

Delta Risk Management Strategy (DRMS) The Challenges the Delta is Facing

**Presented to:
Pacific Earthquake Engineering Research
(PEER) Center
October 15, 2009**

**by
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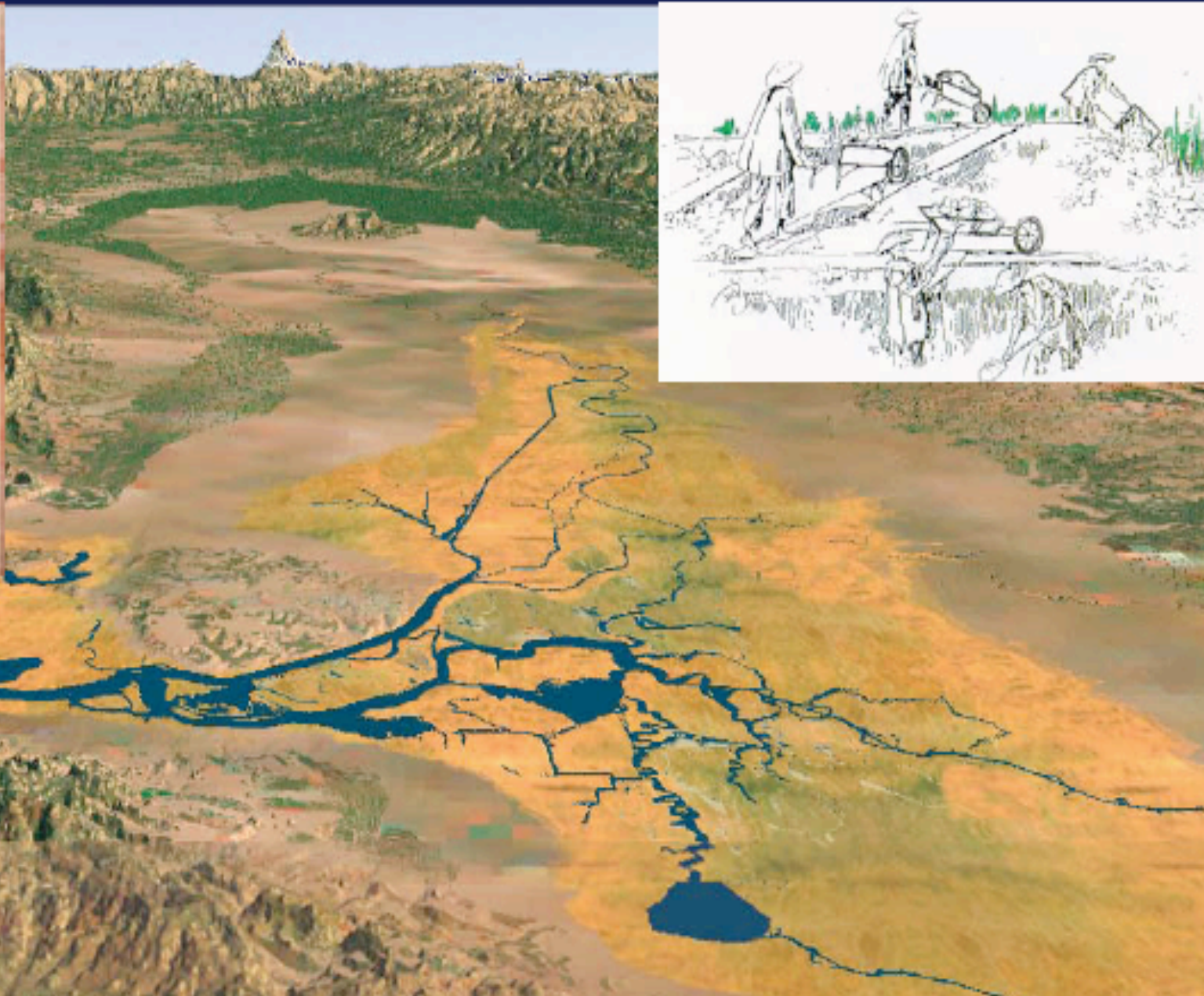
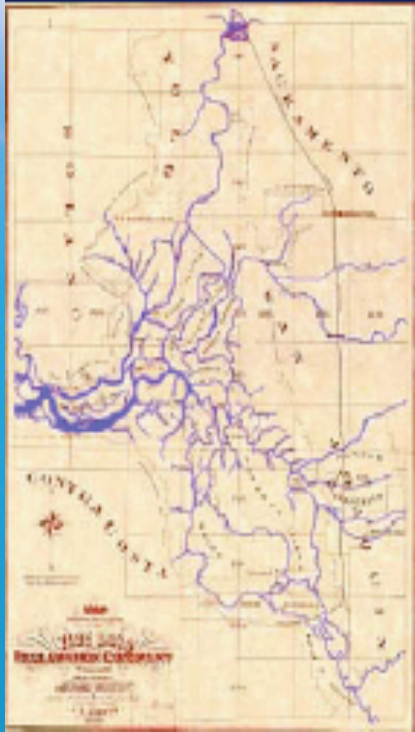
Sacramento-San Joaquin Delta



From: Les Harder

Sacramento – San Joaquin Delta

Reclamation of a Tidal Marsh – beginning in late 1860's



From: Les Harder

The Legal Delta:

738,000 acres

~ 60 islands/tracts

1,115 miles of levees

- 3 State Highways
- Major Rail Lines
- Major Water and Natural Gas Pipelines
- 1 Critical Natural Gas Reservoir
- 2 Deep Water Ports
- Major Power Transmission Lines

From: Les Harder





- Supplies water to more than 22 million Californians, industry and agriculture
- Water supply supports \$400 billion state economy
- Home for more than 400,000 people
- Habitat for 500 species
- Highways, pipelines, power distribution, railroads, and deep water ports



Sacramento Pocket Area



Ref: "Flood Warning -Responding to California Flood Crisis" DWR Jan 2005

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Sutter Bypass 1997 & Taylor Island 1986



Ref: "Flood Warning -Responding to California Flood Crisis" DWR Jan 2005

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Jones Tract, June 2004



Ref: "Flood Warning -Responding to California Flood Crisis" DWR Jan 2005

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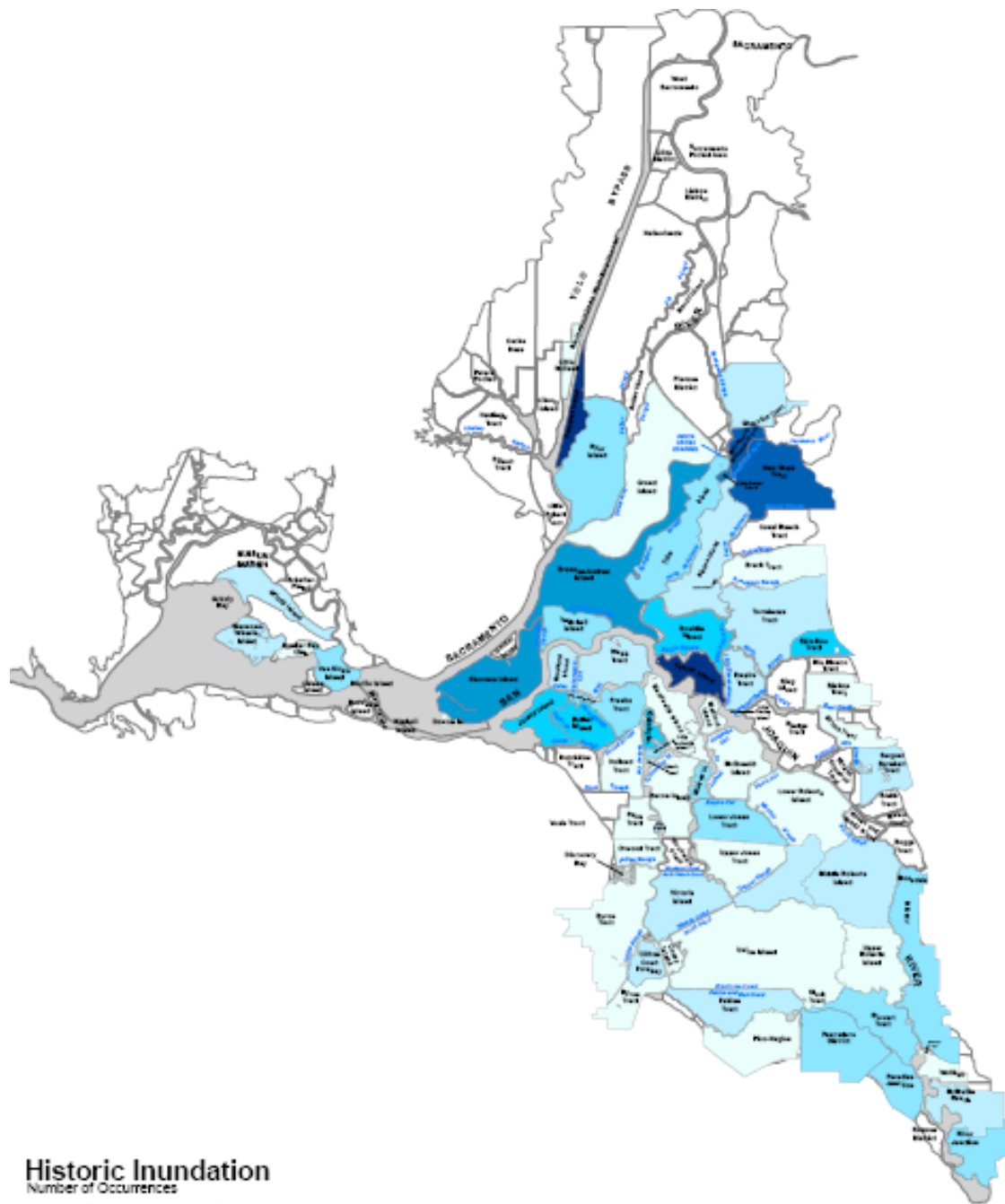
Bradford Island

Jones Tract Failure, June 2004

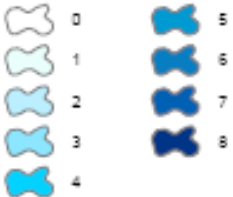


Webb Tract - Today





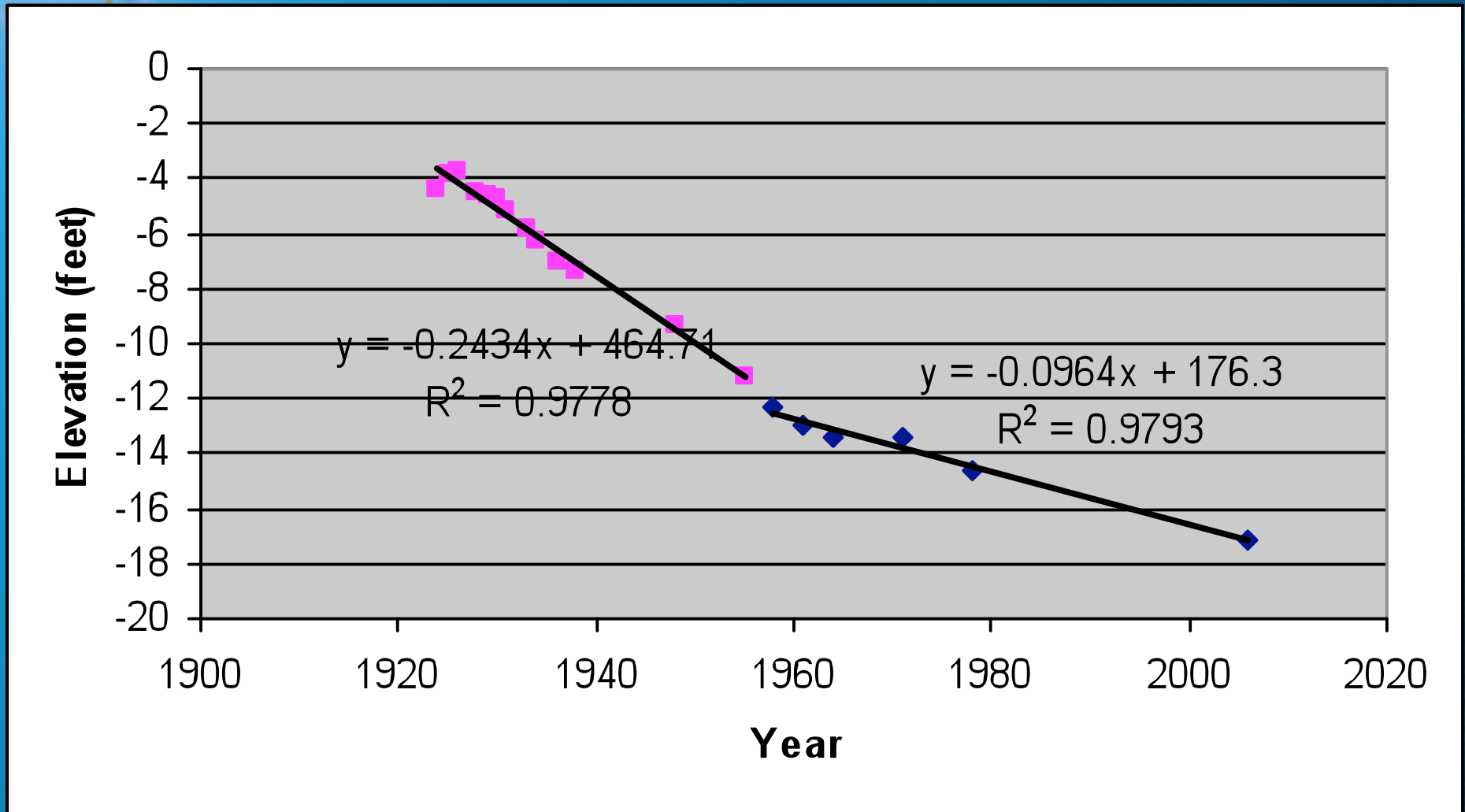
Historic Inundation
Number of Occurrences



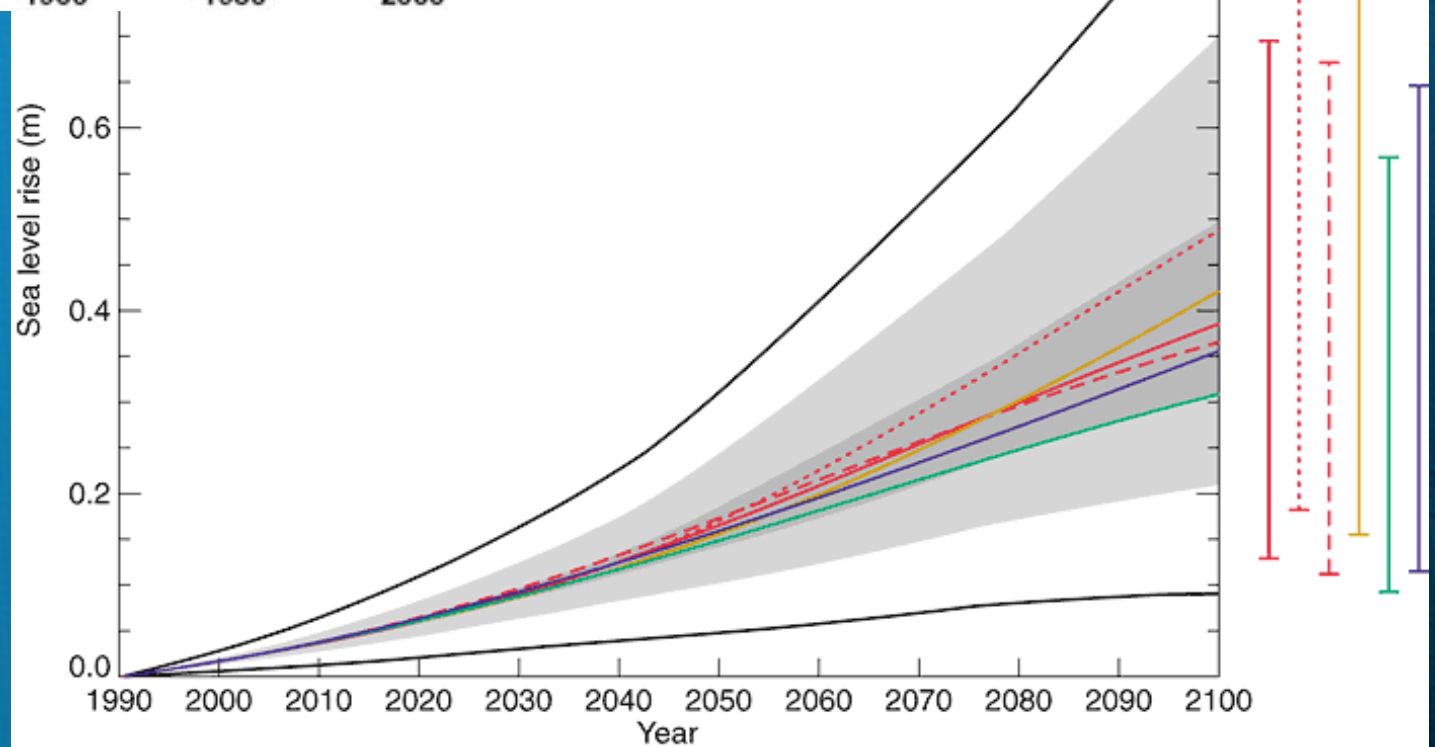
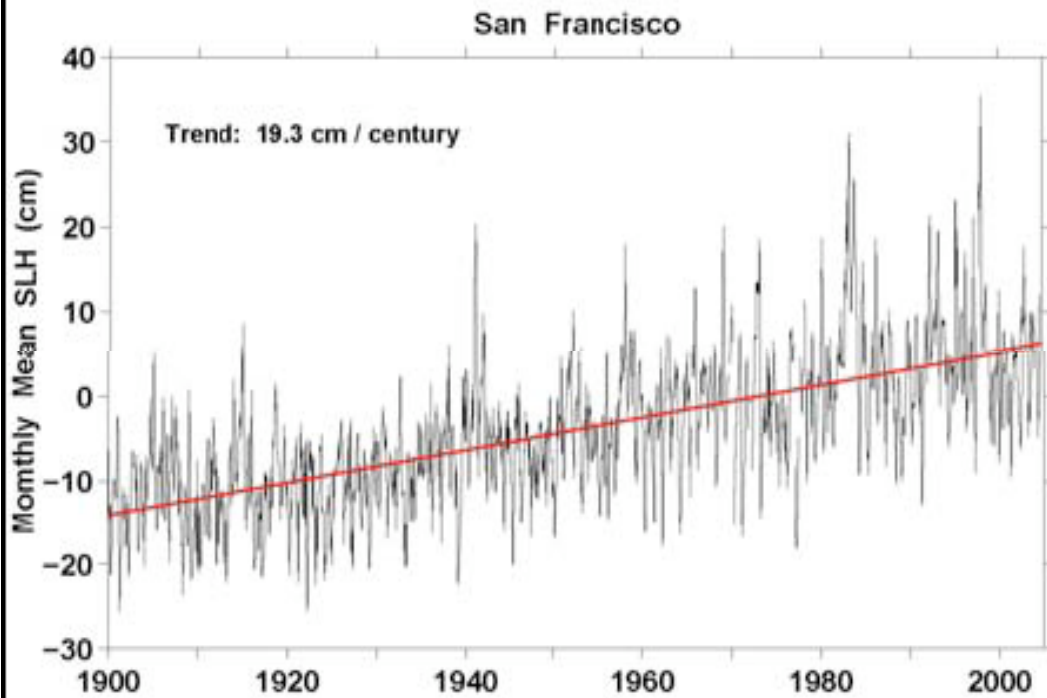
160+ Islands
Flooded
in the Delta
Since 1900

What are the Delta Threats?

