State DOT Seismic Resiliency Assessment Process and Mitigation Program

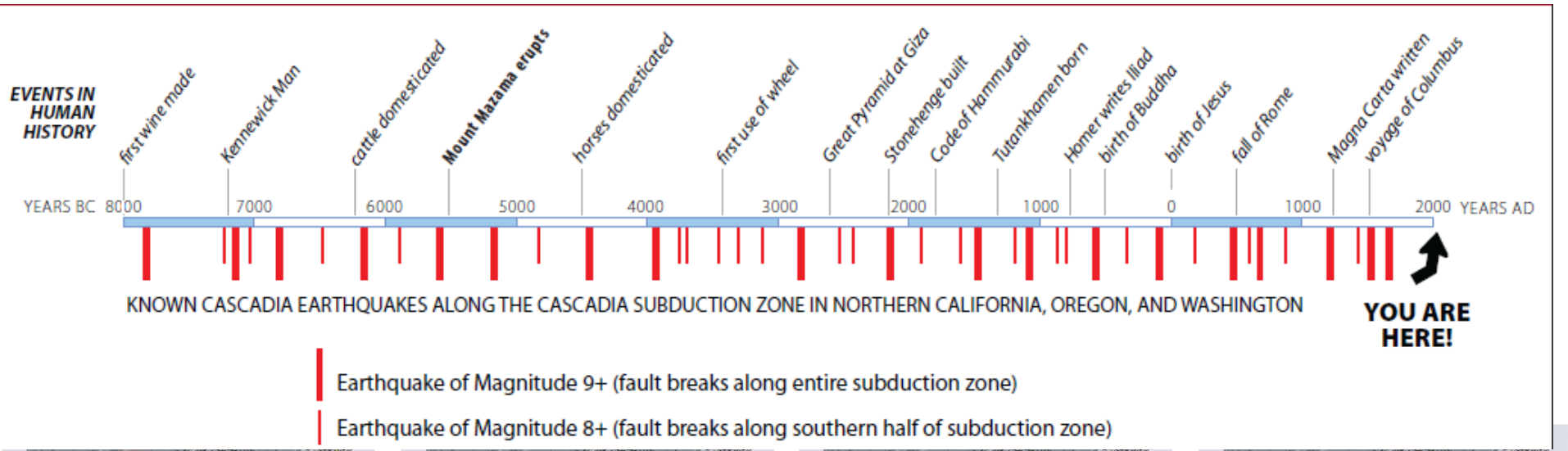
Bruce Johnson, Otak

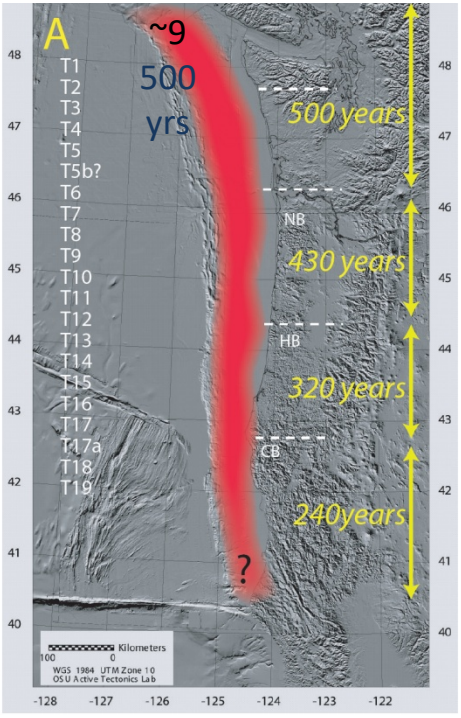
PEER Annual Meeting, January 2020

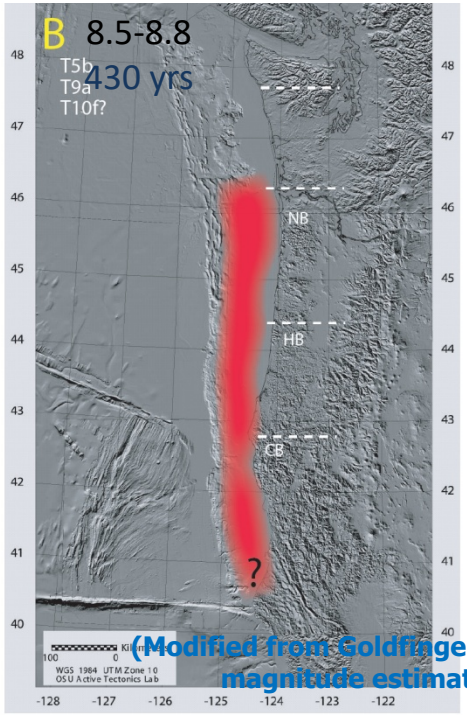
10-Step Process for Resiliency Planning

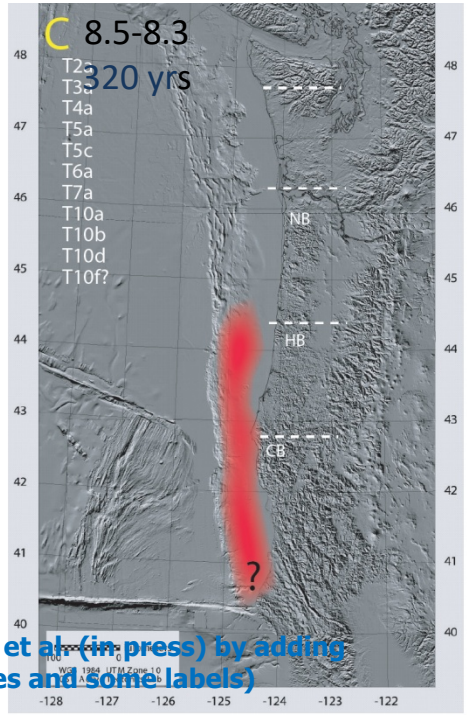
1. Assess Vulnerability of Assets (bridges and landslides)
2. Identify bridge damage states and landslides/rockfall dynamic stability
3. Validate Design Criteria consistency with risk
4. Estimate cost of mitigation (retrofit or replace)
5. Identify Lifeline Routes and Priority Routes for rescue, recovery
6. Estimate impact to rescue efforts and economy
7. Prioritize a plan for mitigation, considering condition of assets
8. Establish Resiliency Investment options
9. Develop triage approach for reduced level of mobility
10. Coordinate investment plan statewide with other modes/sectors through DHS/TSA Regional Resiliency Assessment Program (RRAP)

