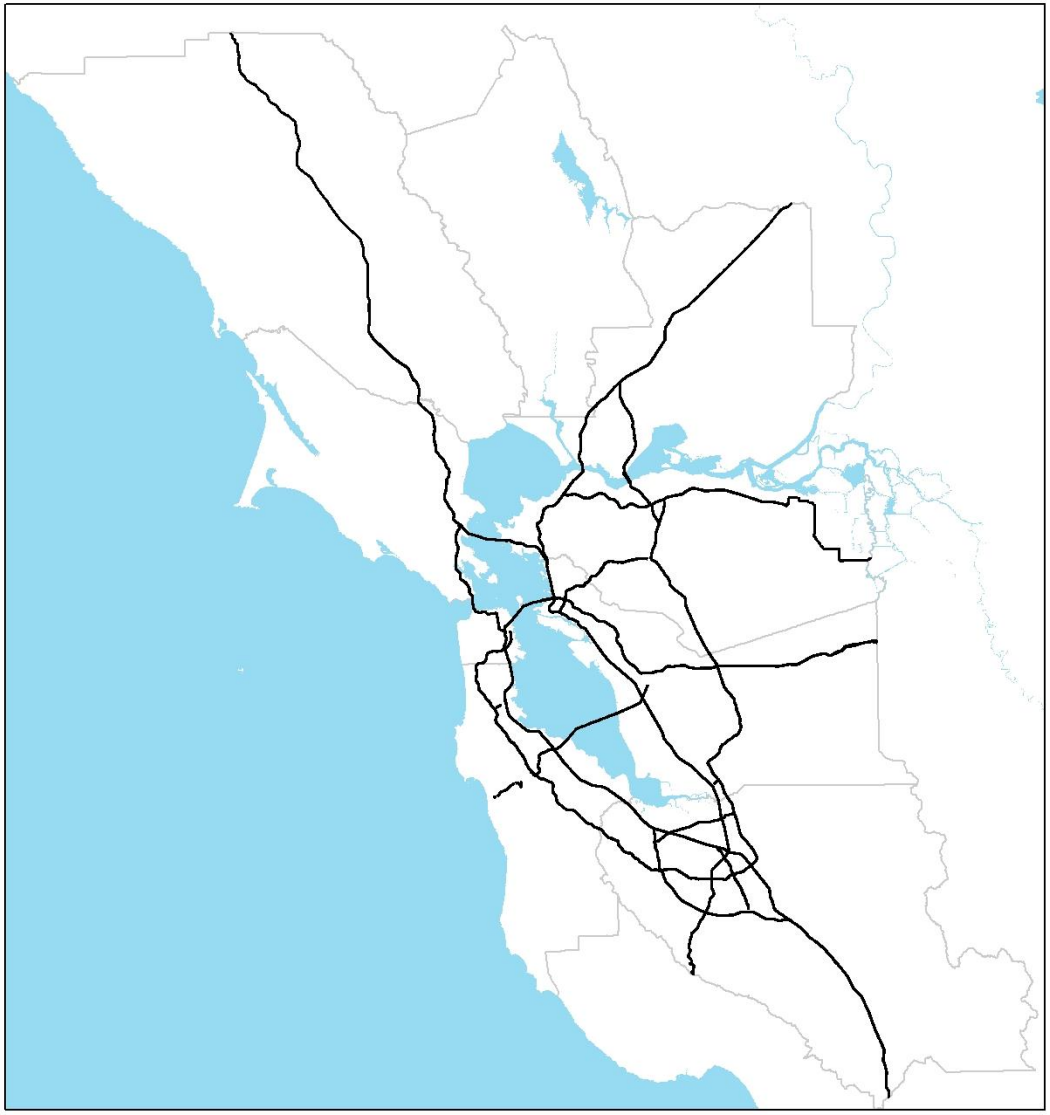


Thinning Methodology

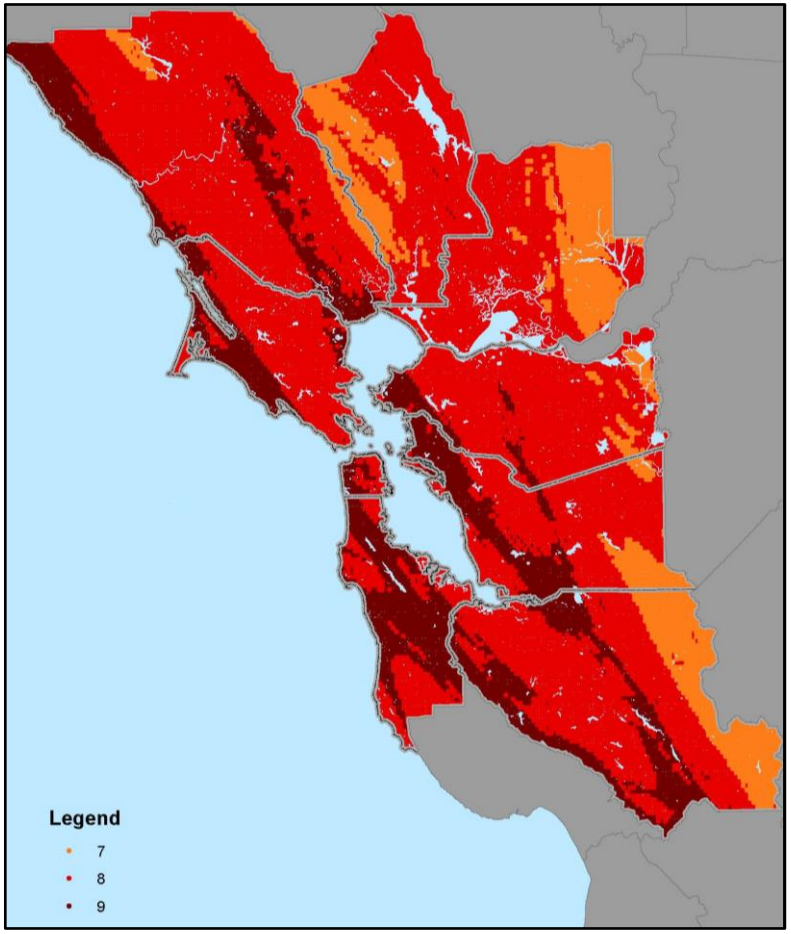
1) Regional

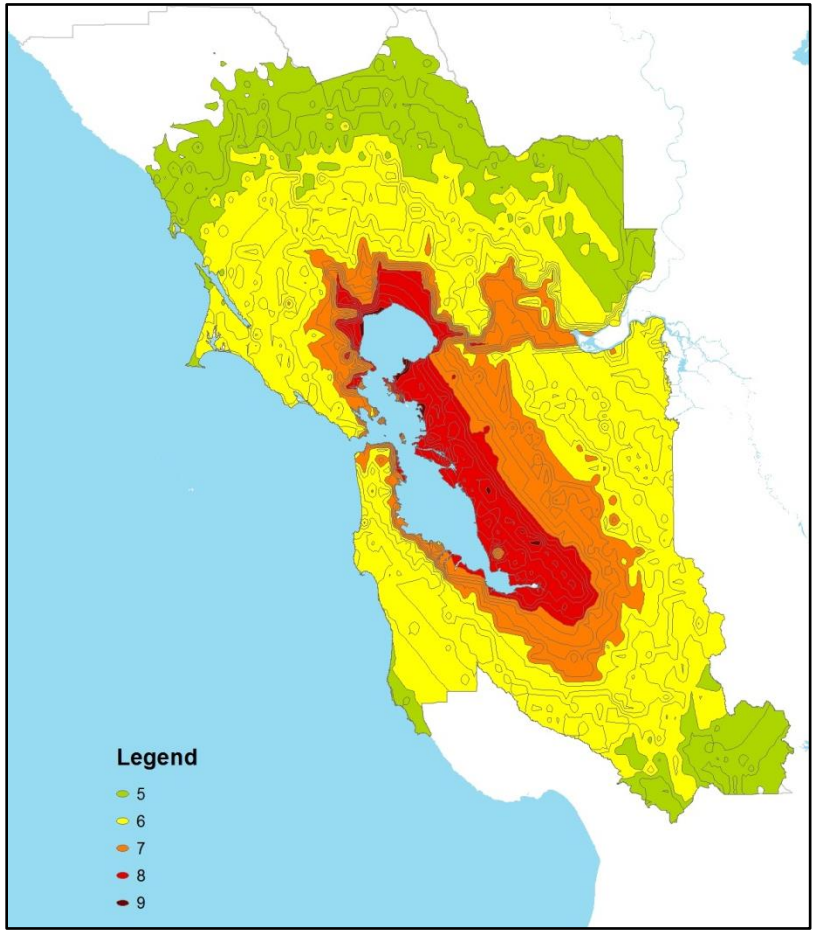
2) Hierarchy/Importance

3) Historic Performance

- How do components of systems respond in earthquakes?
  - Which hazard governs damage?
- What is most significant?
  - What is likely to be damaged?
  - What is likely to govern system restoration?

Need to understand system performance, not just component performance.