Land Subsidence, Bacon Island



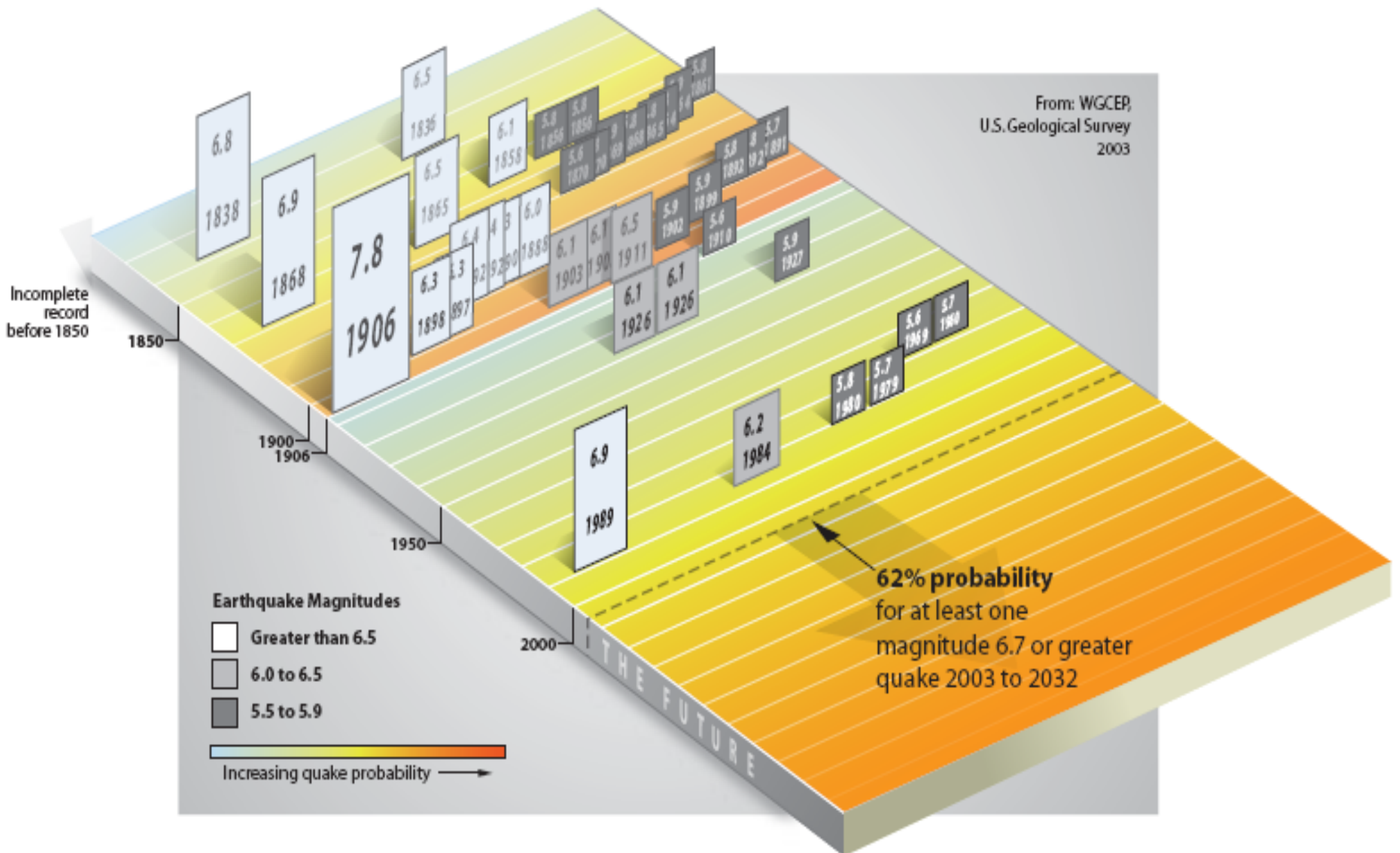
Sea Level Rise



Dan Cayan et al., March 2006

CRIS

PAST AND FUTURE SEISMIC EVENTS IN THE BAY-DELTA REGION



Kobe 1995 M 6.9 Earthquake, Japan



From: Prof. Ray Seed

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Moss Landing, 1989 Loma Prieta EQ, M 6.7



Pajaro River Levee, 1989 Loma Prieta EQ, M 6.7



DRMS - Project Scope

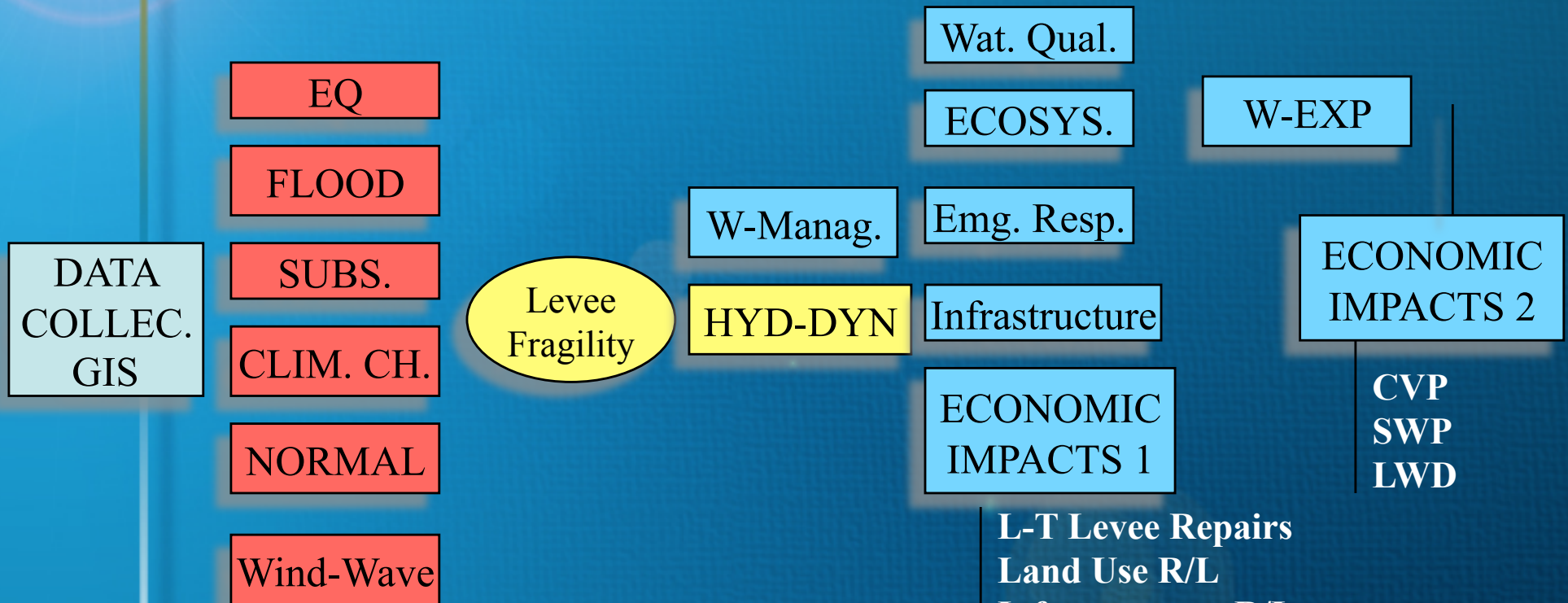
AB-1200 set the General Framework:

- “Risk-Based Evaluation”
- Subsidence, Earthquakes, Floods, Climate Change, “Normal Conditions”, & Combination
- Impacts On 50-, 100-, 200-year Projections
- Develop and Comparatively Rate Each Option
- Prevent Disruption of Water Supplies
- Improve Water Quality

Project Scope (cont.)

- Protect & Enhance Ecosystem
- Assist In Preserving Delta Lands
- Protect The Infrastructure
- Preserve, Protect, Improve Delta Levees
- “Public Safety”

DRMS – Project Activities-Phase 1

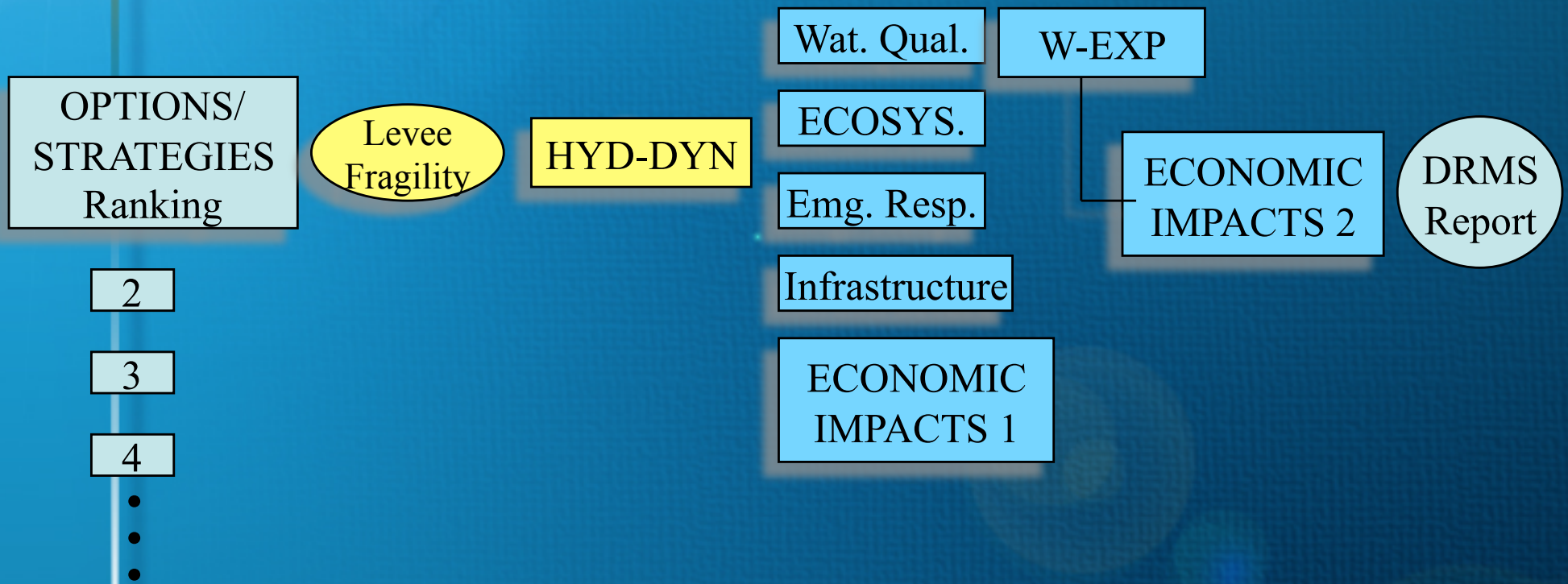


Notes:

R/L: Costs of Repair & Loss of Revenue/Resources

L-T: Long Term

DRMS – Project Activities- Phase 2

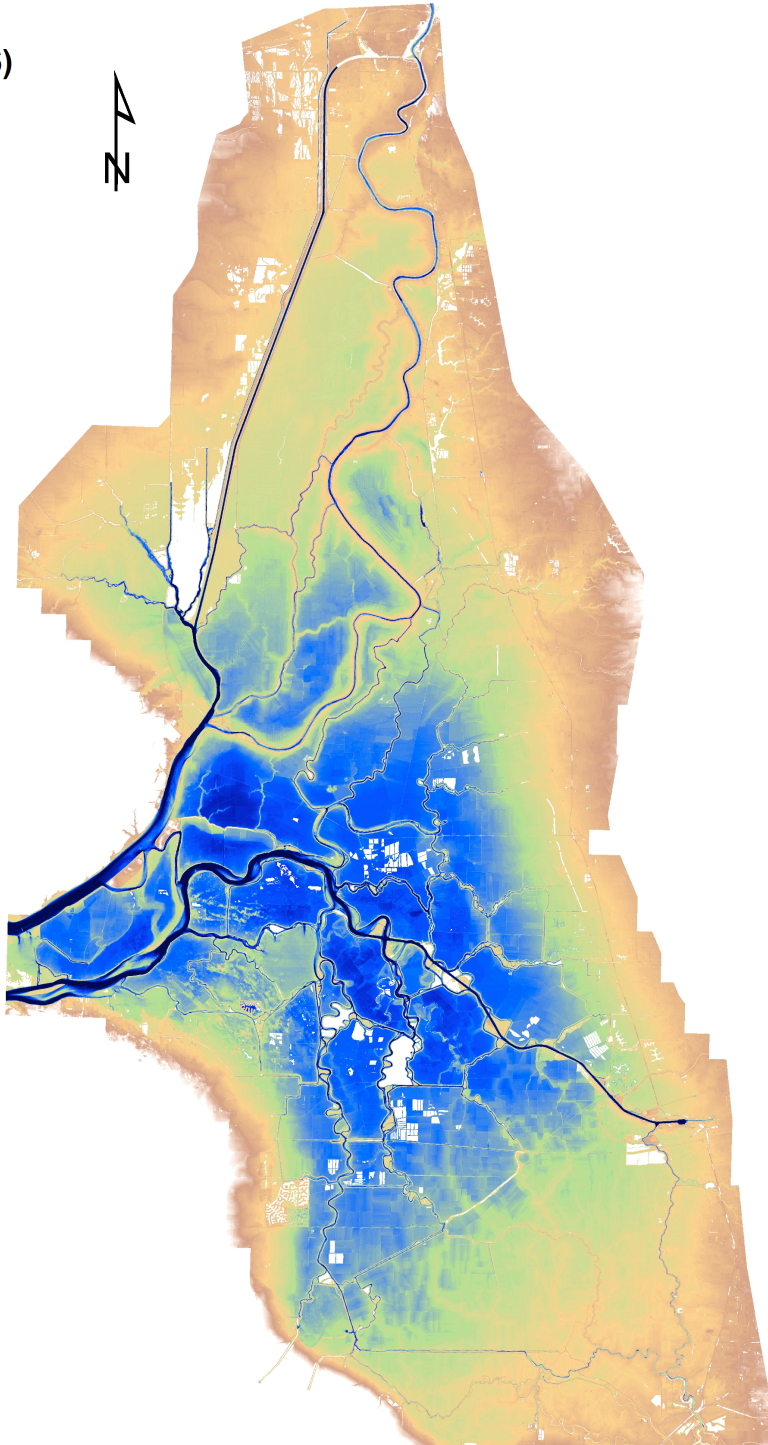
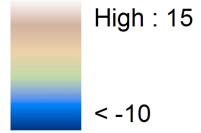


10 0 10 Kilometers



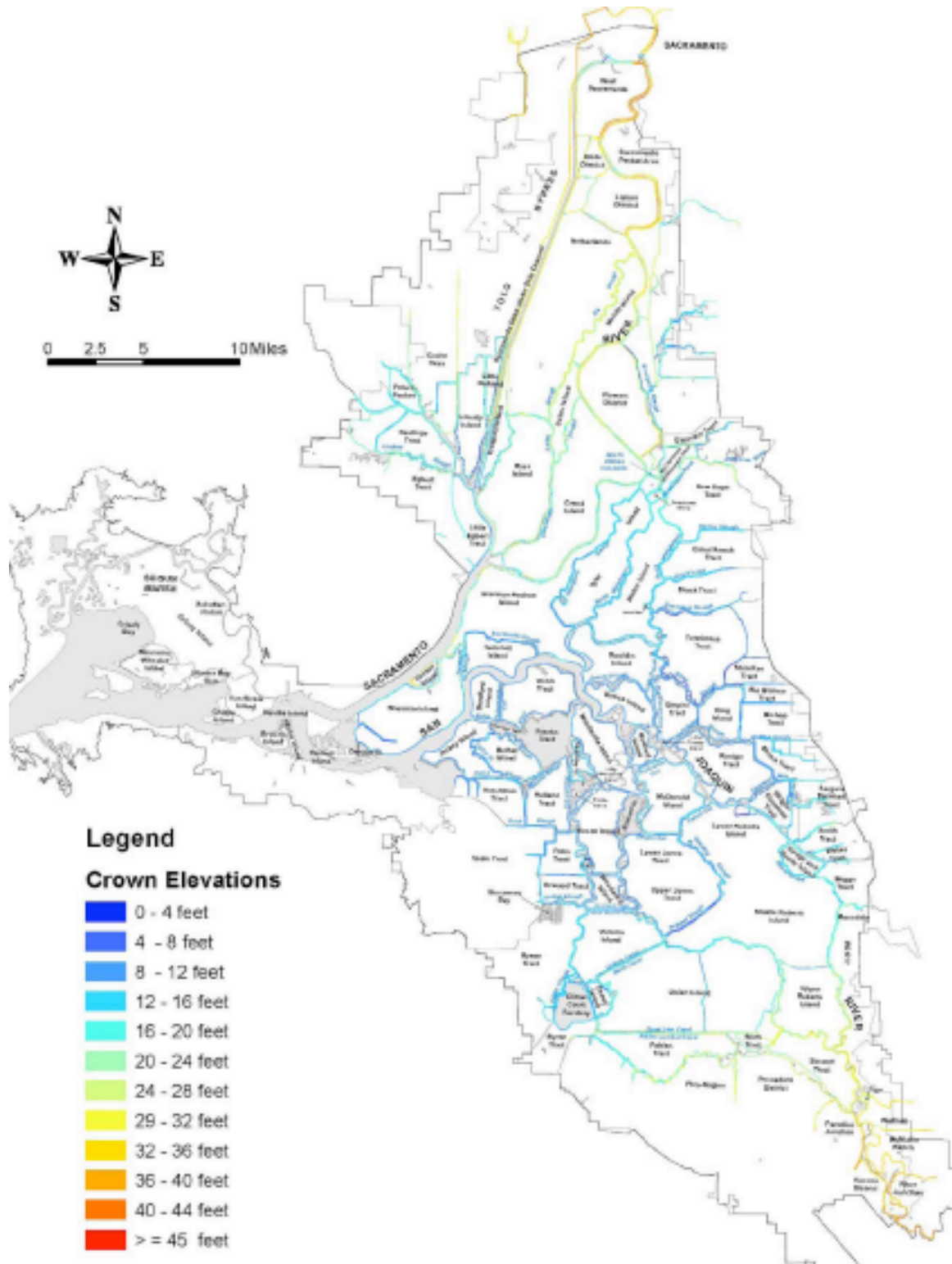
Delta Lidar (2006)

Meters (NAVD88)