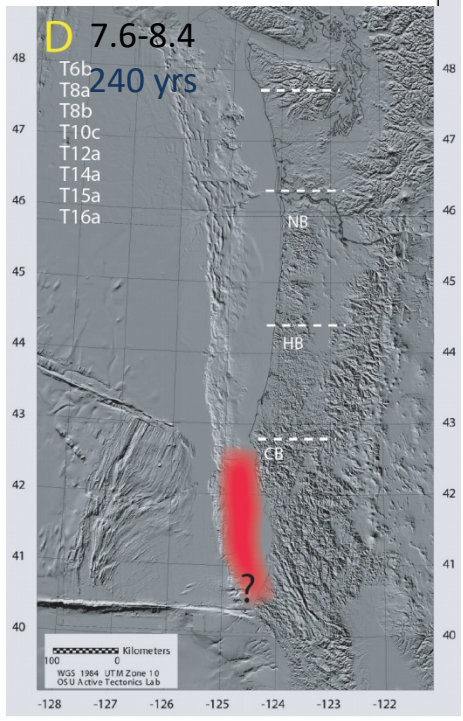
Cascadia Subduction Zone Earthquakes











(Modified from Goldfinger et al. (in press) by adding magnitude estimates and some labels)

FOCUS ON HIGHWAY BRIDGES

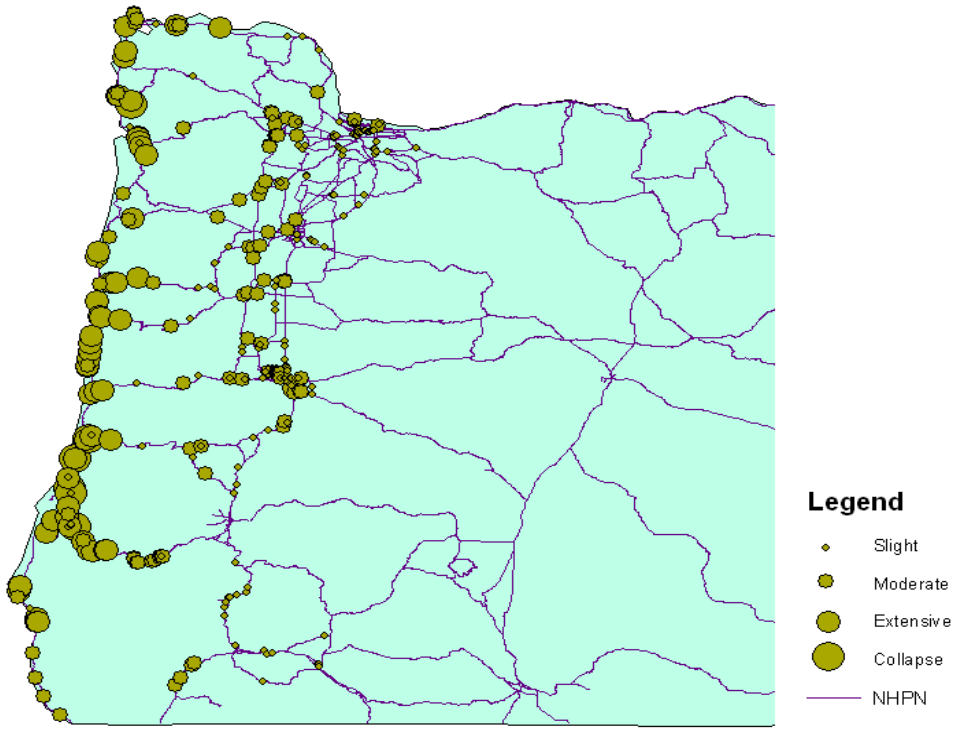
Cascadia Subduction Zone Earthquake (Magnitude 9.0)

From REDARS (similar to Hazus)

6 complete collapses
64 extensive
106 major
164 slight

Estimates Loss:

- **$1,080** million for bridge repair and replacement
- **Significant Economic losses** (travel time related losses)



Route	Damage States			
	Slight	Moderate	Extensive	Complete
I-5 (MWC)	4	1	0	0
I-5 (MLL)	16	3	1	0
I-5 (DJJ)	27	0	0	0
I-84	13	1	0	0
US-101	7	14	36	5
US-26	7	5	0	0
I-205	8	2	0	0
I-405	7	0	0	0
US-30	4	2	2	0
US-20	5	3	5	0
OR-38	3	2	1	0
OR-42	4	13	13	1
Others	59	60	6	0
Total	164	106	64	6

New & Retrofit Highway Bridge Seismic Design Criteria

"Life Safety" (no collapse) connects beams to the columns.

"Serviceability" strengthens the substructure for use within 72 hours after an event. (Building code – "Immediate occupancy")

Hazard Level - Recurrence Interval for Highway Bridges

National Code (AASHTO) - Design for "Life Safety" (no collapse) at a 1000-year recurrence interval using USGS 2002 Hazard Maps.