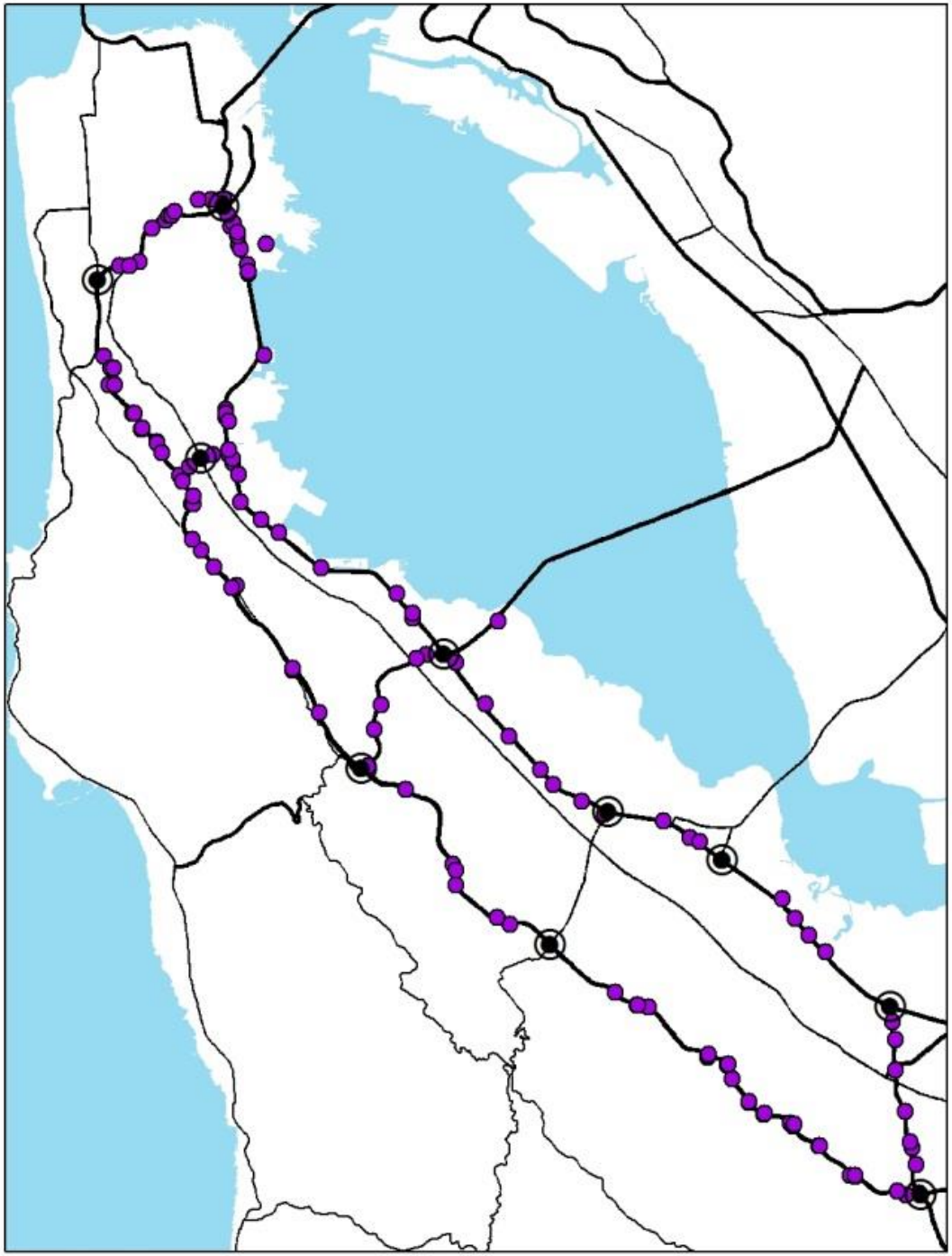


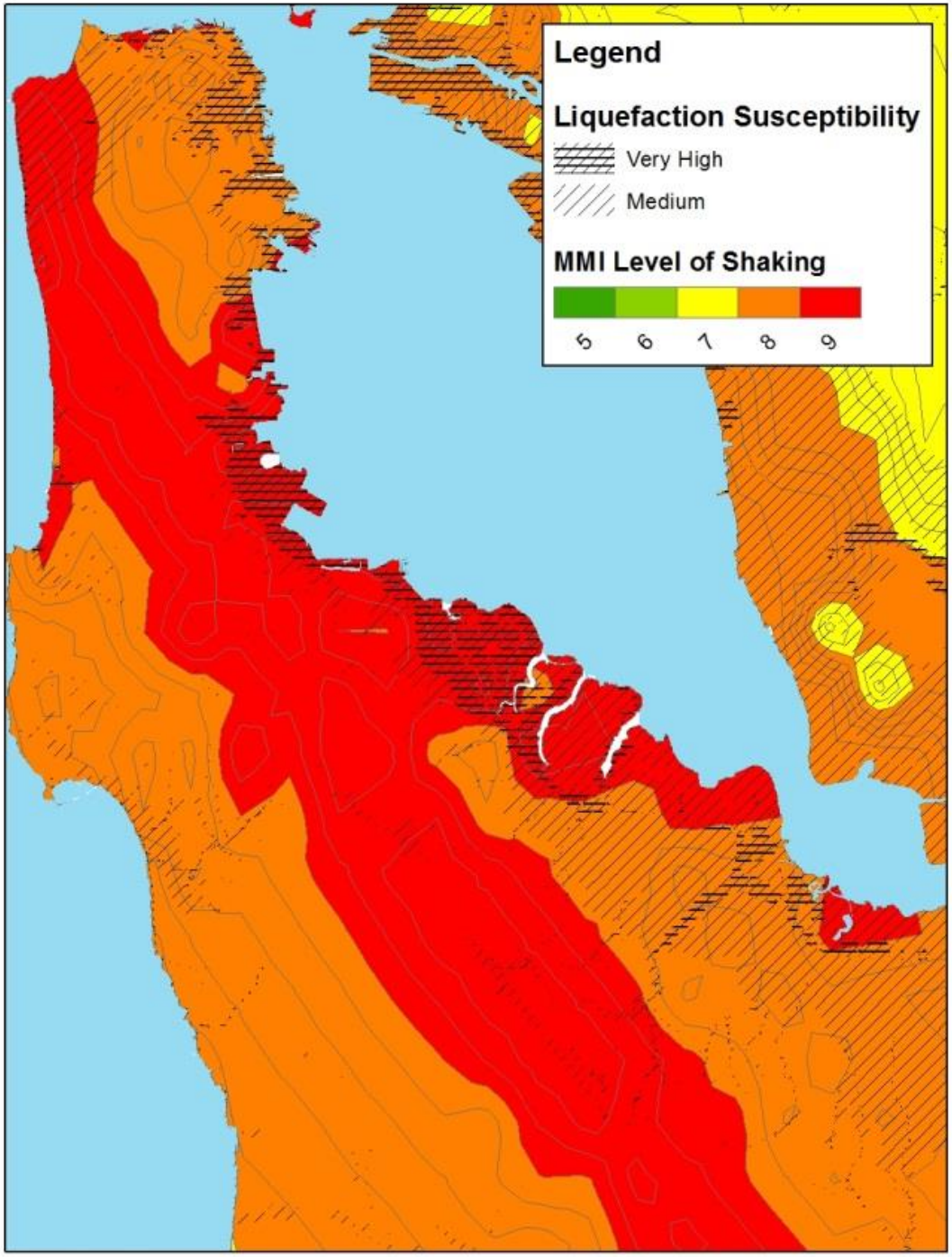


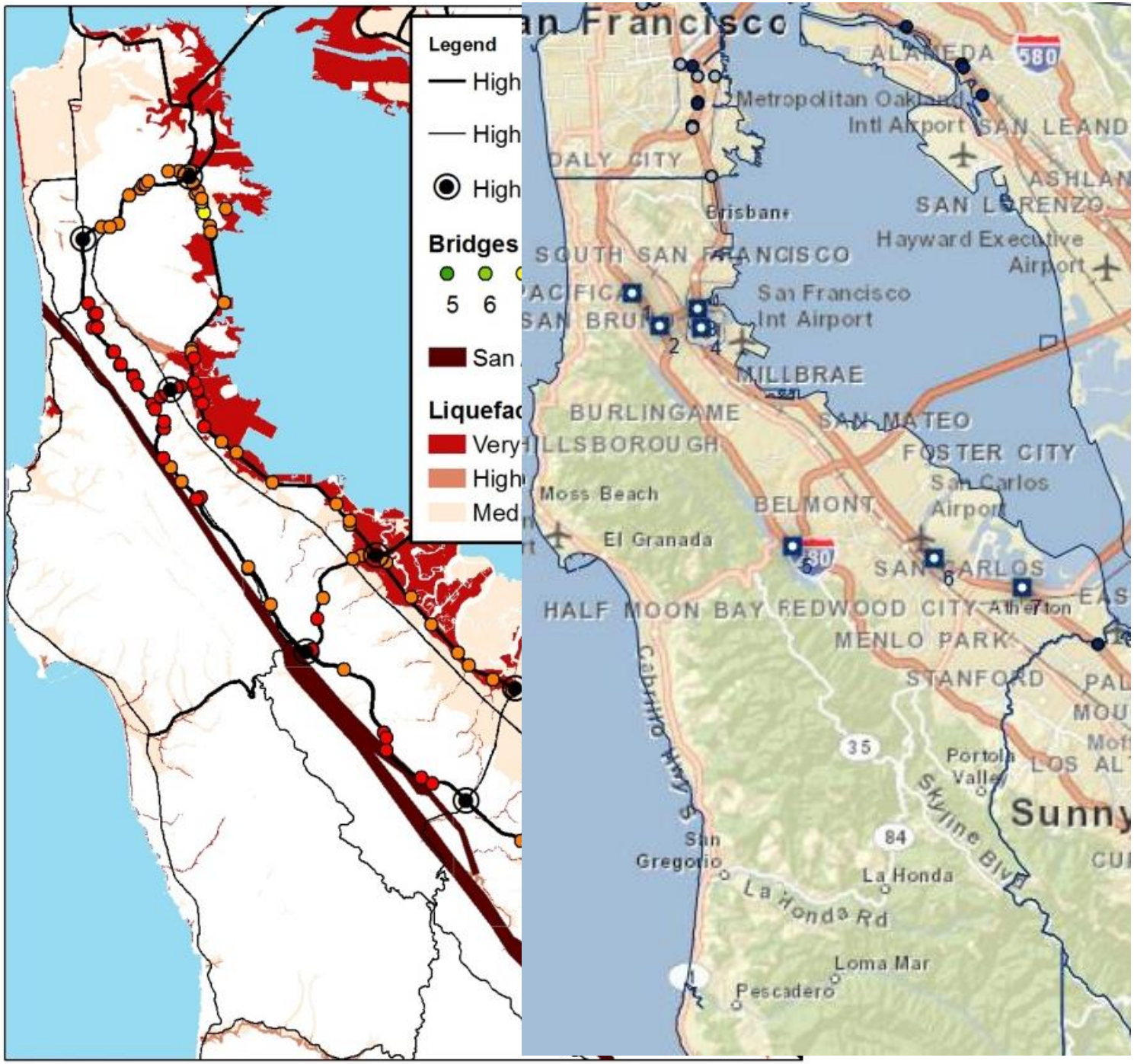
Probabilistic vs. Deterministic

The scenarios studied also need to be narrowed.

- Same thinning process.
  - Regional Earthquake
    - San Andreas
    - Hayward
    - Mention of Others
  - Significant Forces
    - Shaking
    - Fault Rupture, Near Fault Ground Motion
    - Ground Failure
      - Liquefaction
      - Lateral Spreading
      - Landslides / Rockfalls




Legend
Liquefaction Susceptibility
Very High
Medium
MMI Level of Shaking
5
6
7
8
9


Legend
High
High
High
Bridges
5 6
San
Liquefac
Very
High