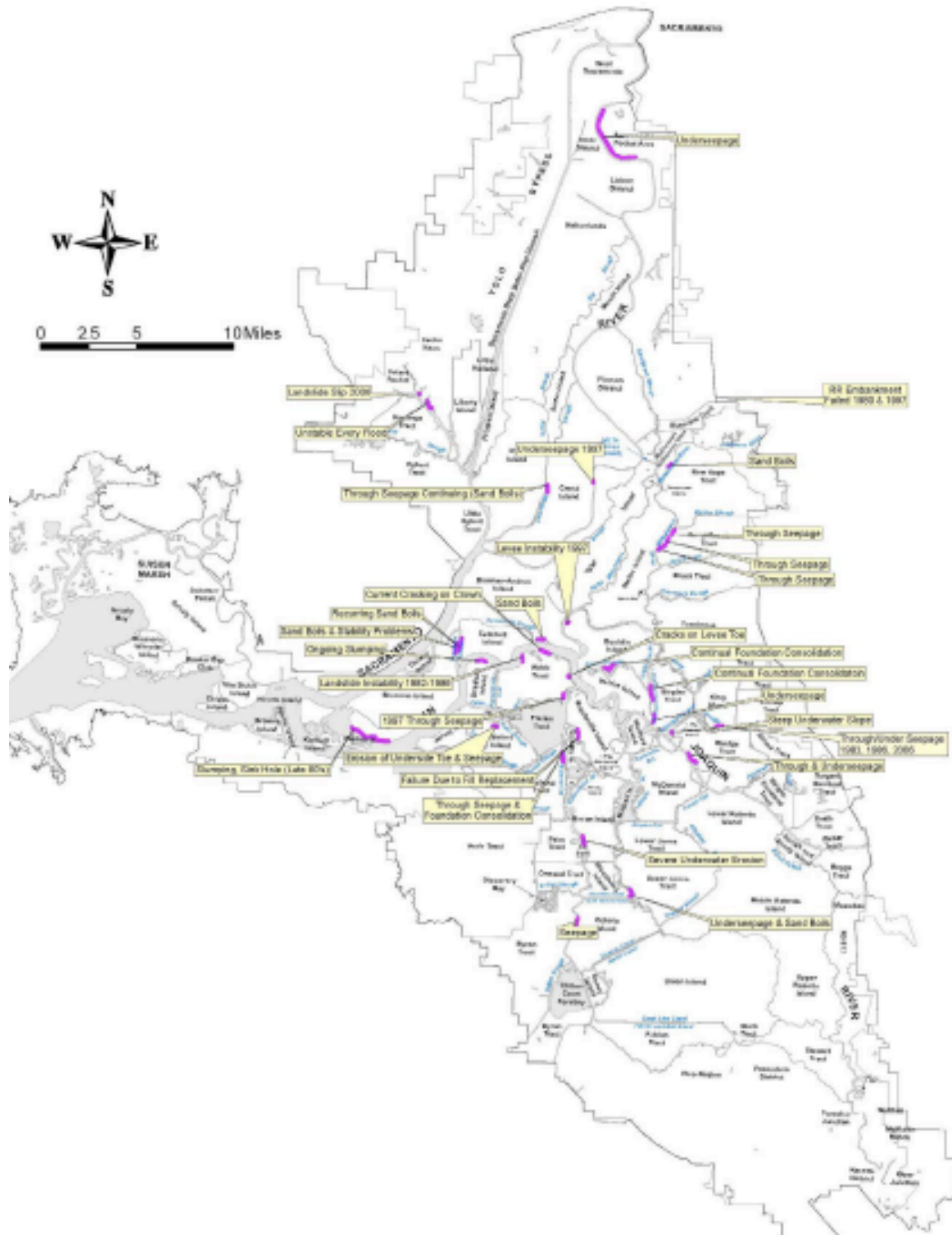


LiDAR Map of the Delta

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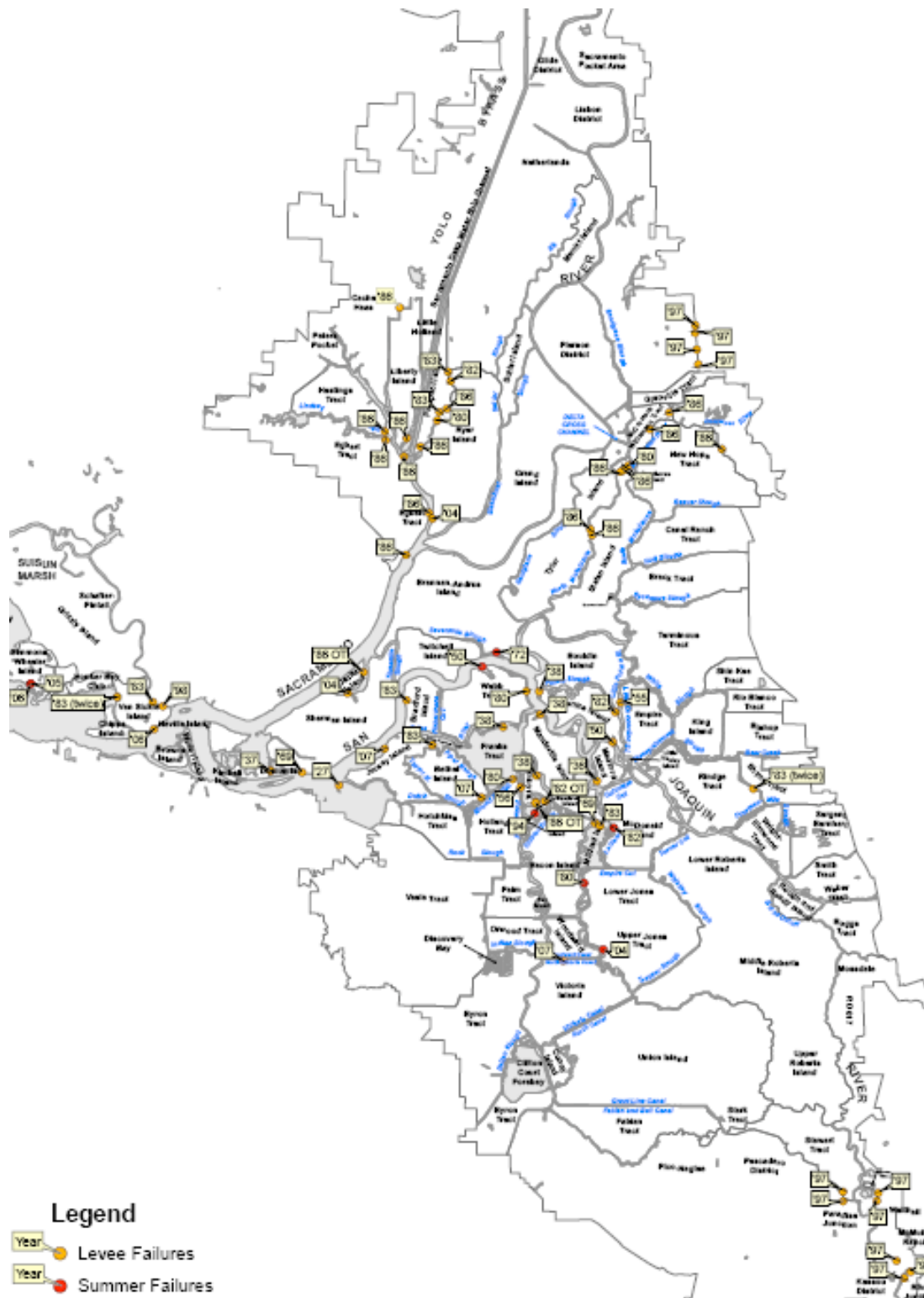


GIS Based Levee Crest Elevations



Recorded Levee Anomalies in the Delta

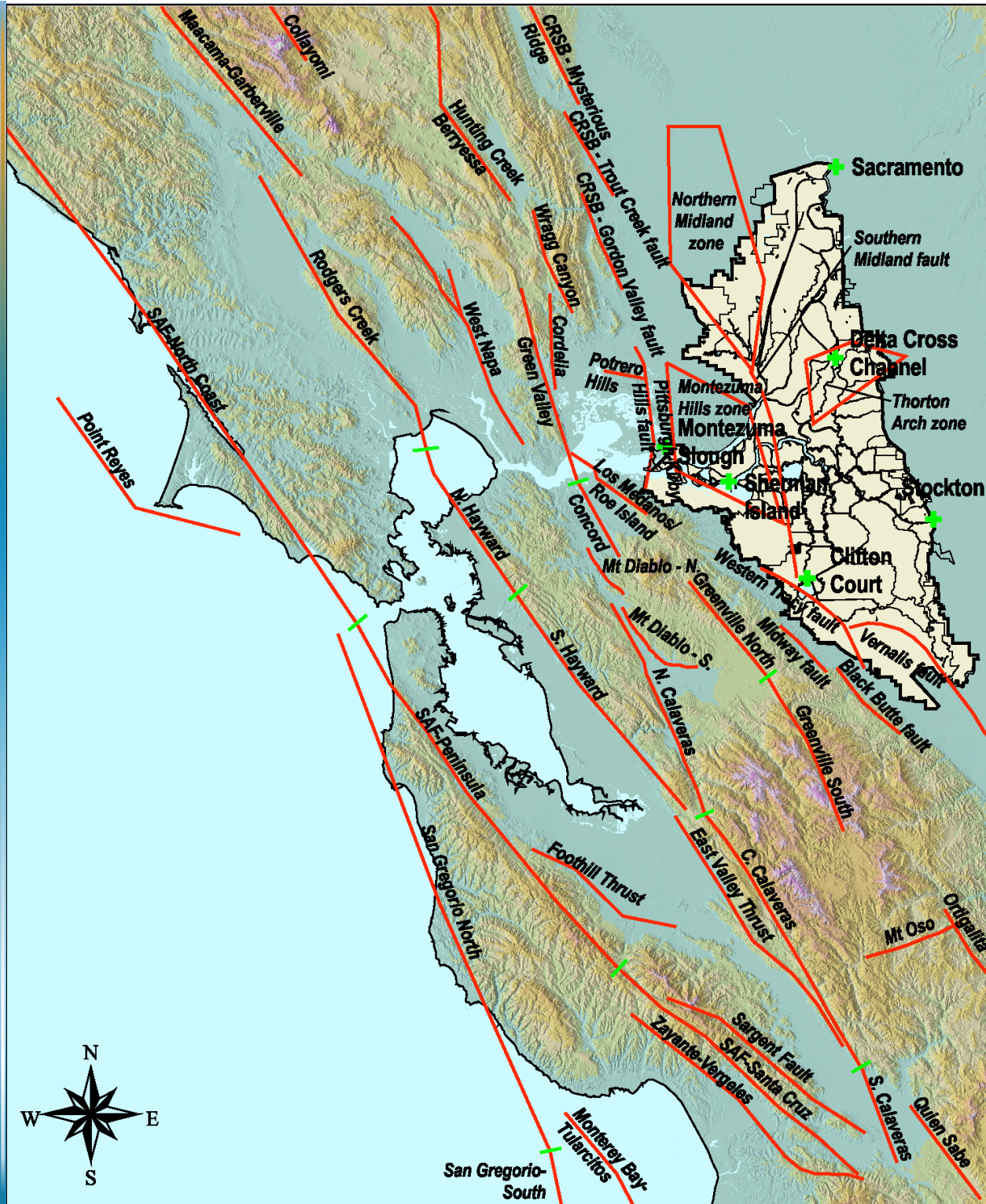
Mapped Location of Levee Breaches



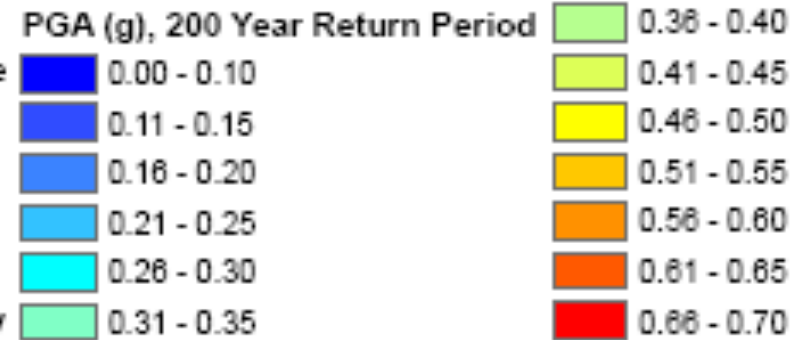
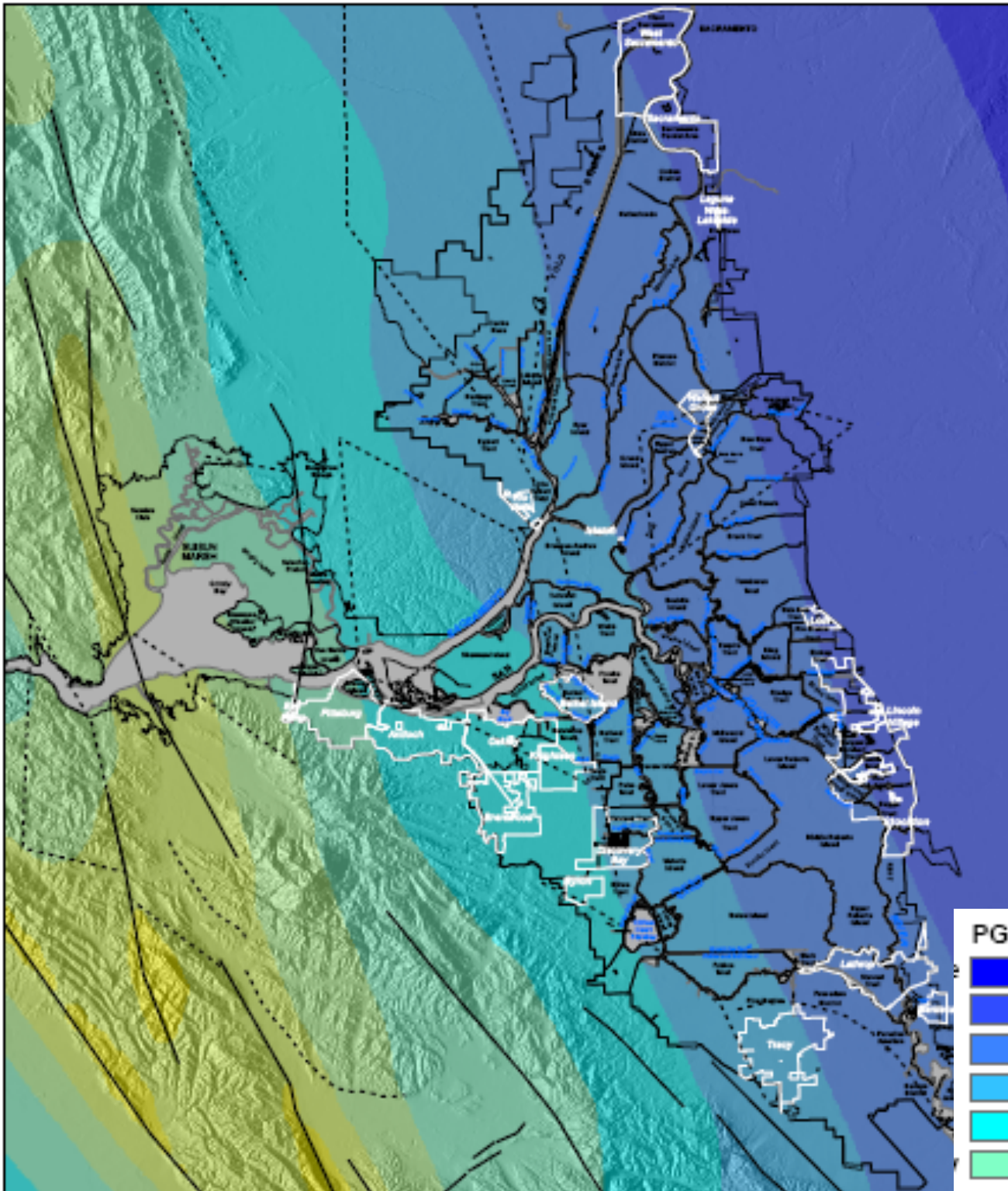
Seismic Hazard

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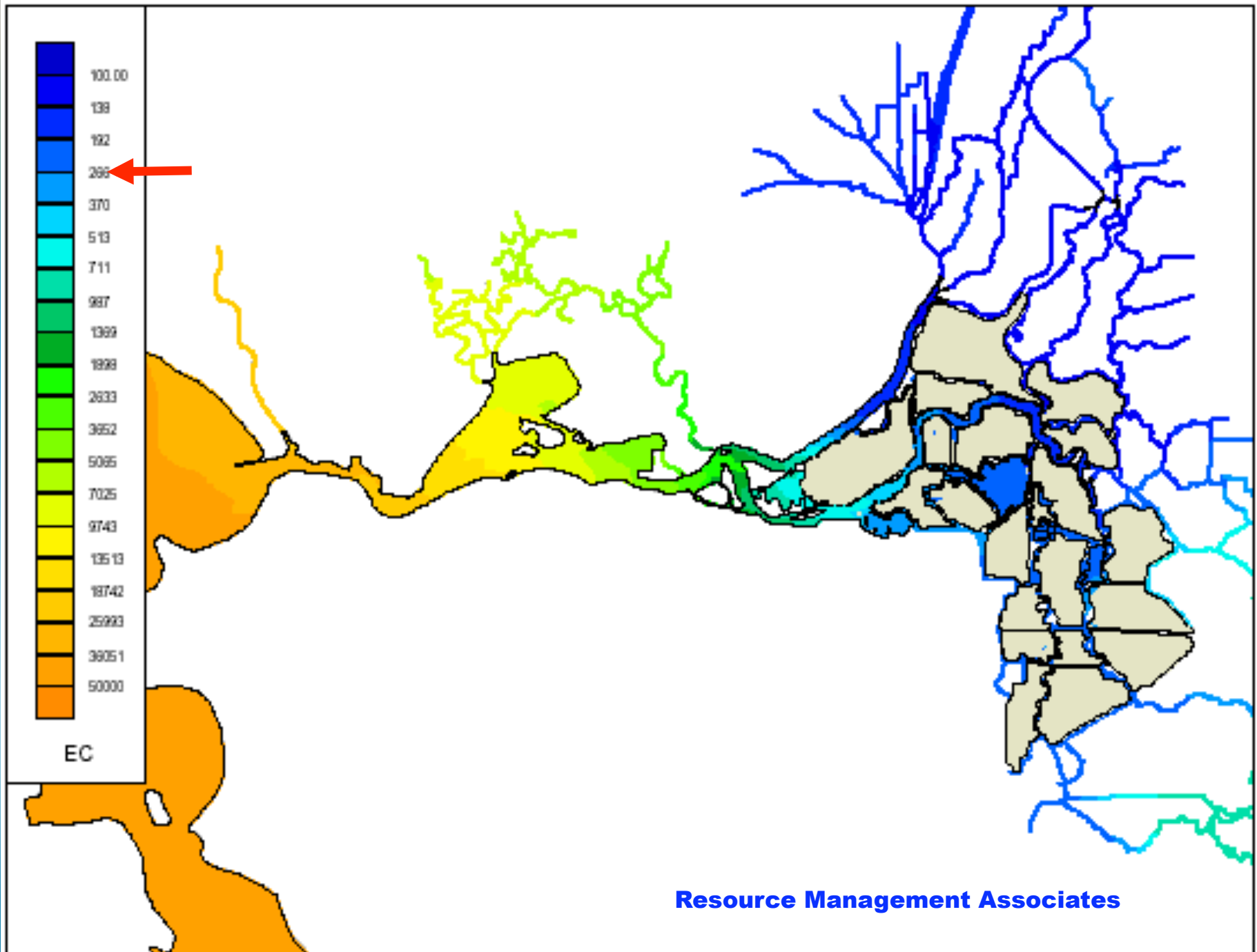
Bay Area Faults