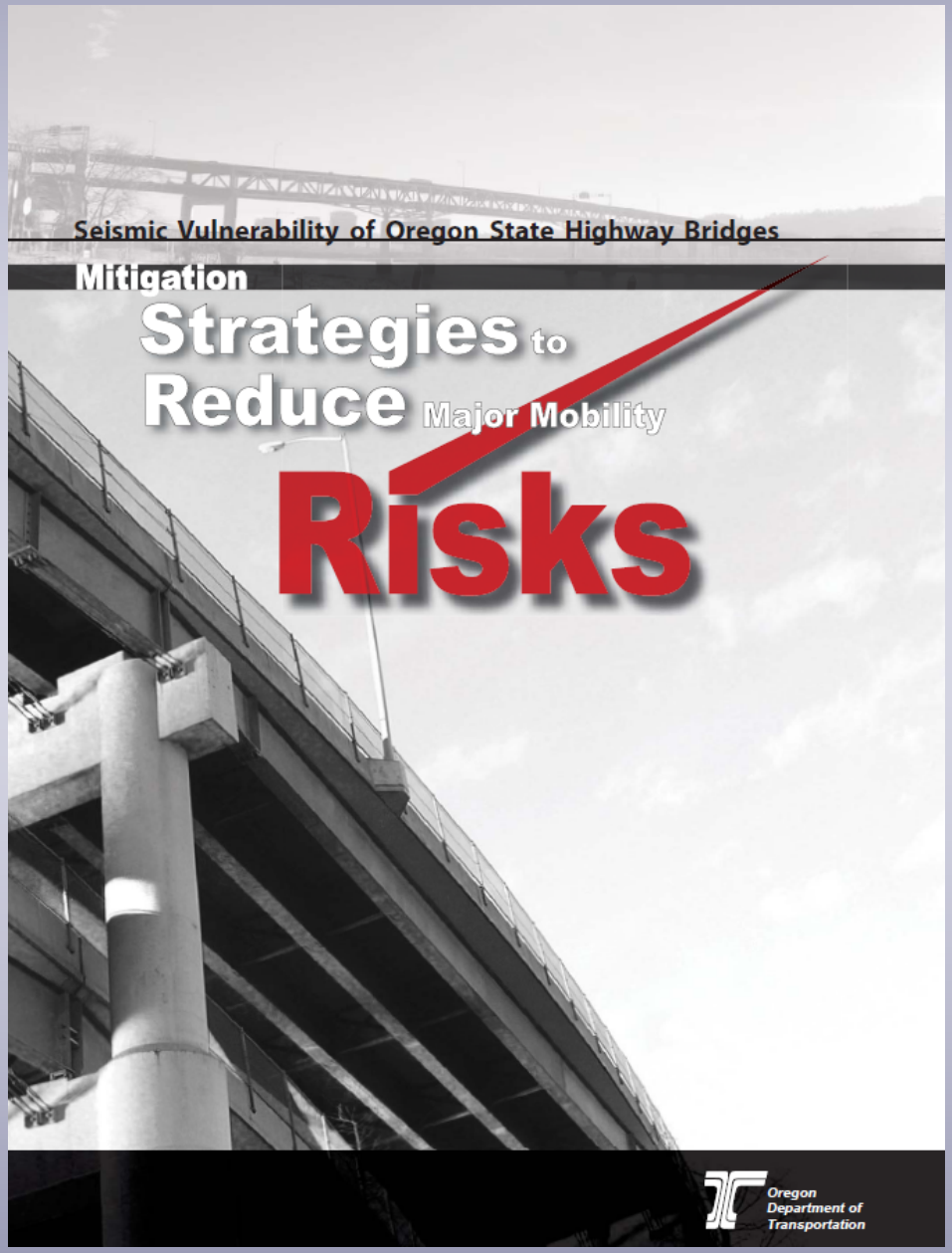
Oregon Code – Design for "no collapse" at a 1000-year recurrence interval using 2014 USGS Hazard Maps and "Serviceability" Design for usability within 72 hours after a CSZ Scenario event, 2014 (USGS) . (2-level design criteria)

Retrofitting Progress Dashboard

First 15 years since vulnerability was identified

Years	Actions	
1994/1997	Prioritized total bridge needs	1155
1985-2012	Phase 1 retrofit added to projects (STIP & OTIA III program) bridges addressed	355
Future	Bridges still needing retrofitting (Over 200 years at current funding)	800


Collapse
I-5 Interstate Bridge



Available on the ODOT Bridge Engineering Section website at:

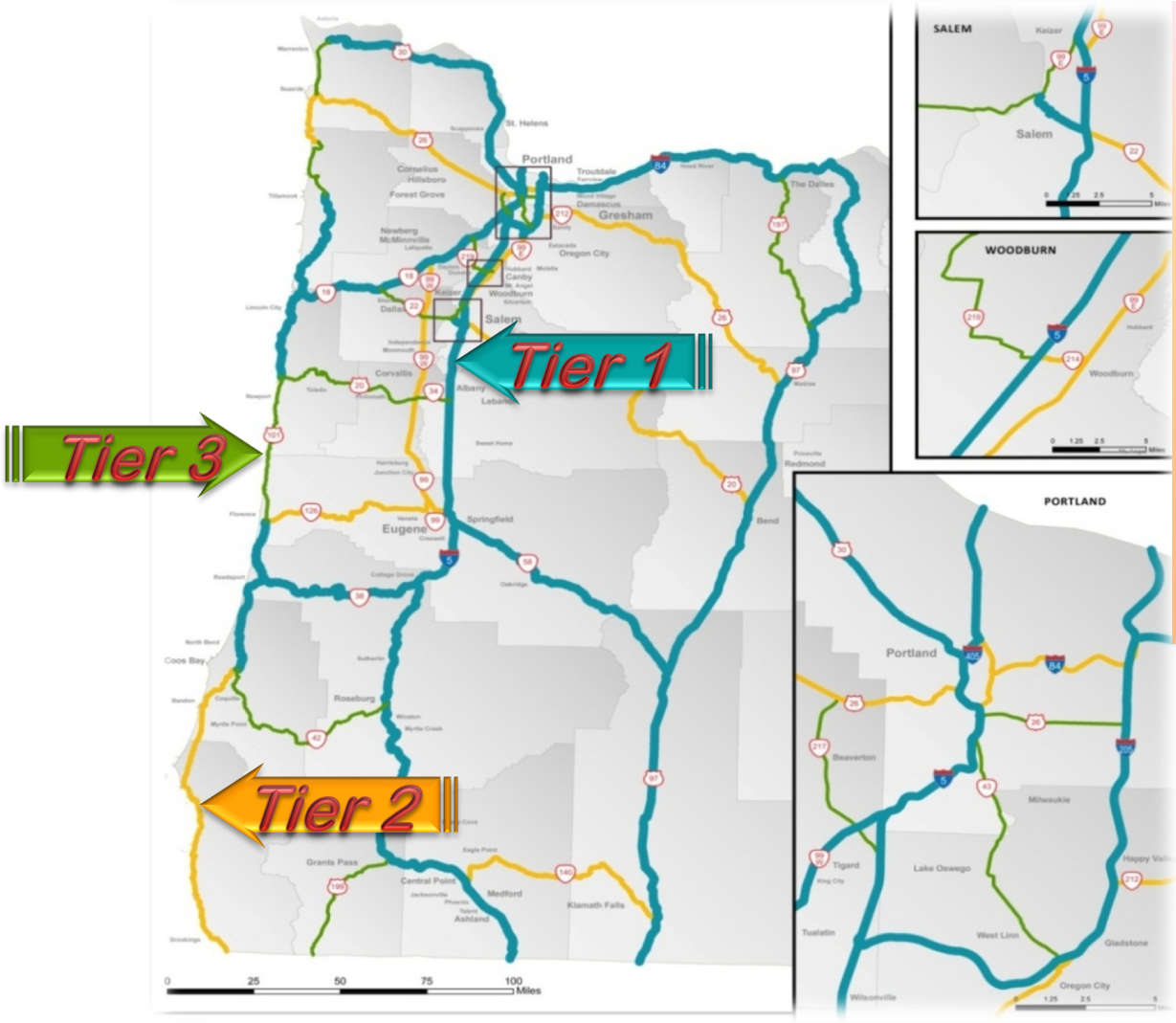
http://egov.oregon.gov/ODOT/HWY/BRIDGE/

November 2009

Transportation Resiliency depends on Landslides, as well as Bridges

Recommended Lifeline Routes

~~(Essential, Critical, Normal)~~



- **2012** – Seismic Lifelines evaluation
- **2012** – First "Full" (Phase 2) seismic retrofit project for ODOT