Med
an Francisco
ALAMEDA
580
Metropolitan Oakland
Intl Airport
SAN LEAND
DALY CITY
ASHLAN
Brisbane
SAN LORENZO
Hayward Executive
Airport
SOUTH SAN FRANCISCO
PACIFICA
San Francisco
Int Airport
SAN BRUN
MILLBRAE
BURLINGAME
SAN MATEO
HILLSBOROUGH
FOSTER CITY
San Carlos
Airport
Moss Beach
BELMONT
El Granada
SAN CARLOS
HALF MOON BAY
REDWOOD CITY
Atherton
MENLO PARK
STANFORD
Cabrillo Hwy S
35
Portola
Valley
Skyline Blvd
Sunny
84
San
Gregorio
La Honda
La Honda Rd
Loma Mar
Pescadero

System structure will be discussed implicitly.

$$\cancel{Pf_{Peninsula\ NS\ travel} = Pf_{280} + Pf_{101} - Pf_{280 \cap 101}}$$

"Between the 280, 101 interchange and highway 92, both 280 and 101 could experience failures. A deficient bridge on 280 will experience severe shaking, while 101 passes through a long stretch of very high liquefaction."

Data needs

- Geographic data (GIS) of system components.
- System understanding.
- Status of system components
  - Age, retrofit (Y/N), etc.
- Customer grid.

DATA WISH LIST

	INFRASTRUCTURE	GEOGRAPHIC DATA	RESISTANCE DATA	CONSEQUENCE DATA
WATER	Potable Water	Transmission Pipes	X	Reservoir Capacity
		Reservoir		Public Users
		Pumping Facility, Surge Control	X	Crit. Facility Users
ENERGY	Electric	Transmission Lines		Public Users
		Substations	X	Crit. Facility Users
		Source Plants	X	
	Fuel (Jet, Crude)	Transmission Pipes	X	Crit. Facility Users
		Refineries	X	Regional Storage
		Shutoff Points	X	
	Natural Gas	Transmission Pipes	X	Public Users
		Source Plants, Storage Sites	X	Crit. Facility Users
		Shutoff Points	X	Regional Storage
TRANSIT	Roads	Highways	X	Trips
		Bridges	X	
		On & Off Ramps???		
	Rail (Passenger)	Bart Line	X	Trips
		Caltrain	X	
		Amtrak	X	
	Rail (Cargo)	Rail Lines	X	Trips
Comm.	Internet	Line		Public Users
		Servers/Hub???	X	Crit. Facility Users
	Cell Phone	Towers???	X	Public Users
				Crit. Facility Users

*Critical Facilities: Seaports, Airports, Hospitals