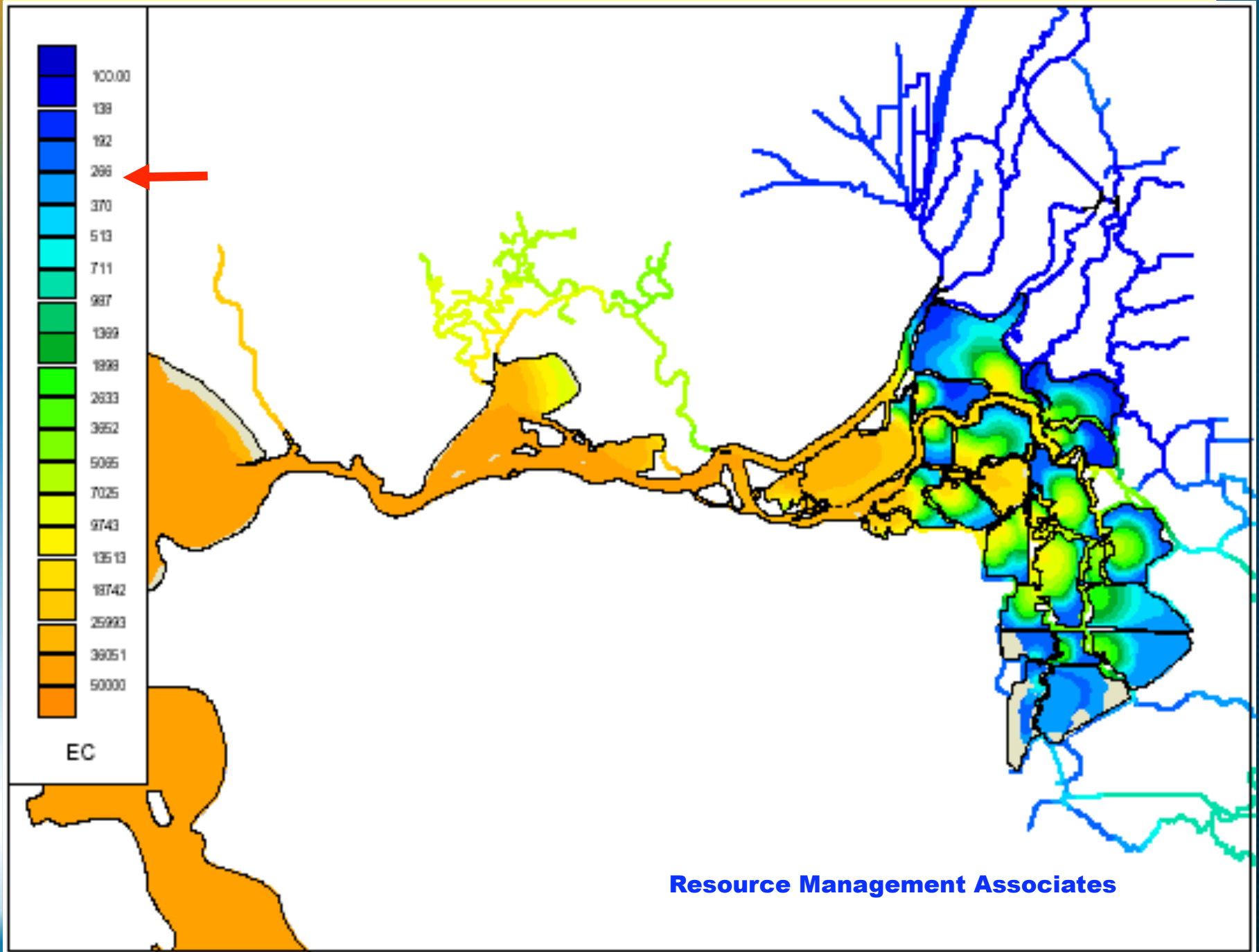
DRMS (200-Year Return Period Ground Motions)



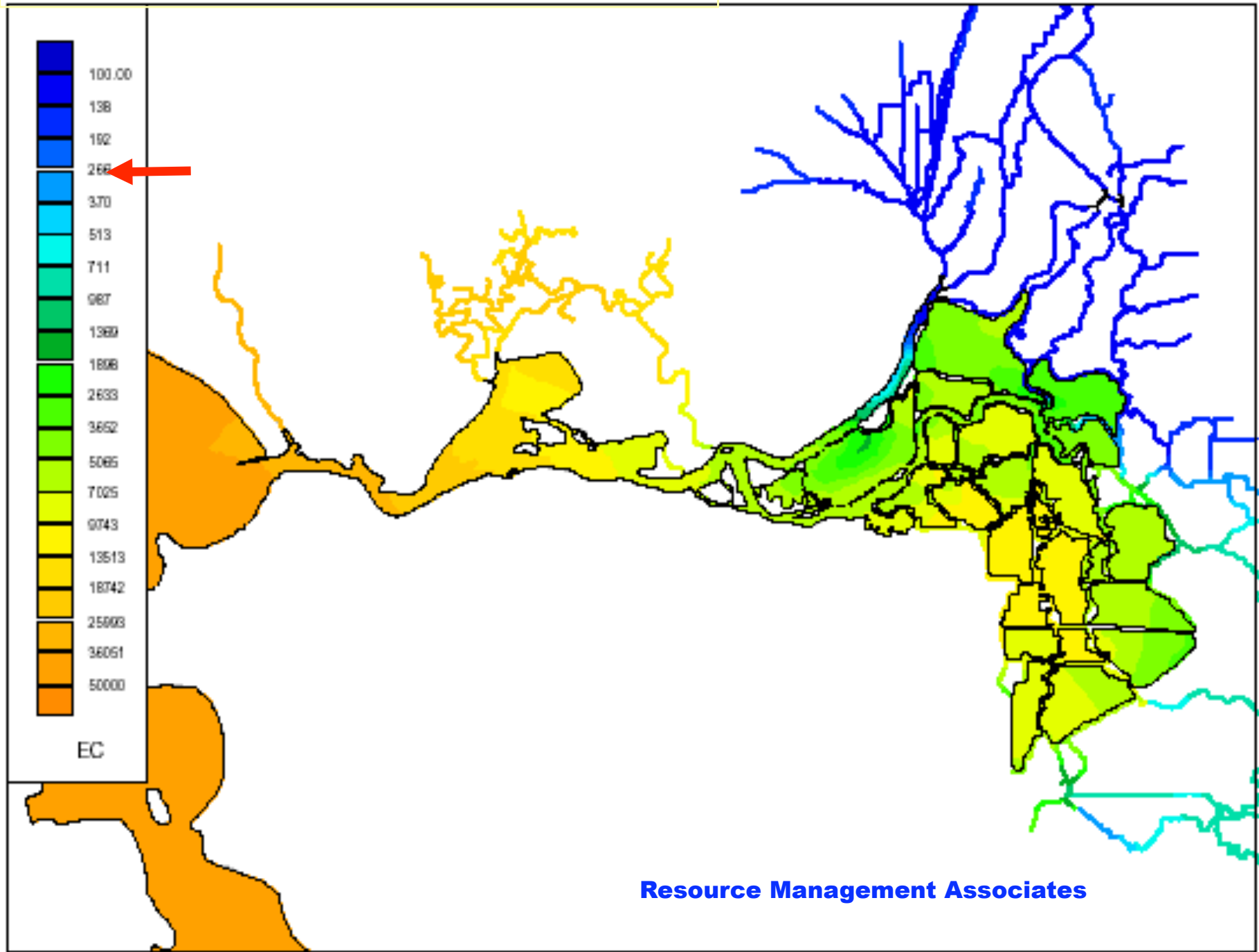
50 Breach Simulation – July 1 Prior to the Event



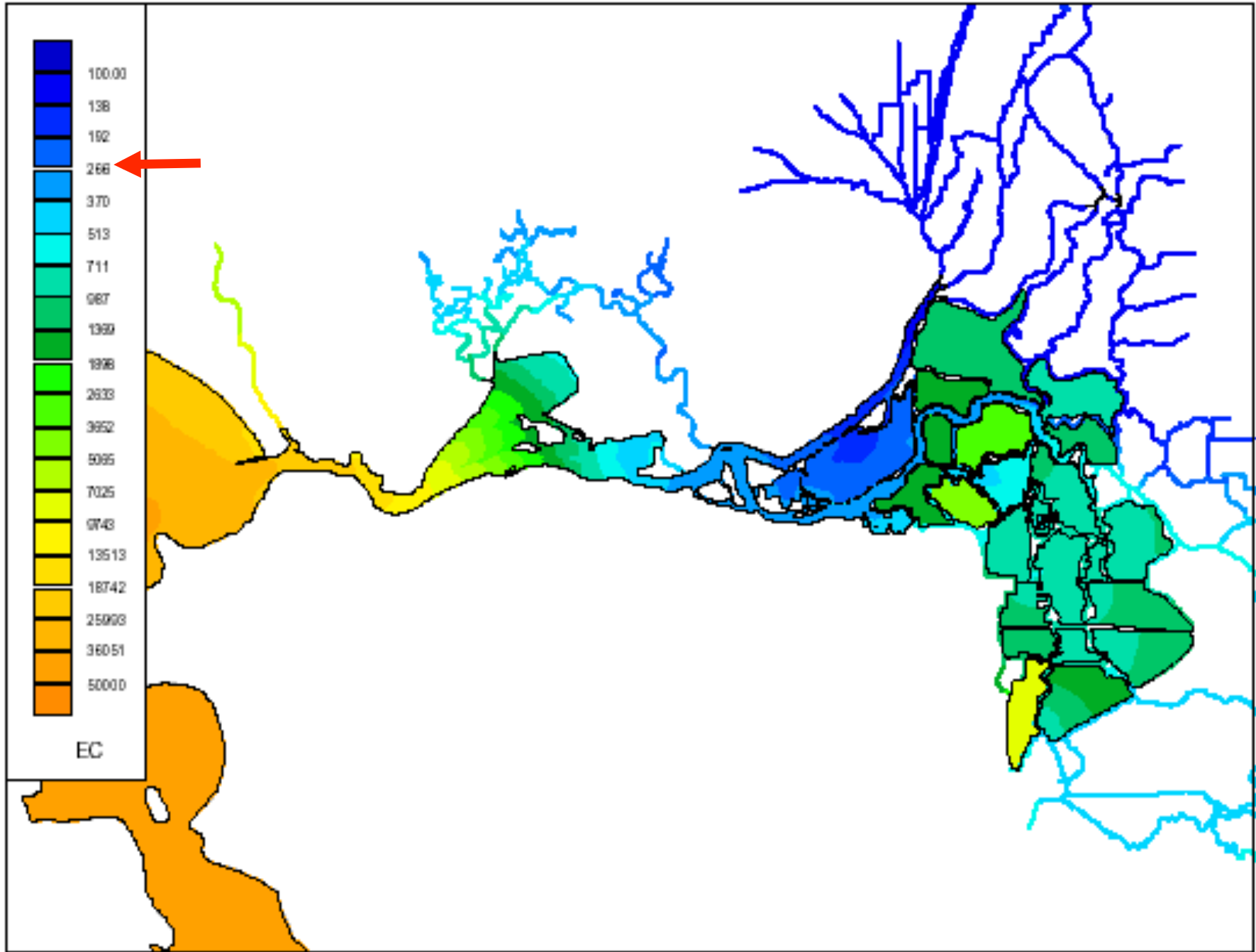
50 Breach Simulation – July 1, 12 hours after the breach



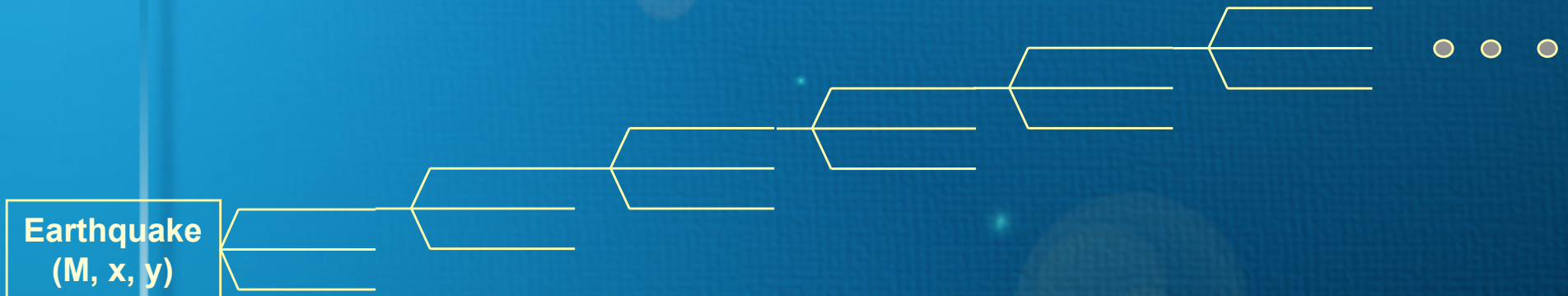
50 Breach Simulation – August 1



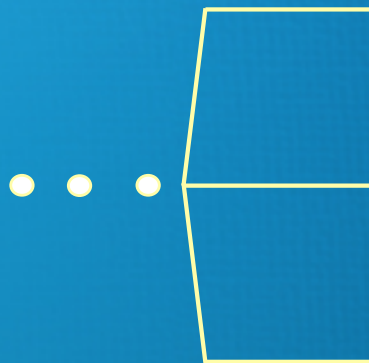
50 Breach Simulation – One Year Later



When the Earthquake Occurs



When the Earthquake Occurs



$F(L > l)_1$	$F(T_D > t)_1$	$F(\$ > c)_1$	$F(\$ > c)_1$	$F(E > e)_1$
⋮		⋮		⋮
⋮		⋮		⋮
⋮		⋮		⋮
$F(L > l)_i$	$F(T_D > t)_i$	$F(\$ > c)_i$	$F(\$ > c)_i$	$F(E > c)_i$
⋮		⋮		⋮
⋮		⋮		⋮
⋮		⋮		⋮
$F(L > l)_n$	$F(T_D > t)_n$	$F(\$ > c)_n$	$F(\$ > c)_n$	$F(E > e)_n$

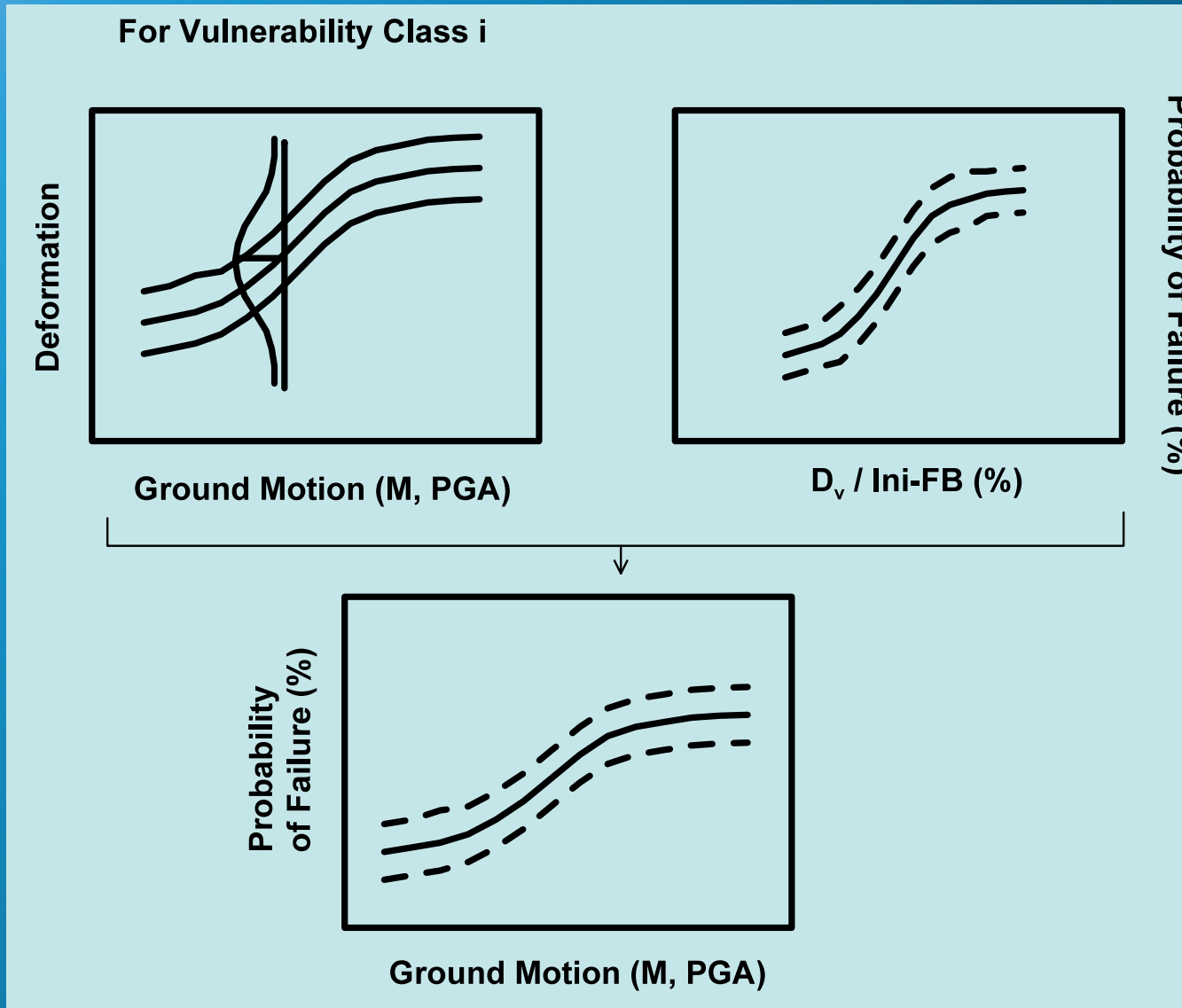
Risk Analysis Products by Category

Category	Metric
Levee Infrastructure	a. Flooded Islands
	b. Levee Breaches
	c. Individual Island
Water Exports	a. Number of Months of No Export Pumping (Months)
	b. Number of Months of No or Partial Pumping (Months)
	c. Million Acre-Feet/Year Exported (Fraction of 2005 Normal)
Public Health & Safety	a. Fatalities
	b. Injuries
	c. Homeless
Economic	a. In-Delta Economic Consequences
	b. Water Export Economic Consequences
	c. Other Statewide Economic Consequences
Ecosystem	a. Aquatic Species (Delta Smelt...)
	b. Loss of Habitat
	c. Terrestrial Species