SEISMIC PLUS PROGRAM
State Highway Network
Investment Strategy

LEGEND

- Program Phase 1
- Program Phase 2
- Program Phase 3
- Program Phase 4

Phase 5 (replacements) not shown for clarity

- Interstate
- U.S. Routes
- Oregon Routes
- County
- City Limits

1 in = 39 miles

0 20 40 80 Miles

N

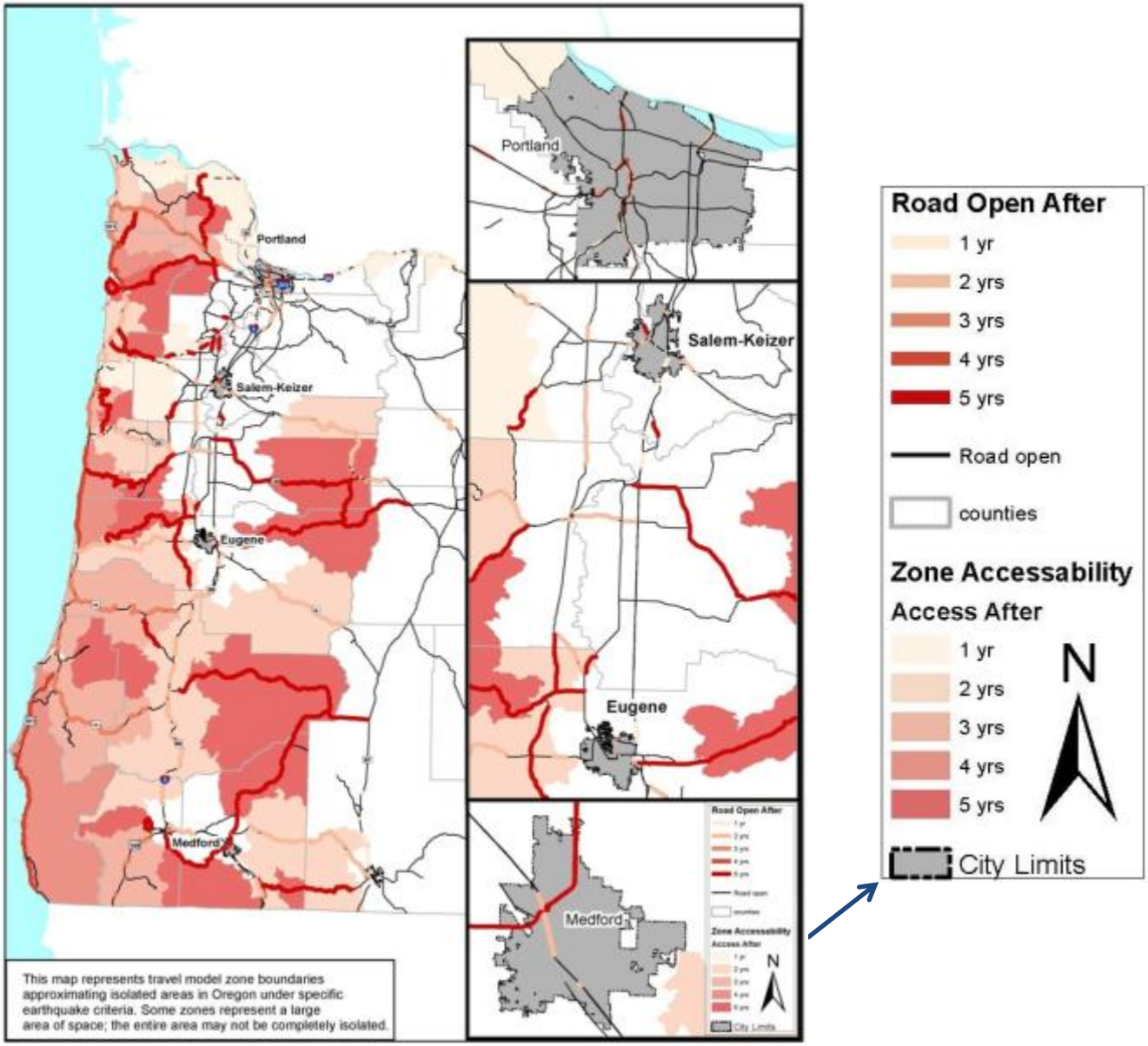
August 2014

Total Seismic PLUS Program Cost

Program Phases	Total Bridge Cost	Landslides/Rockfalls Cost	Total Seismic PLUS Program Costs
1	$738 Million	$197 Million	**$935 Million**
2	$632 Million	$272 Million	**$904 Million**
3	$612 Million	$483 Million	**$1,095 Million**
4	$640 Million	$126 Million	**$766 Million**
5	$1,432 Million	$0	**$1,432 Million**
Total	**$4.1 Billion**	**$1.0 Billion**	**$5.1 Billion**

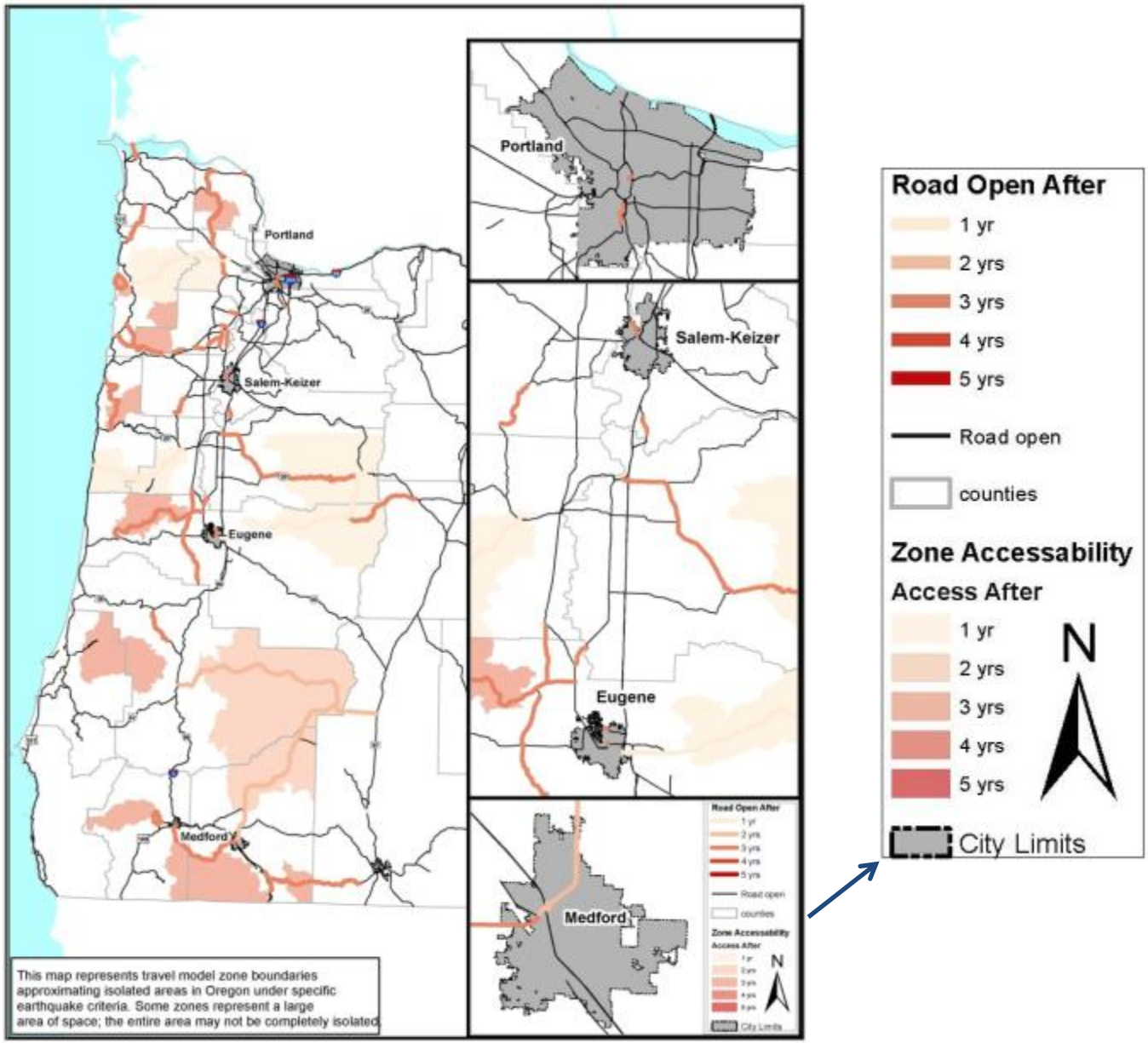
Major Seismic Event: "Islands of Isolation"

Total economic loss: $350 B



Isolated Zones: Full Seismic Program

Reduce economic loss by:
$84 B



15:1

Cost = $5.1 Billion
Economic Loss Avoided = $84 Billion

Overall Seismic Resiliency Triage Strategy

$200 M over 20 years

Southern Oregon triage
(bridges and unstable slopes on I-5 and OR 140)

Coastal forward supplies & seismic response kits

1. Astoria
2. Newport
3. Coos Bay

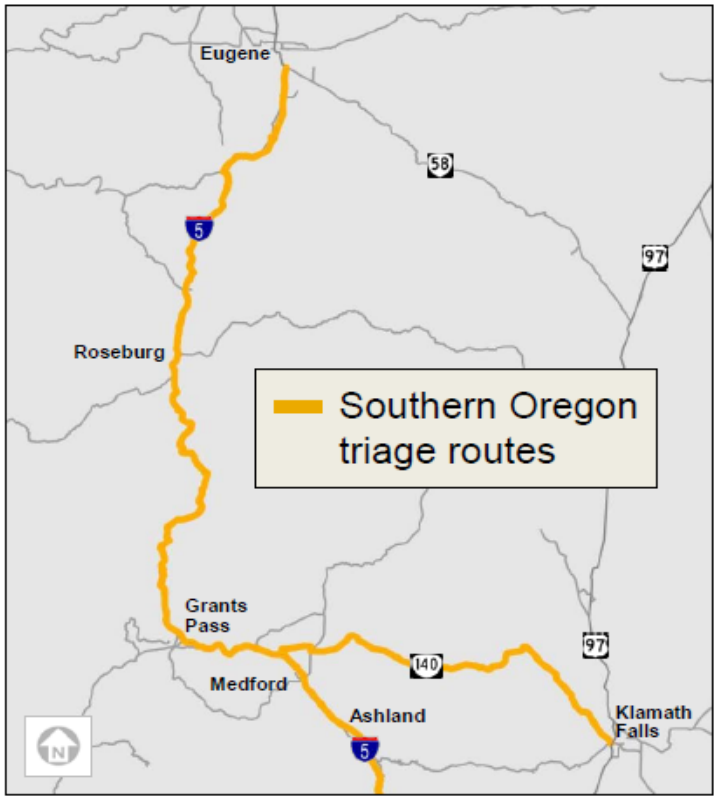
Local ODOT triage
(address strategic ODOT and local bridges/major river crossings)

Seismic Options Report
(not part of $200 M total above)