	n. Environmental Metric n

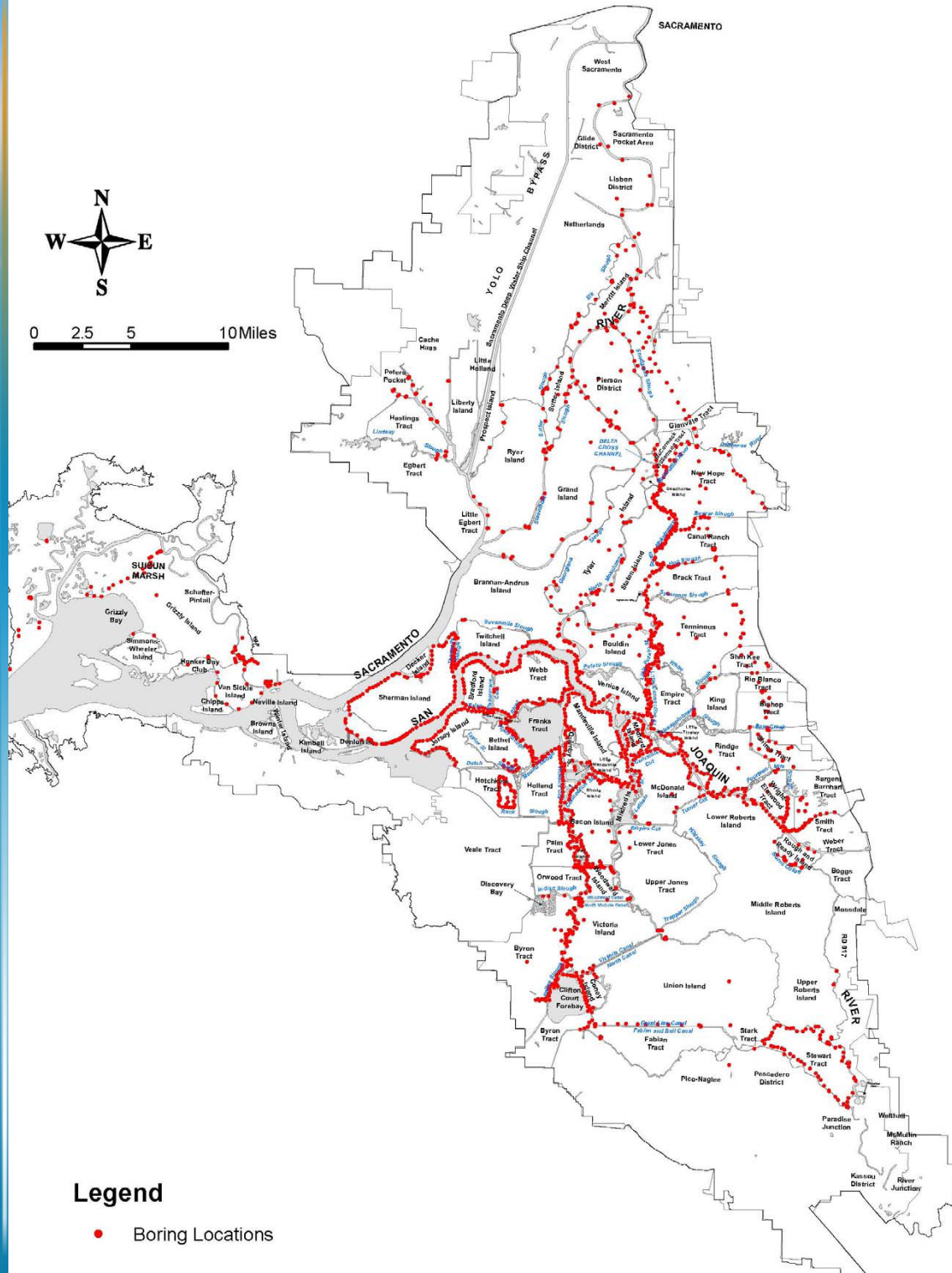
Levees Seismic Vulnerability

Seismic Fragility Functions





0 2.5 5 10 Miles

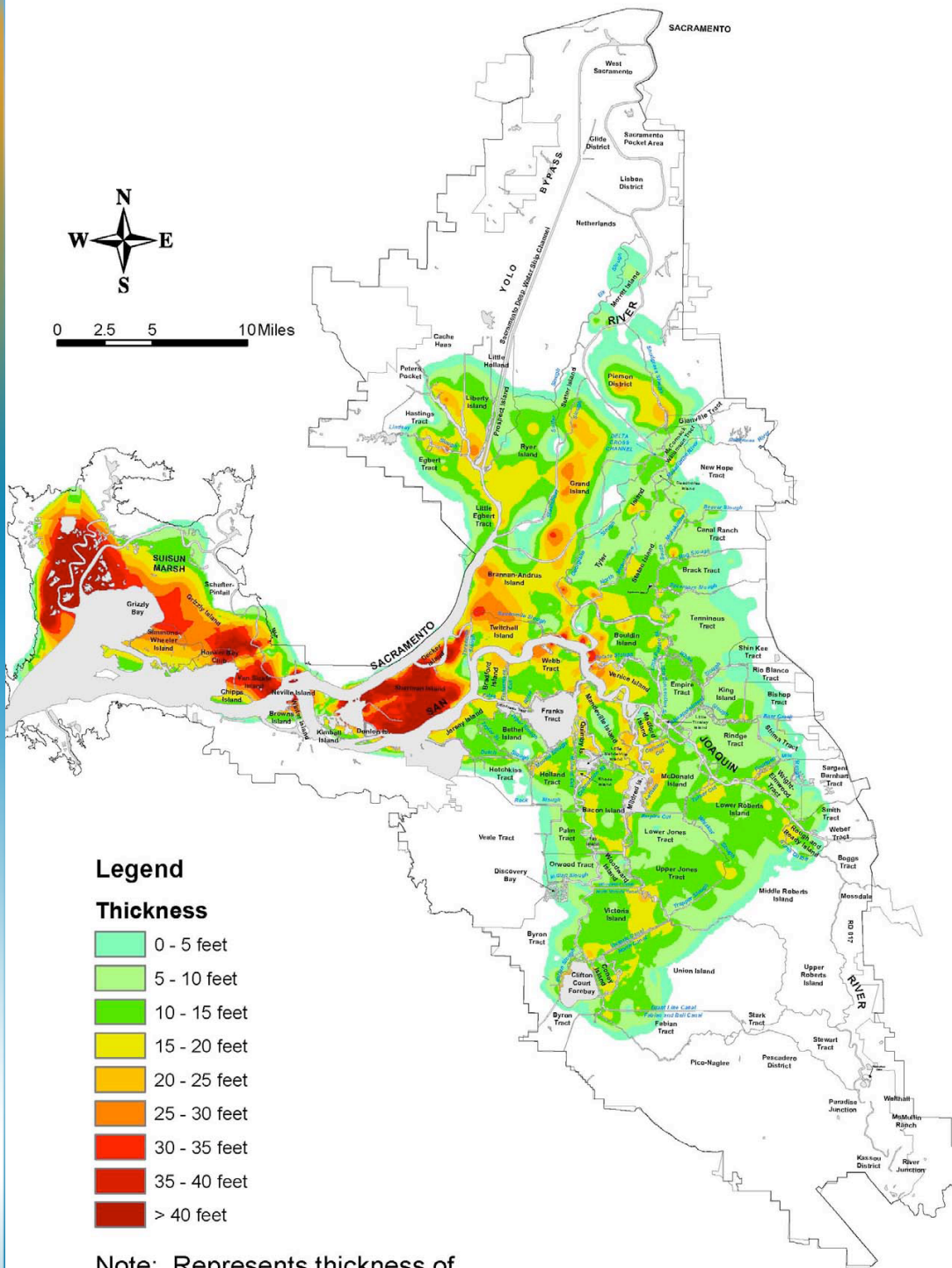


Legend

- Boring Locations

Borings Location Map

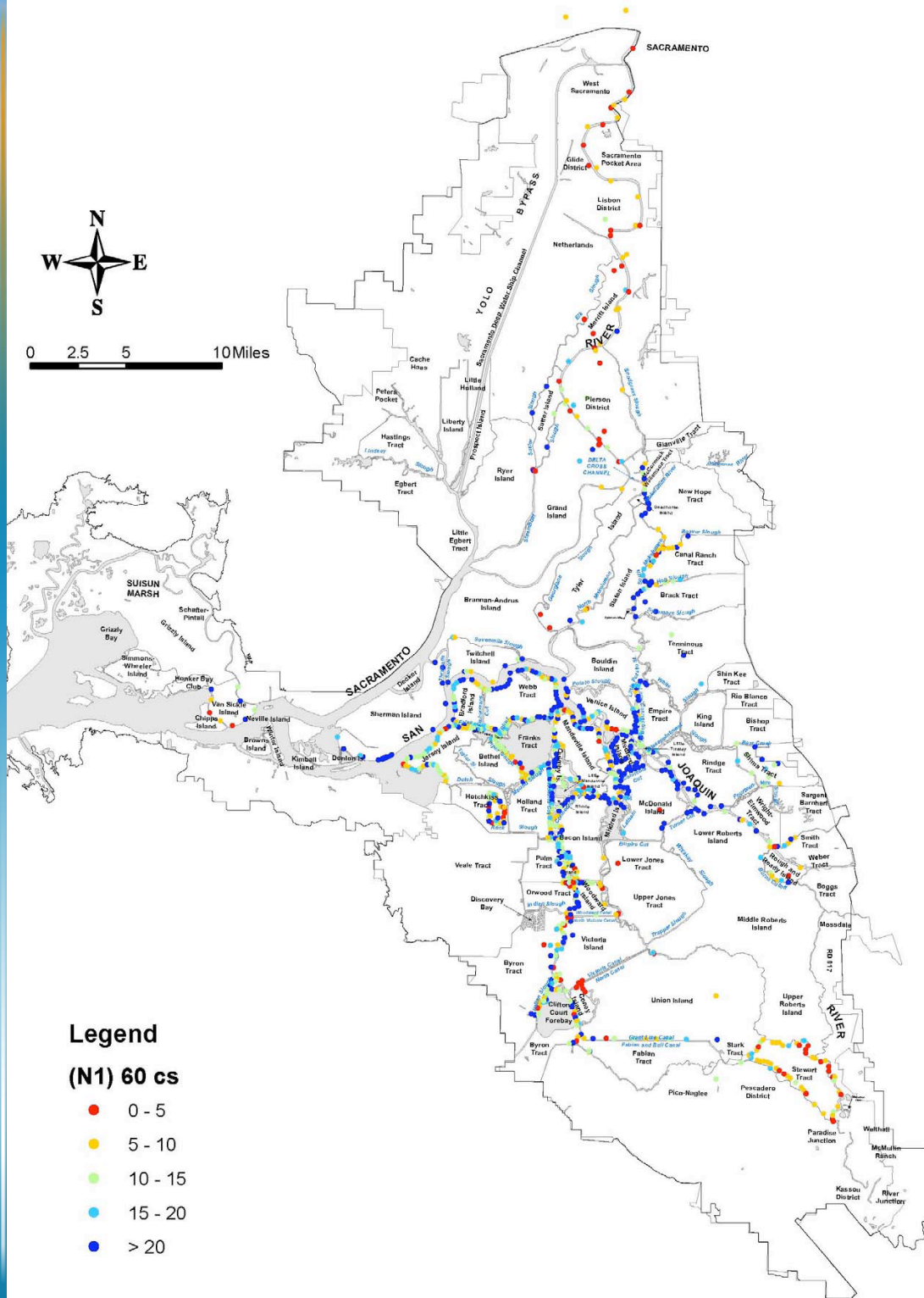




GIS-Based Peat & Organics Thickness Map



0 2.5 5 10 Miles



Legend

(N₁) 60 cs

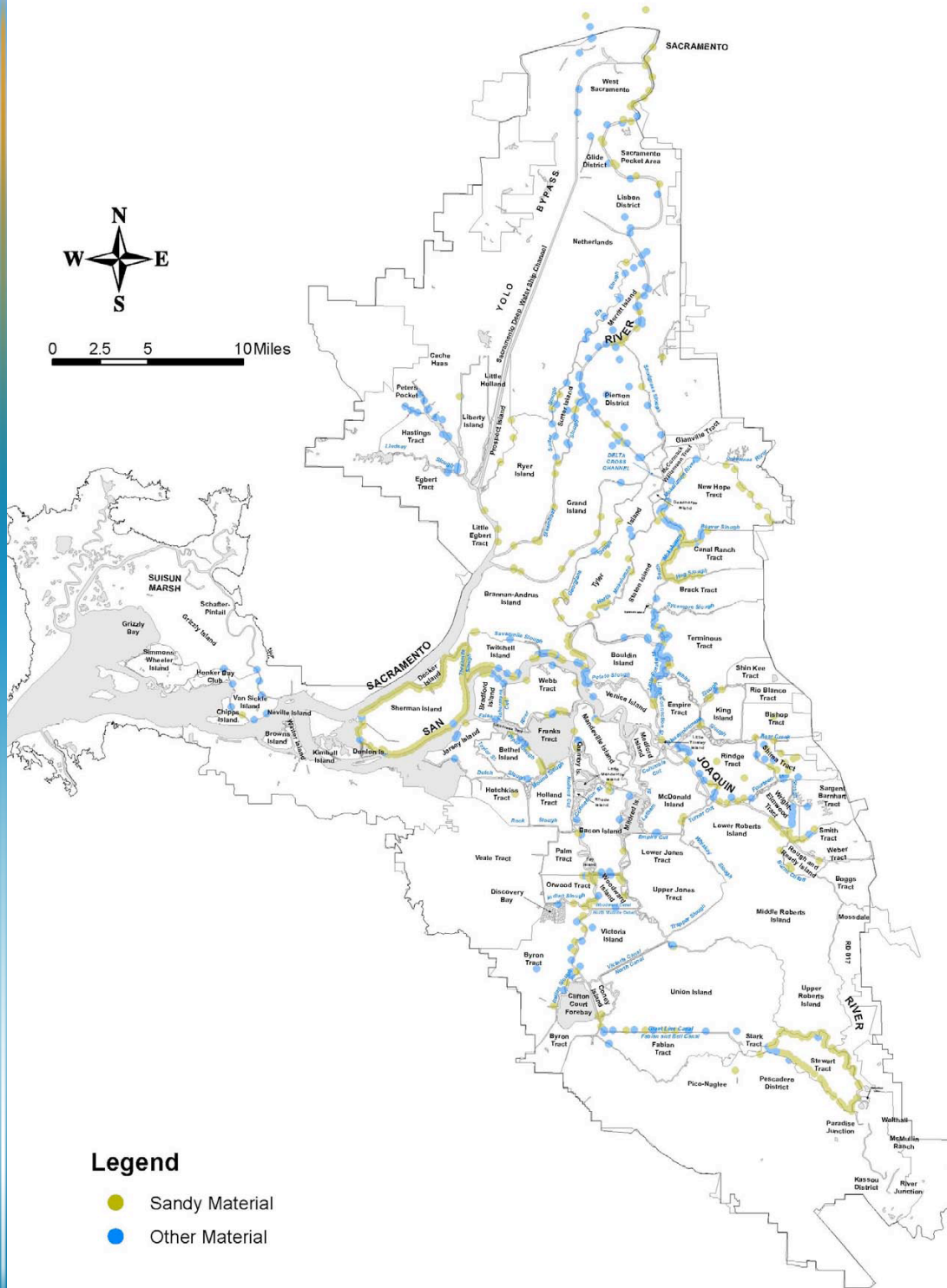
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- > 20