- Phase 1 – partially funded
- Phase 2

Southern Oregon Triage Routes

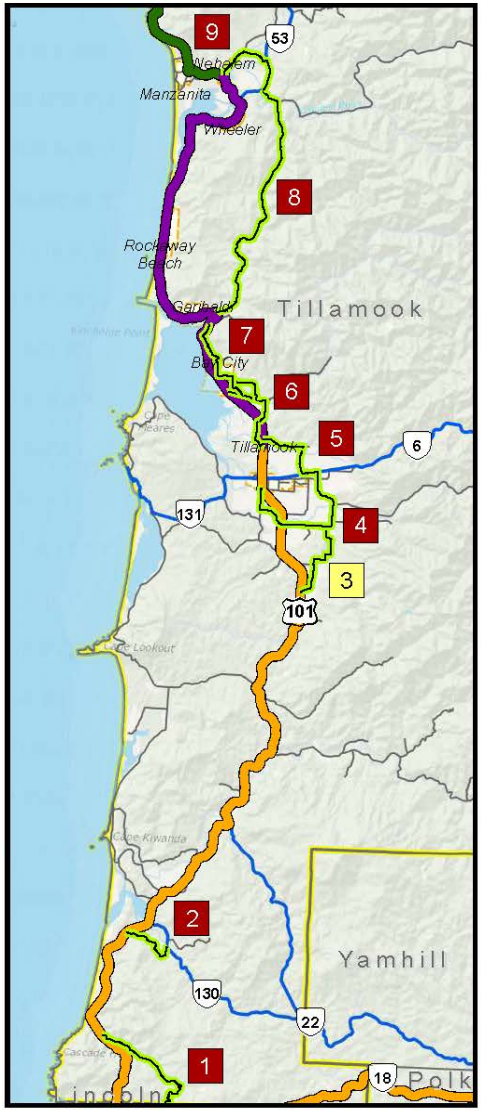
Interstate 5 and OR 140



- I-5 and OR 140
  (key lifeline routes)
- 17 bridges
  7 unstable slopes
- $35 million
  (Mainline cost would be $350 M)

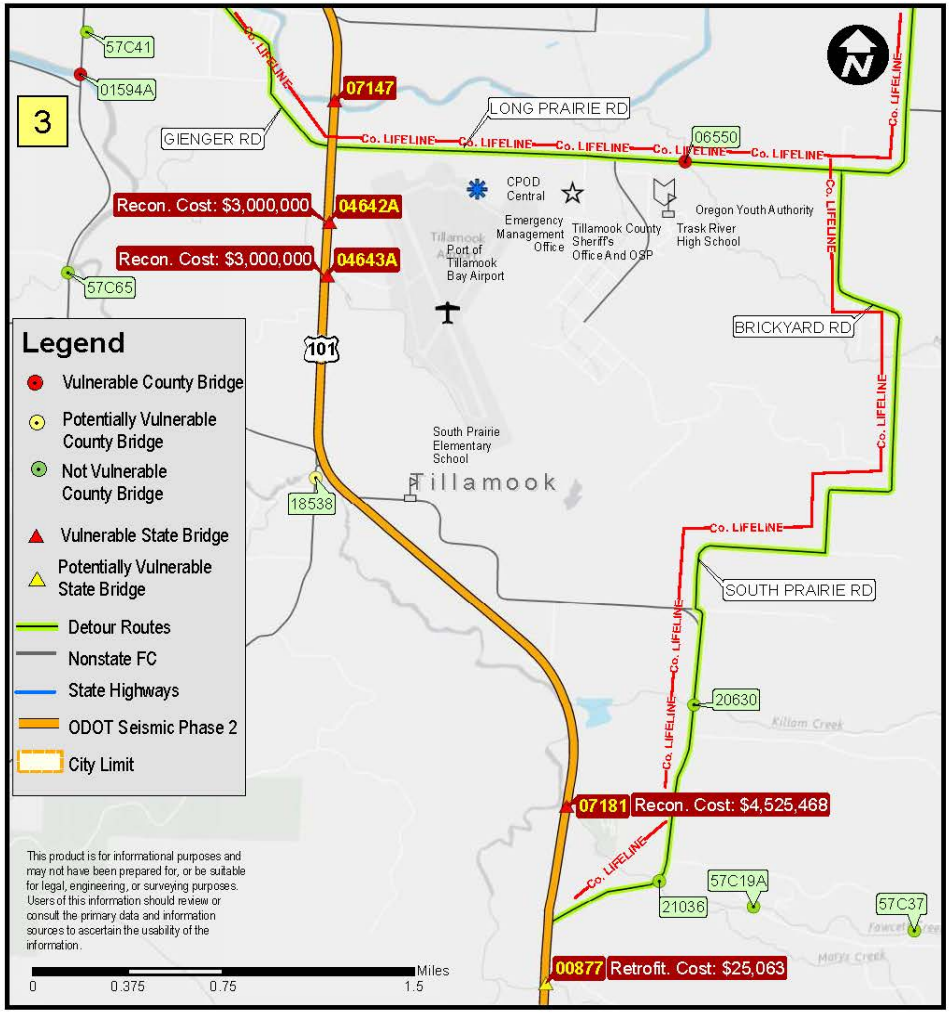
ODOT – Local Agency Triage Routes

(Tillamook County Trial cost is 10% of Original)

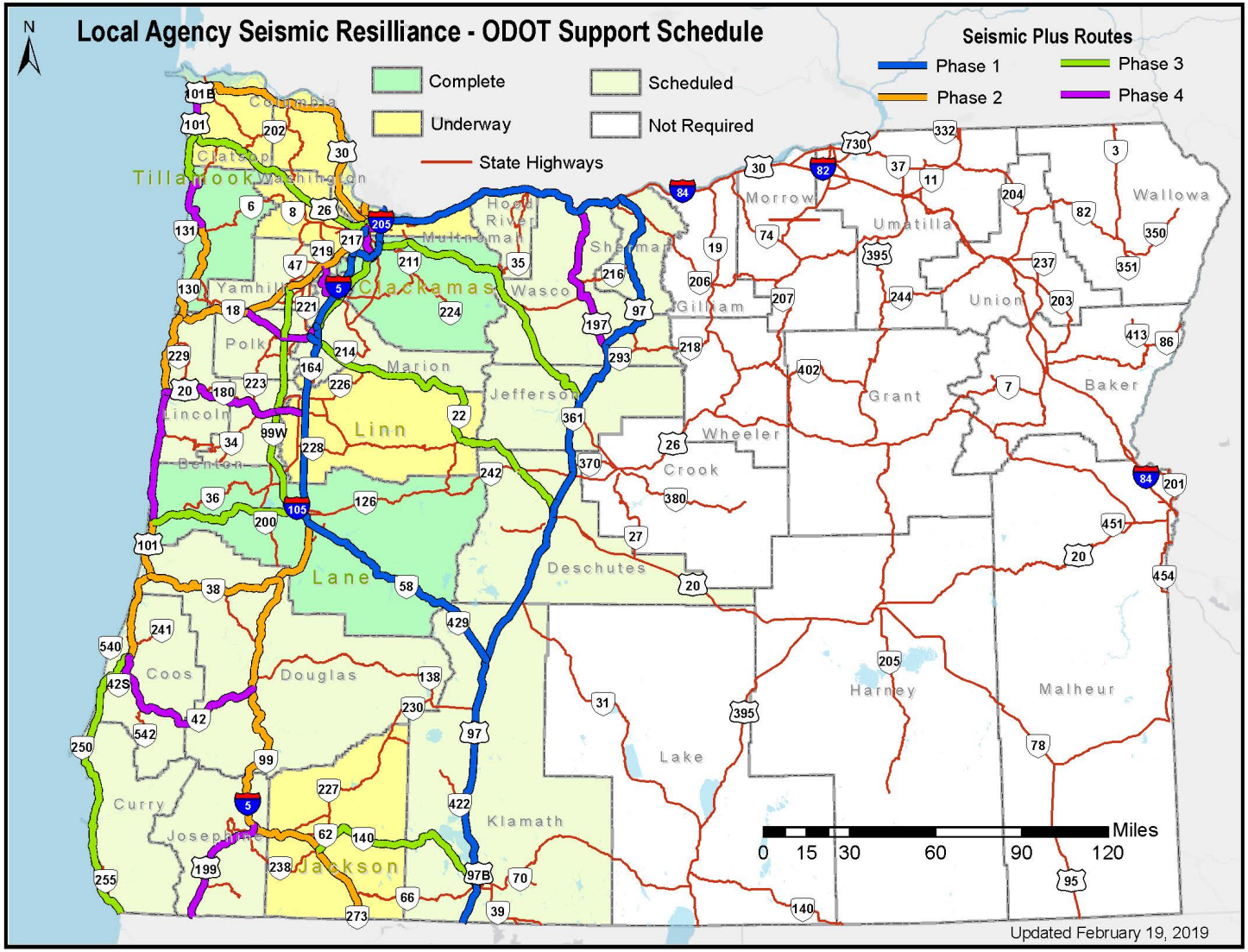


Tillamook County - US 101 Bridge Detour Routes

Prairie Rd, Brickyard Rd, Long Prairie Rd



Local Agency Seismic Triage Project

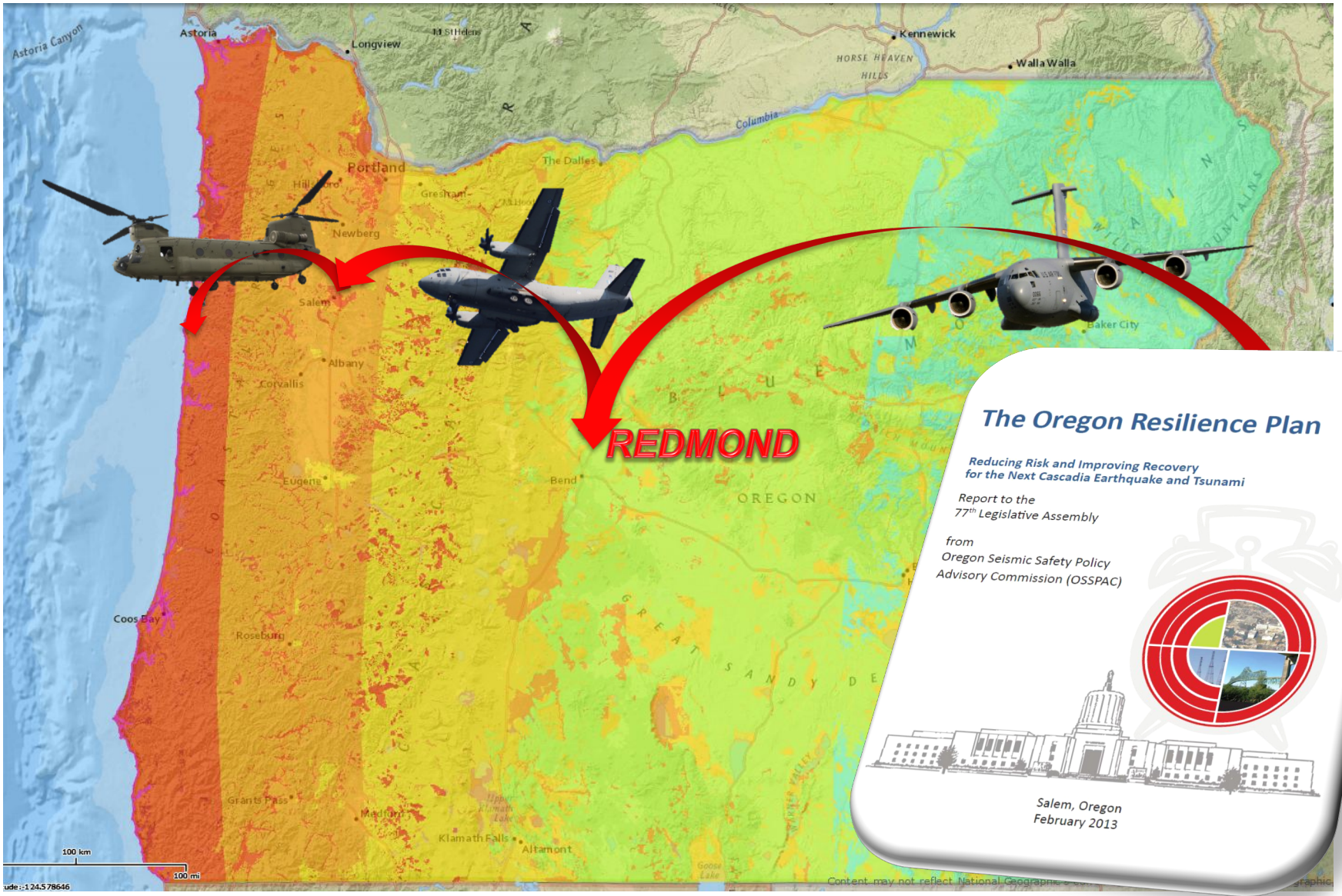


Other Modes Coordination

1. ***The Redmond Airport will be the nexus of relief supplies entering Oregon (Other states may have their own supply issues and may not be able to help)***

2. ***Relief supplies will come overland to the valley and the coast***

Post-Earthquake Response



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Thanks for your attention.