Foundation Sand Blowcount ($N_{1-60-cs}$) Maps

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0 2.5 5 10 Miles



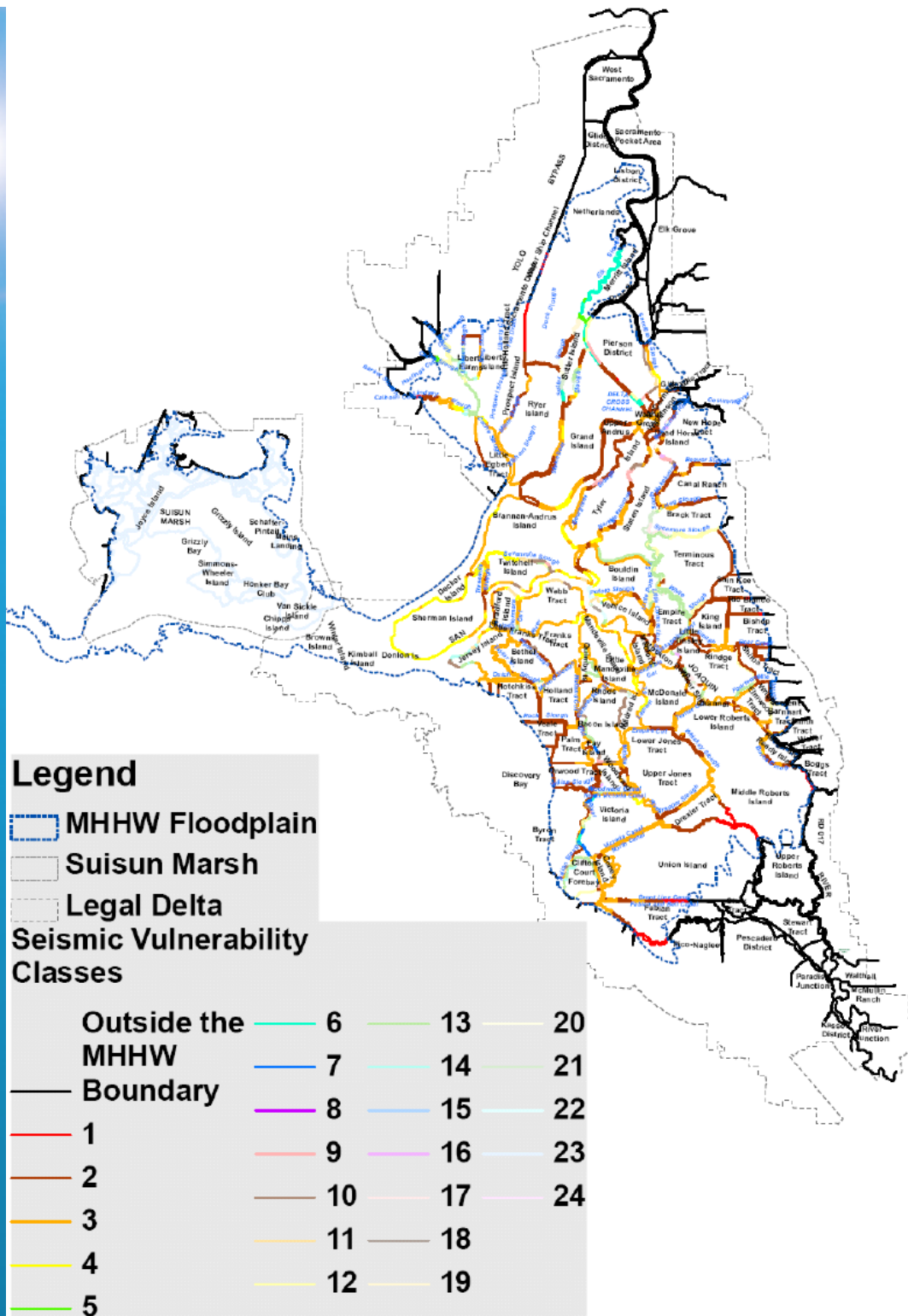
Legend

- Sandy Material
- Other Material

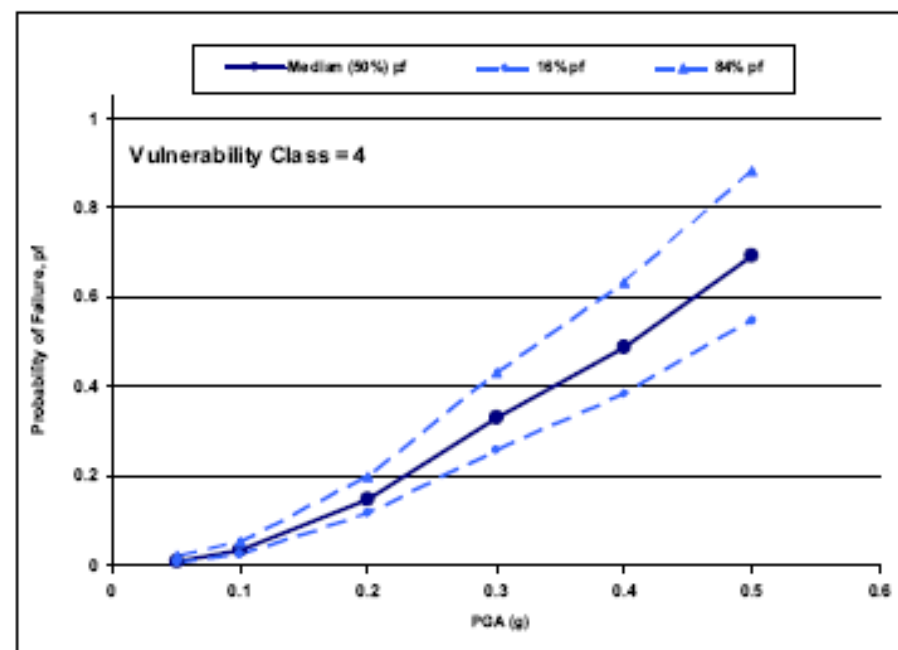
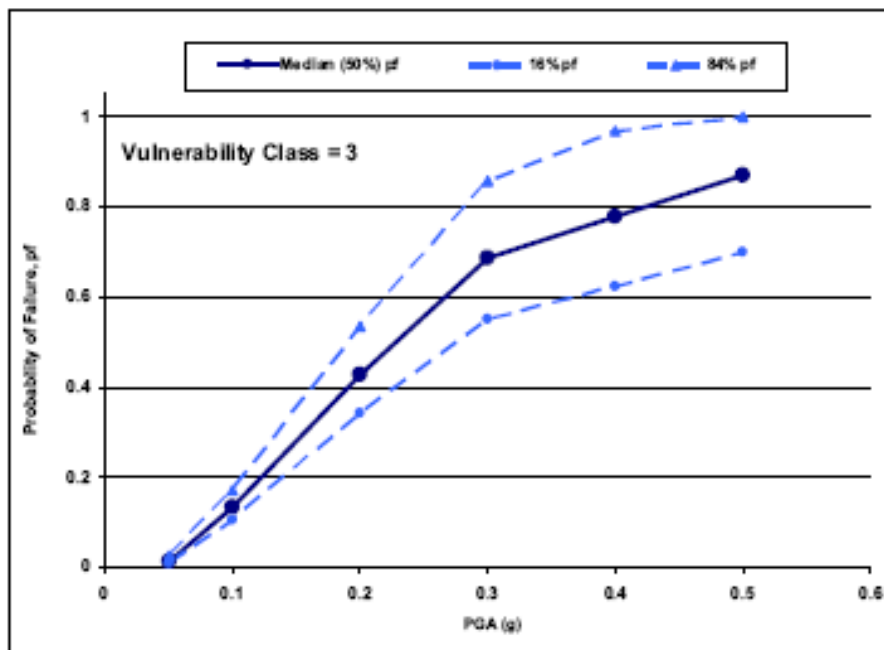
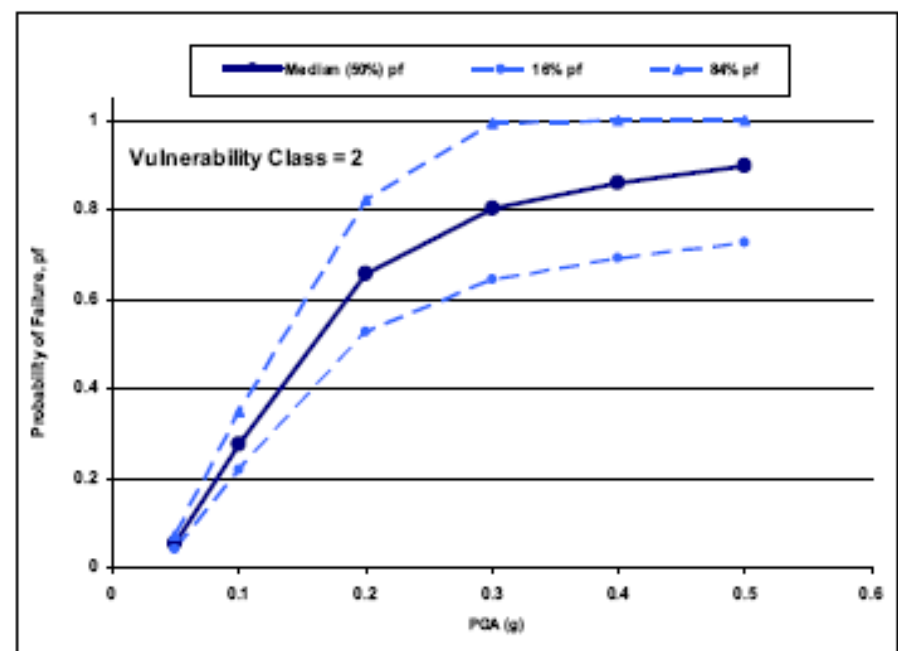
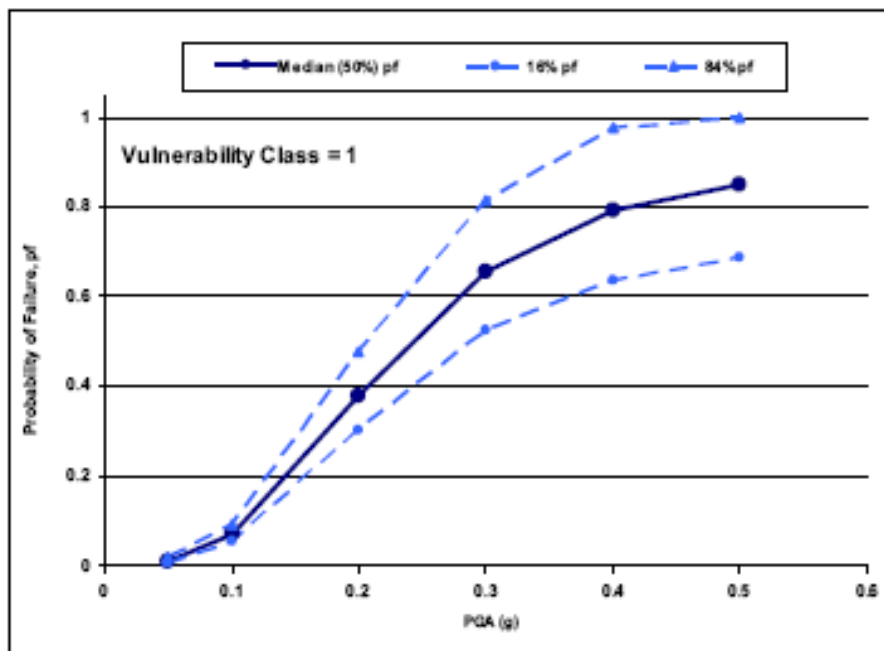
Levee Fill Type Maps



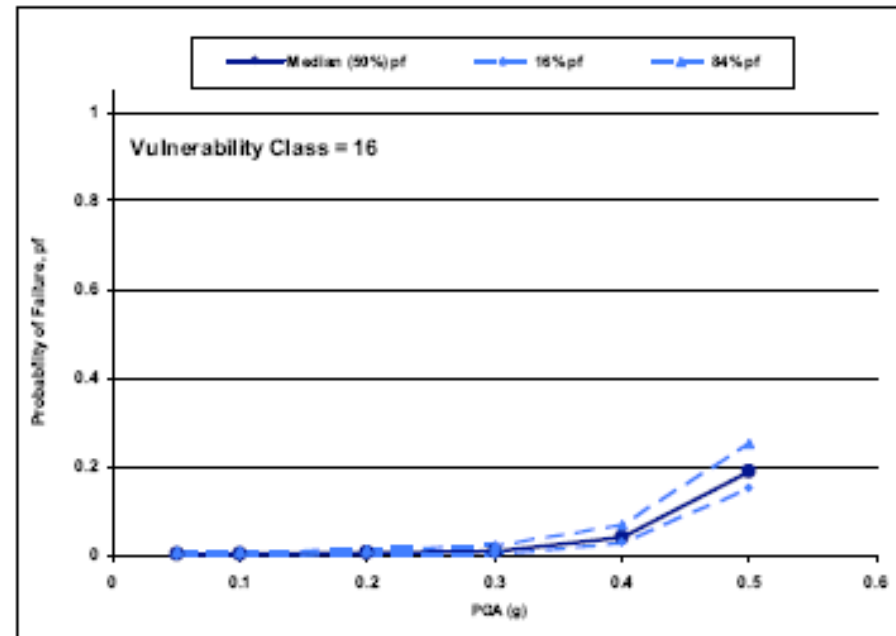
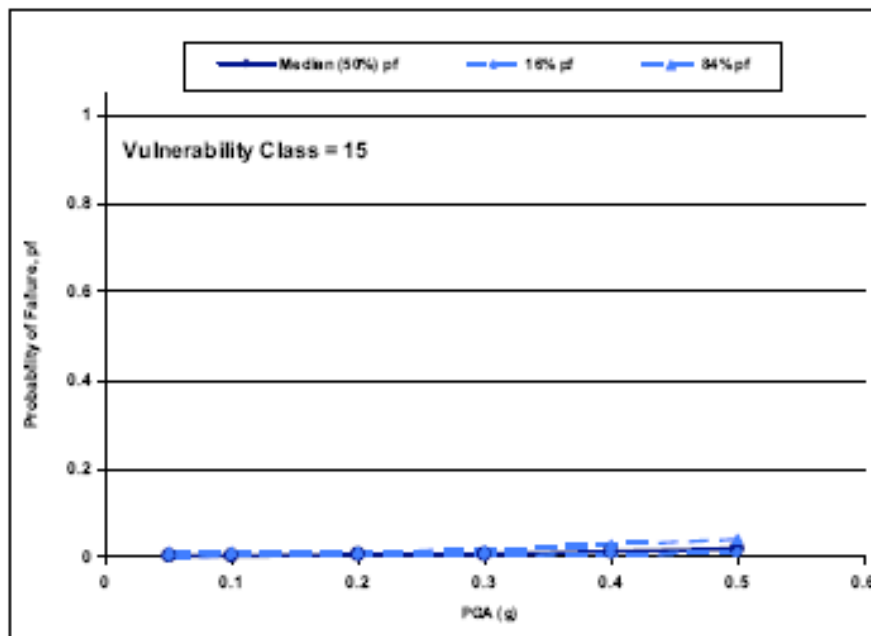
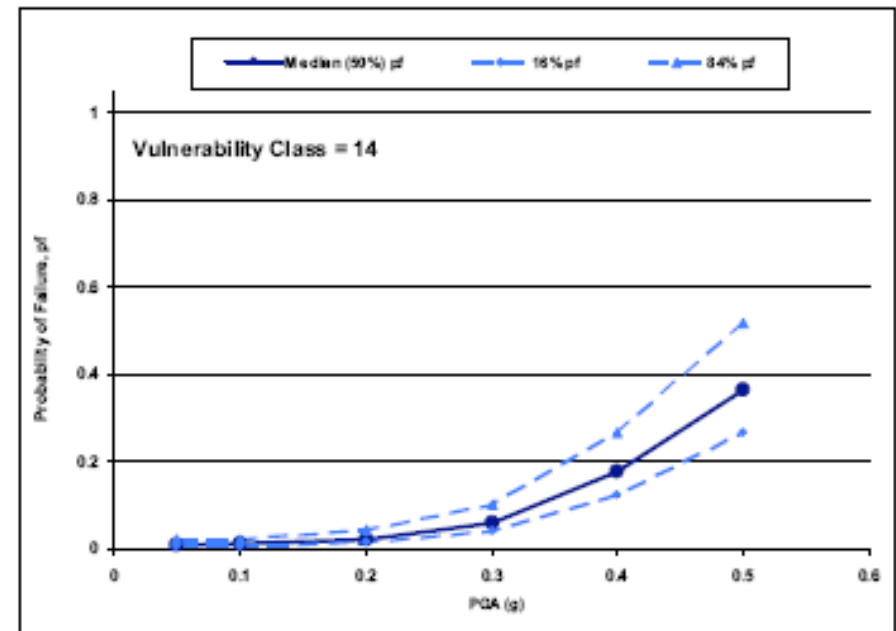
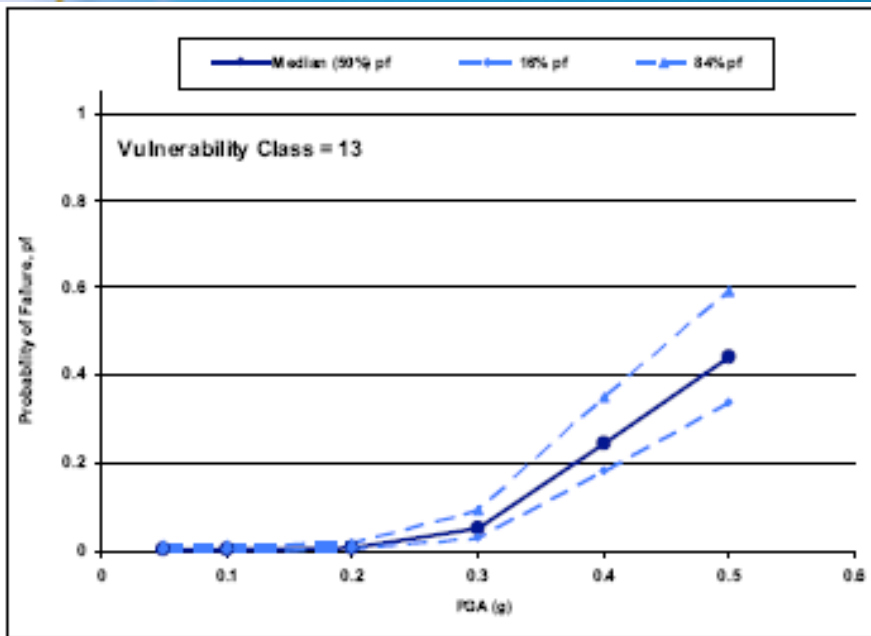
Levee Seismic Vulnerability Classes



Vulnerability Classes: 1-4, M6.5, 2ft freeboard



Vulnerability Classes: 13-16



Key Findings

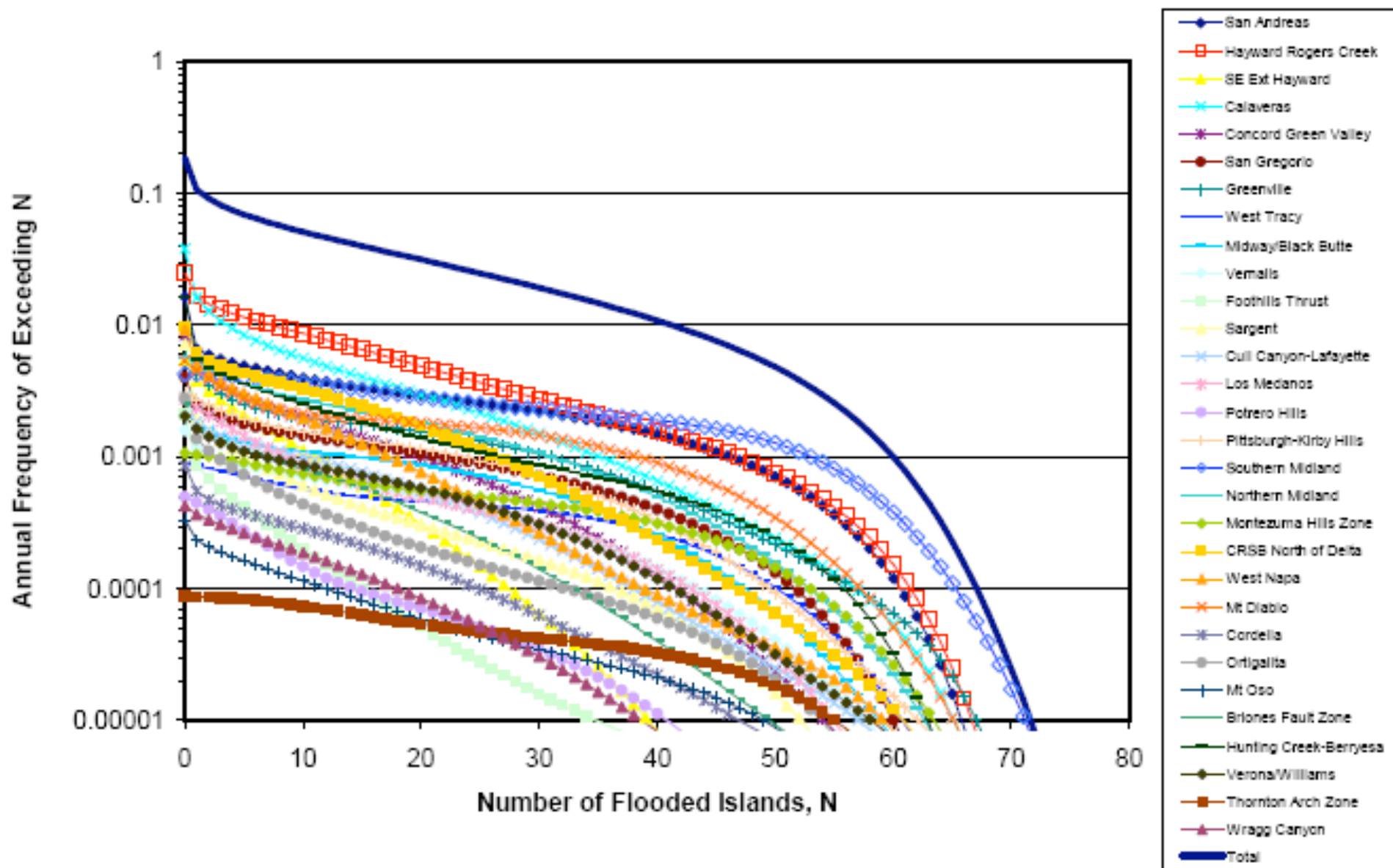


Figure 13-3 Deaggregation of the Mean Frequency Distribution on the Number of Flooded Islands in Delta by Seismic Source

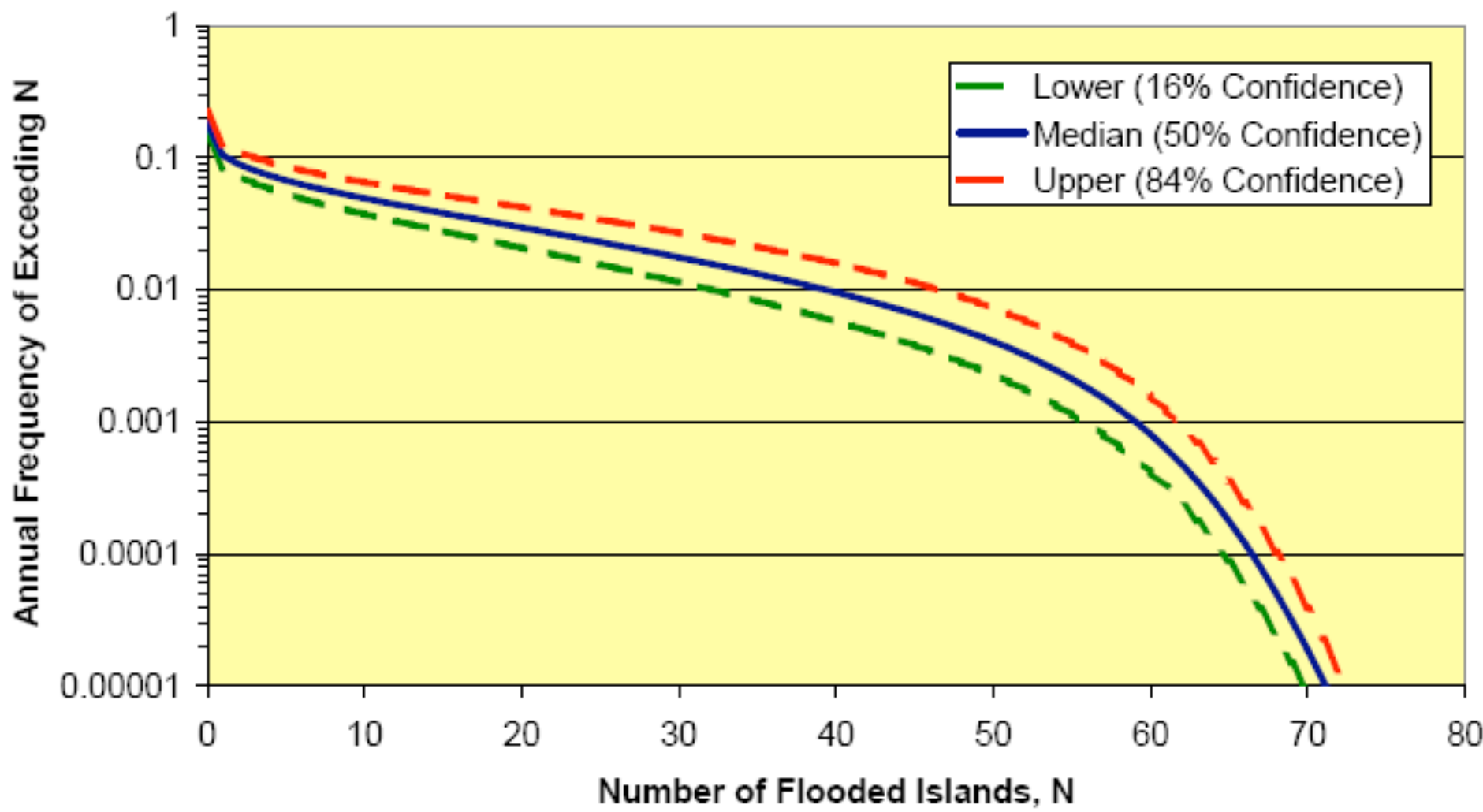


Figure 13-2 Annual Frequency of Exceeding N Flooded Islands due to a Seismic Event

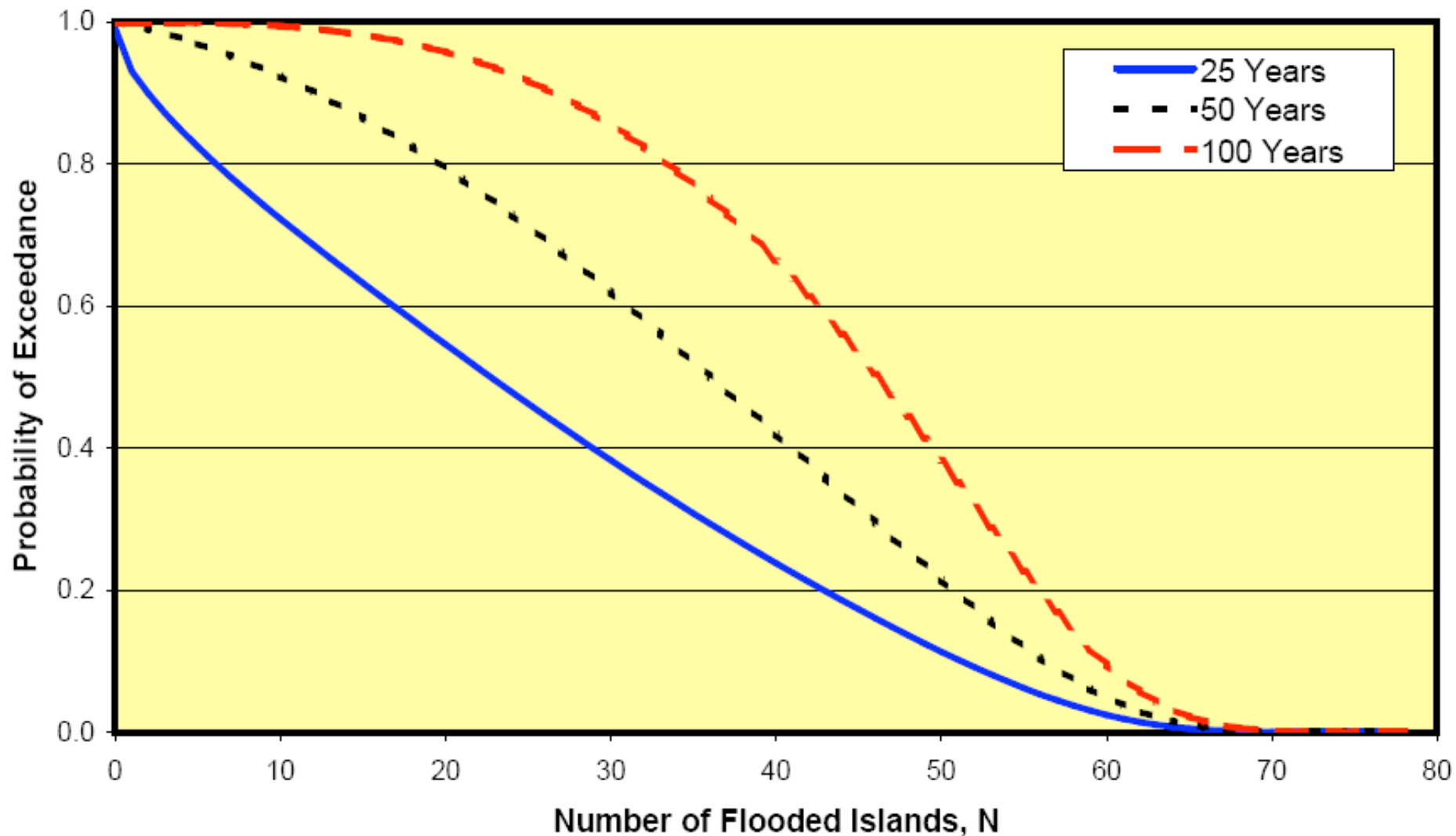


Figure 13-4 Probability of Exceeding a Number of Simultaneous Island Failures Due to Seismic Events for Exposure Periods of 25, 50 and 100 Years

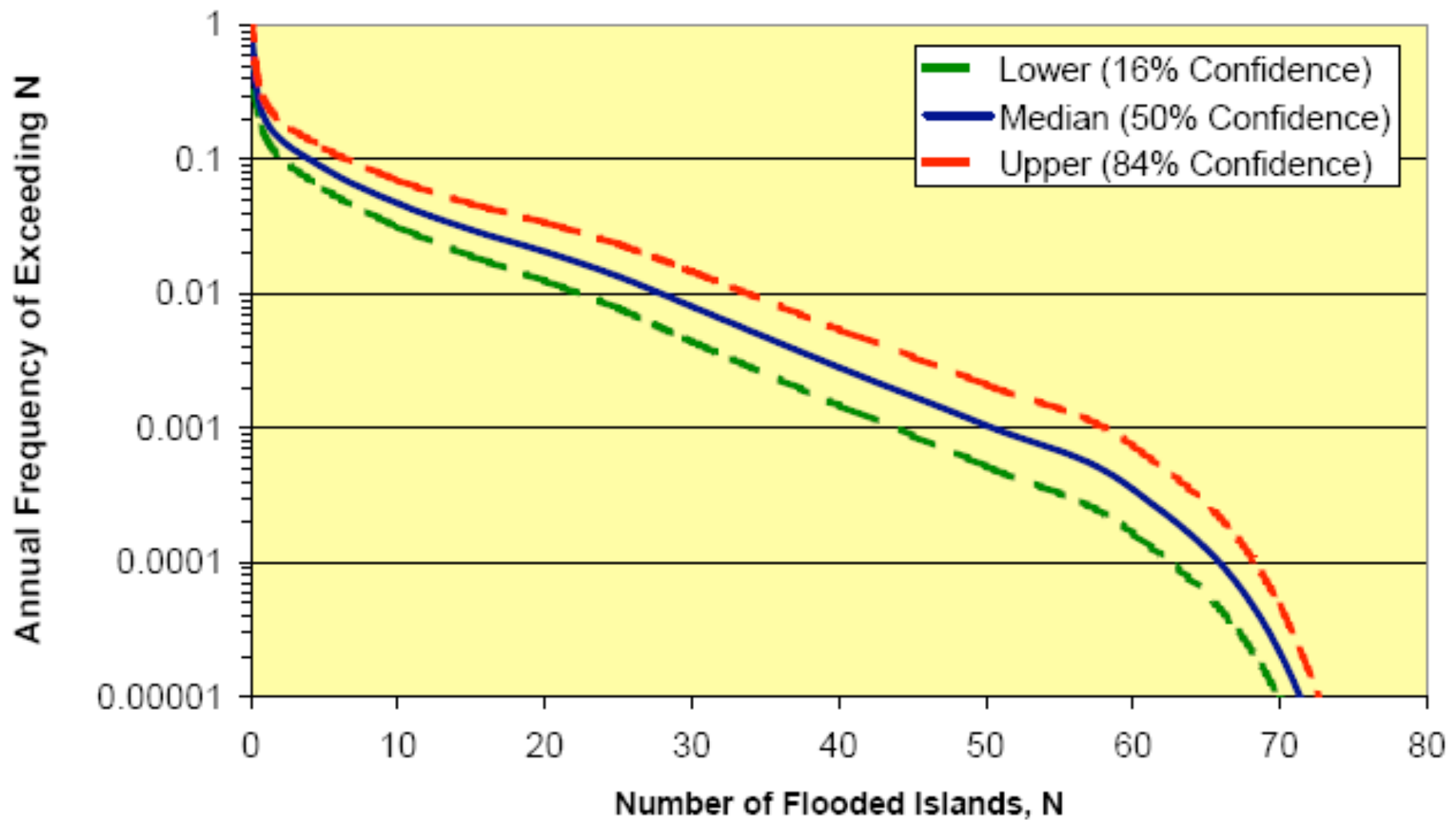


Figure 13-10 Annual Frequency of Exceeding N Flooded Islands Due to Hydrologic Events (Flood)

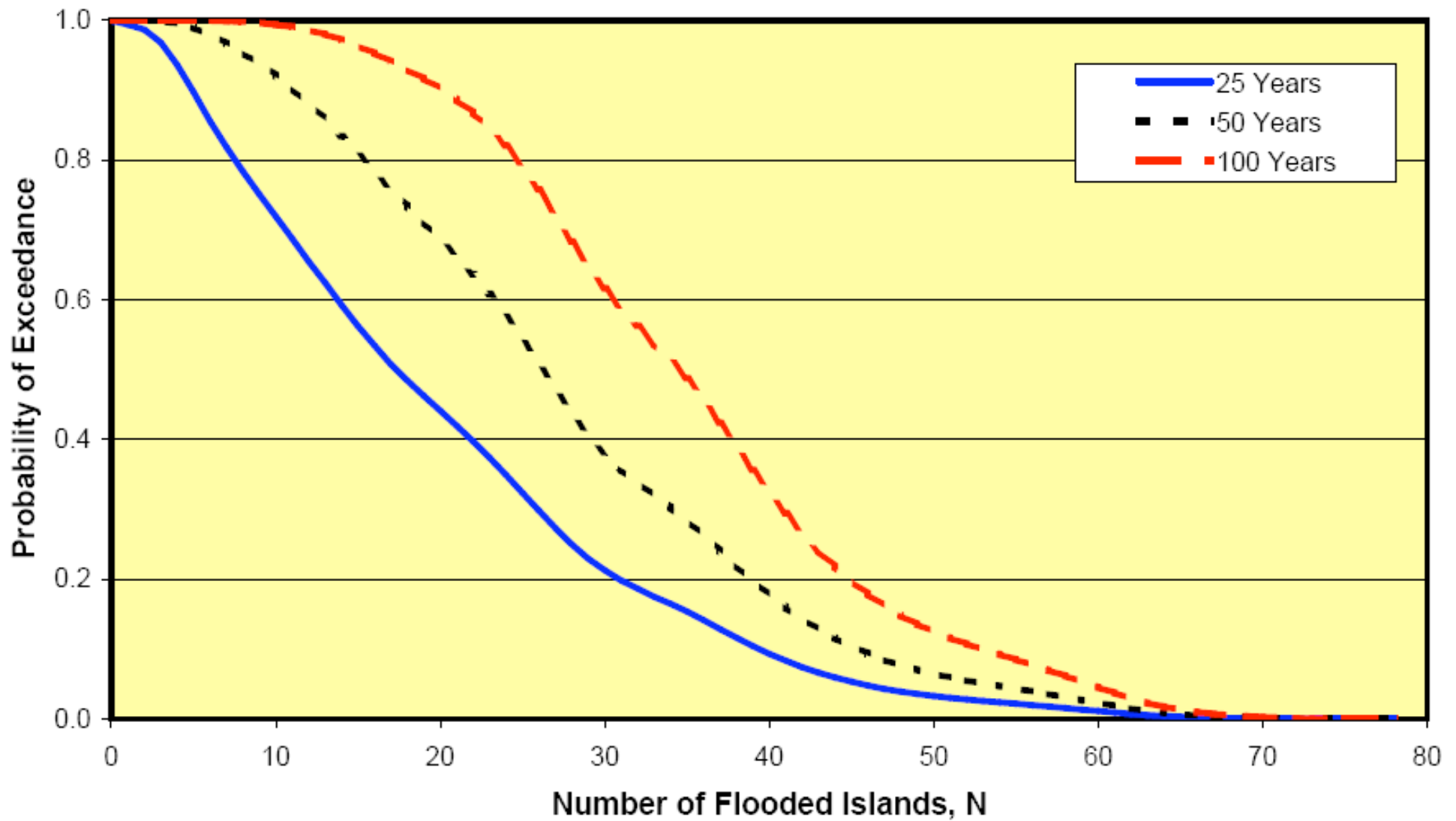


Figure 13-11 Probability of Exceeding a Number of Simultaneous Island Failures Due to Hydrologic Events for Exposure Periods of 25, 50 and 100 Years

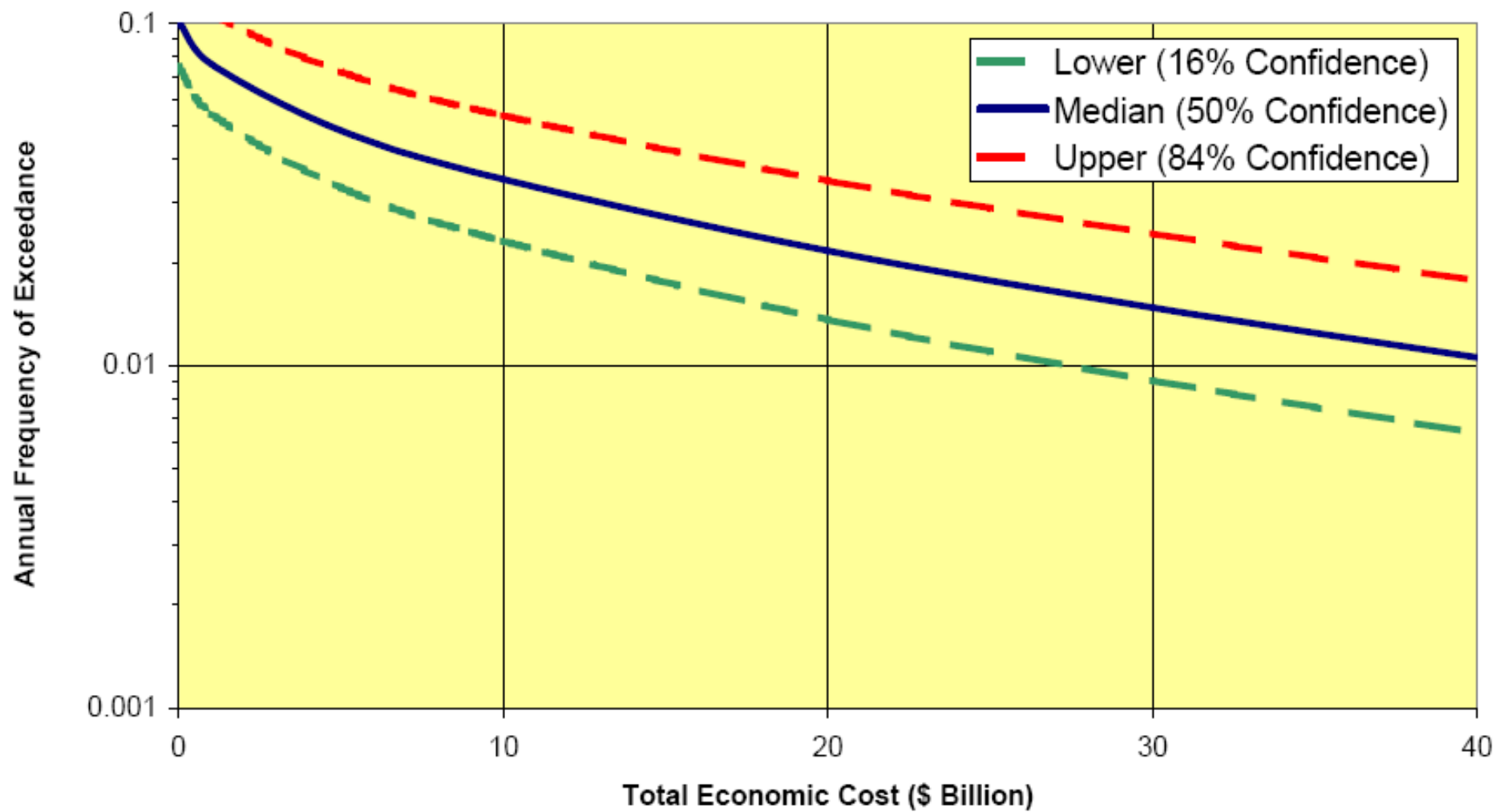


Figure 13-19a Annual Frequency of Exceeding Total Economic Cost due to Seismic Events

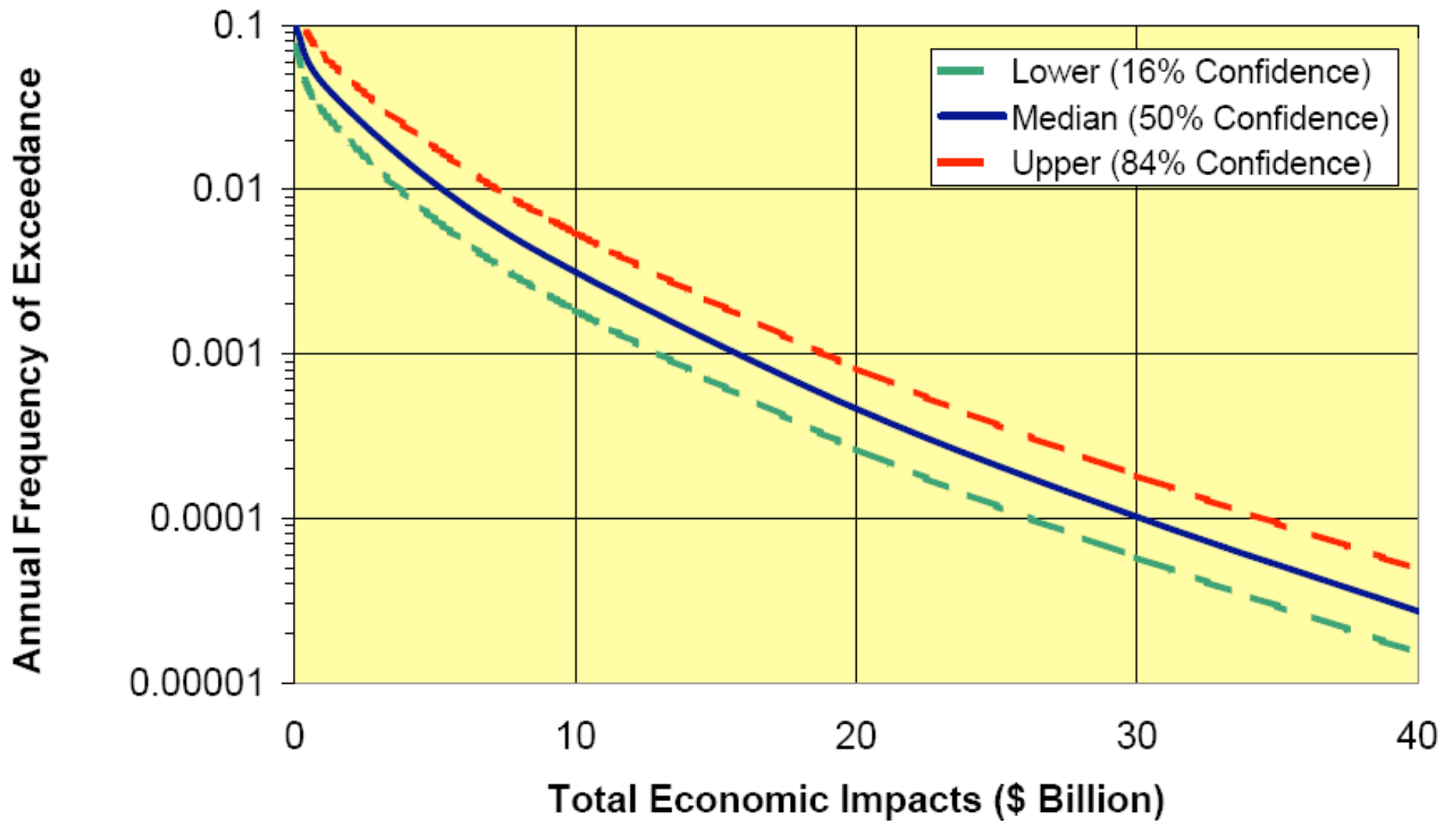


Figure 13-19b Annual Frequency of Exceeding Total Economic Impacts Due to Seismic Events

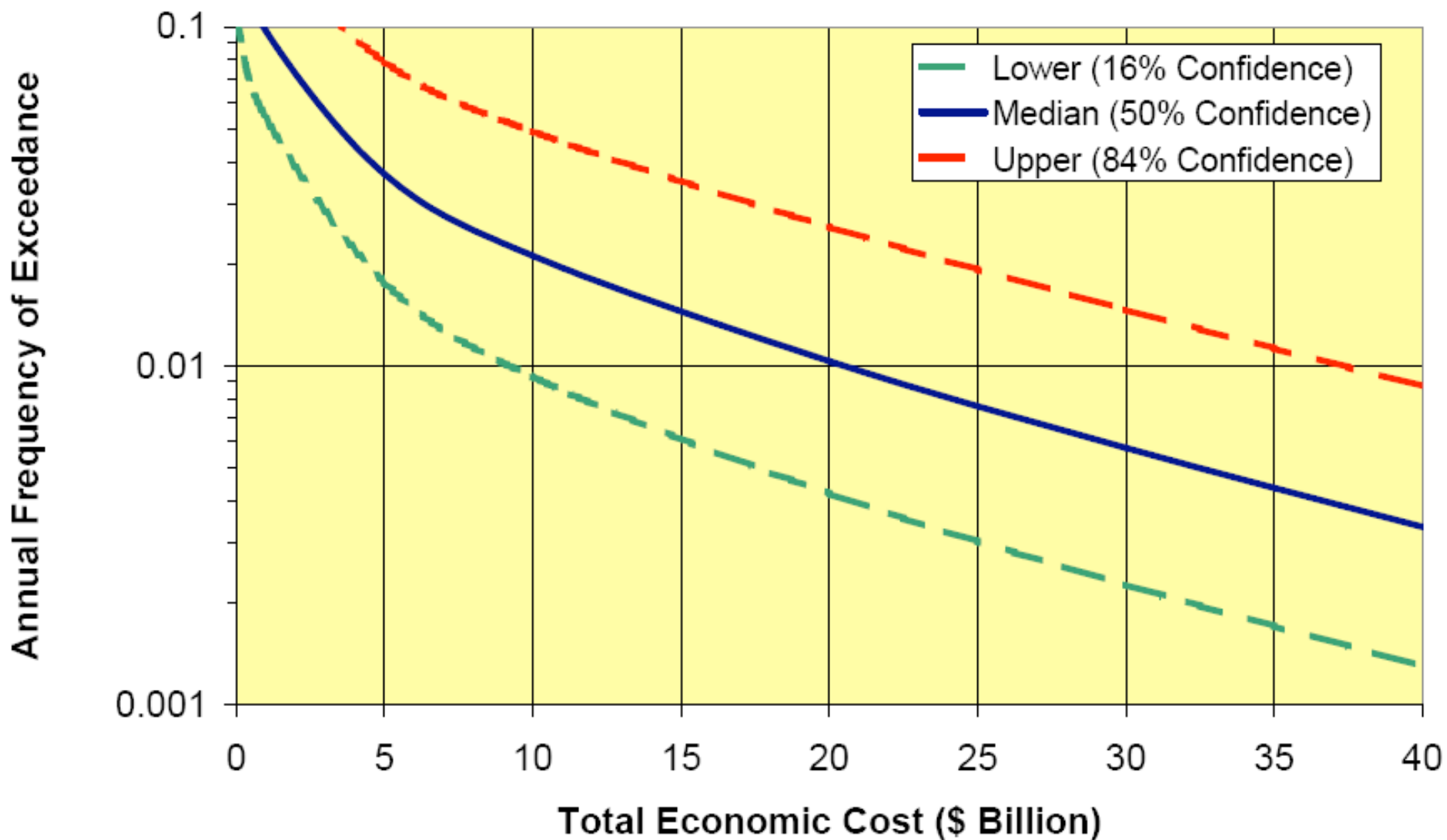


Figure 13-21a Annual Frequency of Exceeding Total Economic Cost due to Hydrological (Flood) Events

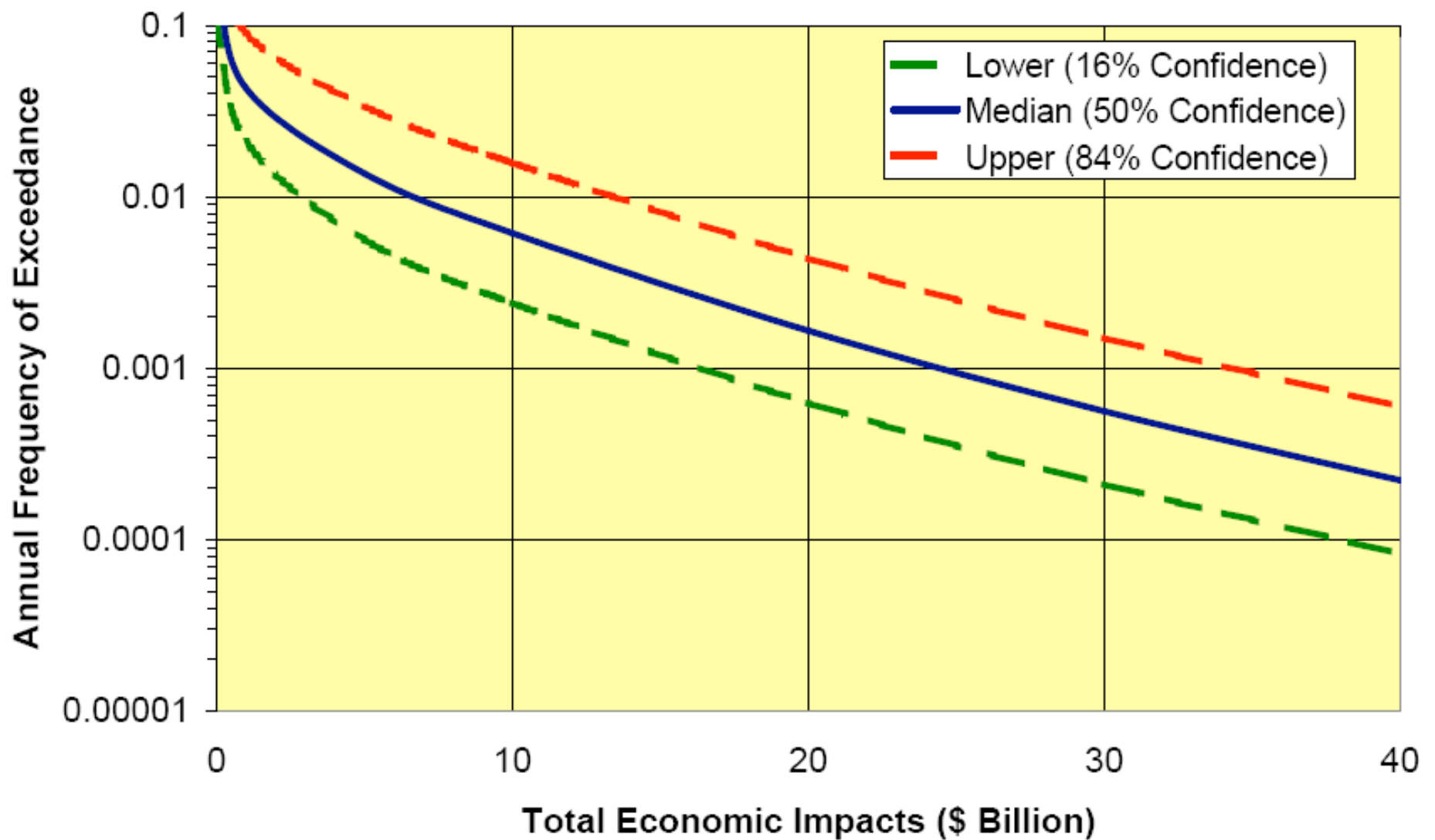


Figure 13-21b Annual Frequency of Exceeding Total Economic Impacts due to Hydrological (Flood) Events

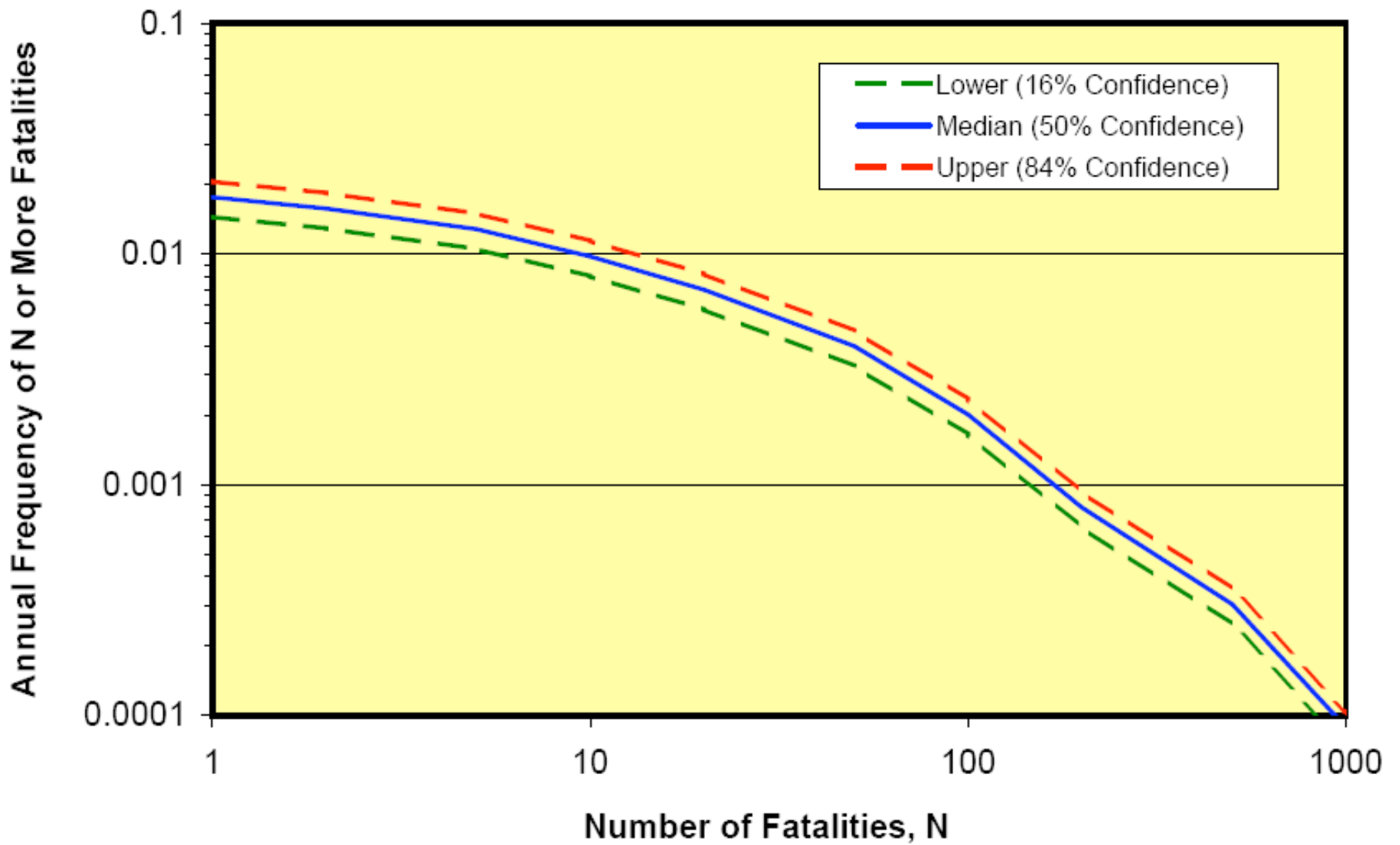


Figure 13-20 Expected Life Loss due to Earthquakes

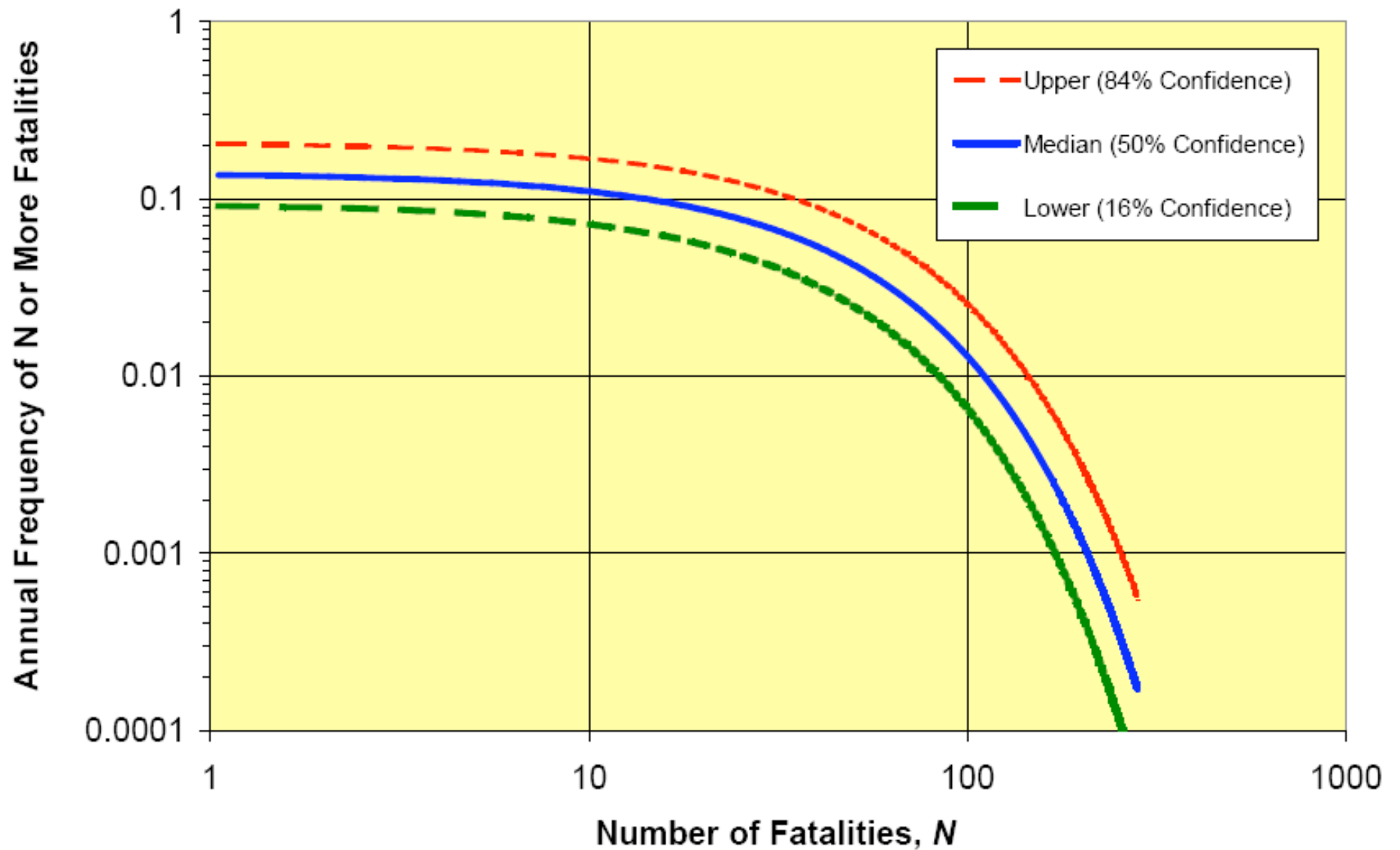


Figure 13-22 Expected Life Loss due to Hydrological (Flood) Events

Thank You

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