Bruce Johnson, Otak
Former State Bridge Engineer, ODOT

Acknowledgement:
Albert Nako, ODOT Seismic Stnds Engr

- Identify strategic lifeline routes
- Minimize long term economic damage
- Estimate Cost to address overall bridge condition

-Oregon Highway Seismic Options Report

Lifelines – Their Function

Facilitate:

- ***<u>Rescue</u> – Emergency response to treat casualties and evacuate survivors***
- ***<u>Relief</u> – Provide basic necessities, restore social equilibrium, and assess damage***
- ***<u>Recovery</u> – Restoring commerce and the economy; bring things back to "normal"***

Lifeline Goals

1. ***Support Survivability and Emergency Response Efforts Immediately Following the Event***

2. ***Provide Transportation Facilities that are Critical to Life Support Functions for an Interim Period After the Event***

3. ***Support Statewide Economic Recovery***

ODOT's Seismic Retrofit Program

By the numbers:

- ***138 bridges to be replaced***
- ***390 bridges to be retrofitted***
- ***190 bridges to be rehabilitated and retrofitted***
- ***1185 landslides and rockfalls to be mitigated***

- ***Program Cost ~ $5.2B***

Take Home Learnings… Next Steps

Bridge condition – include seismic

Bridge funding

Engage local communities for Triage Approach

ODOT Seismic Expenditures In HB2017

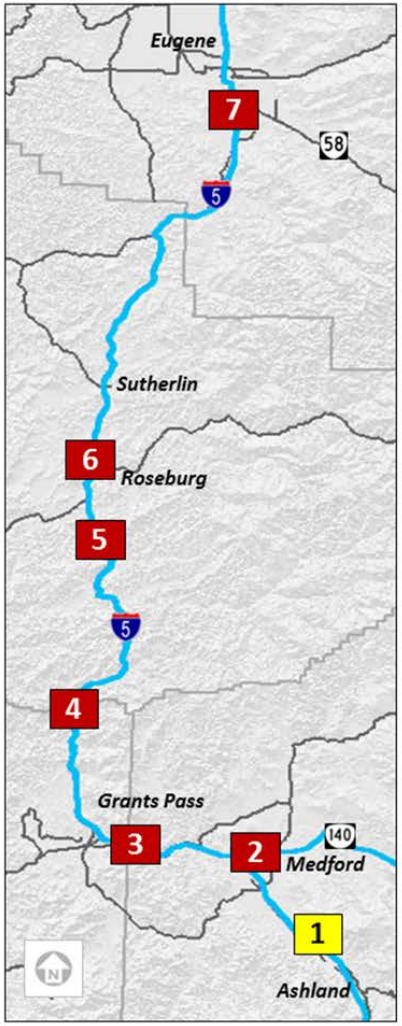
Example: $500 million/yr from HB2017

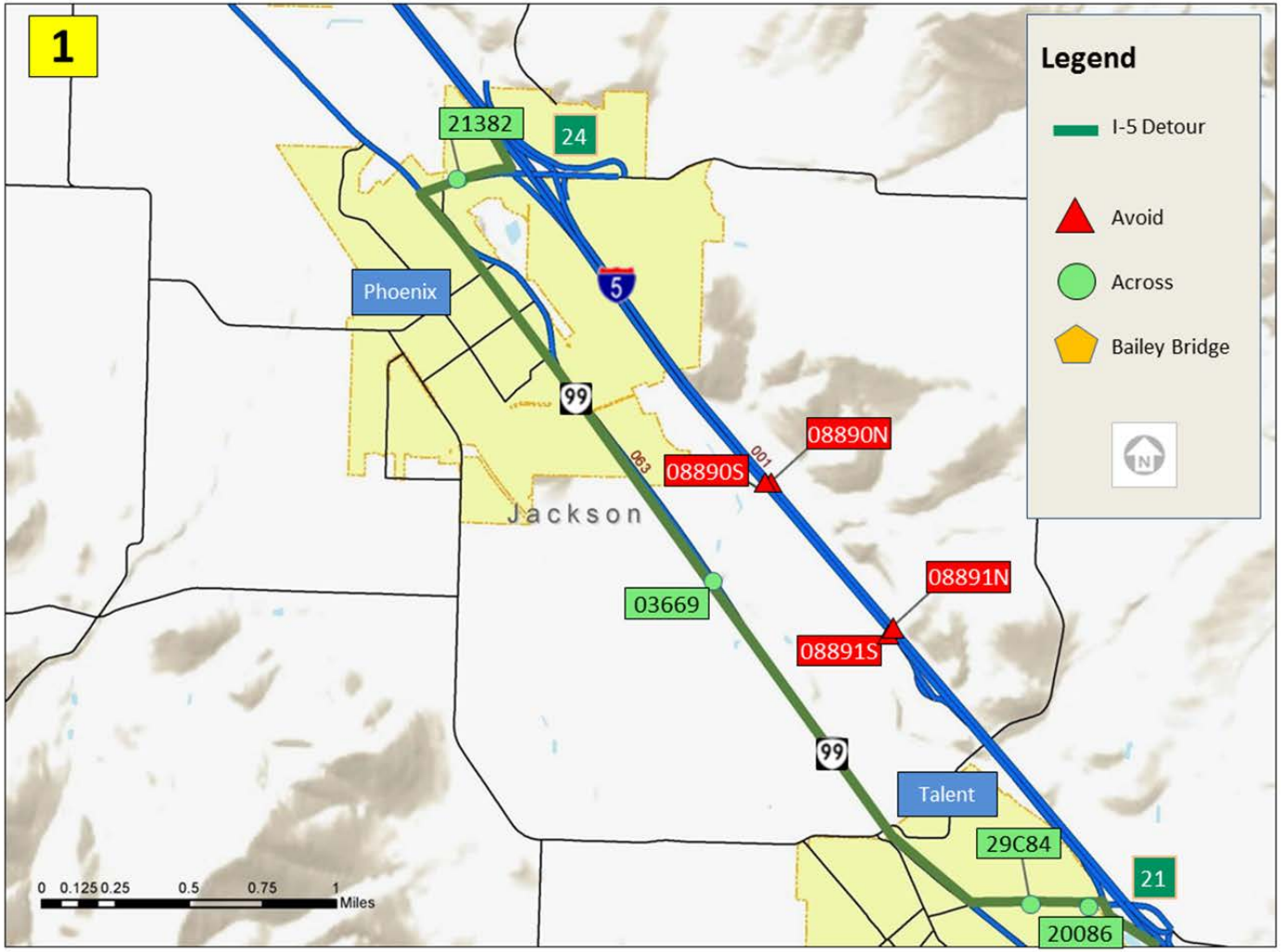
State funds: $250 million

Seismic: $61 million/yr ($31 bridges, $15 unstable slopes and $15 facilities)

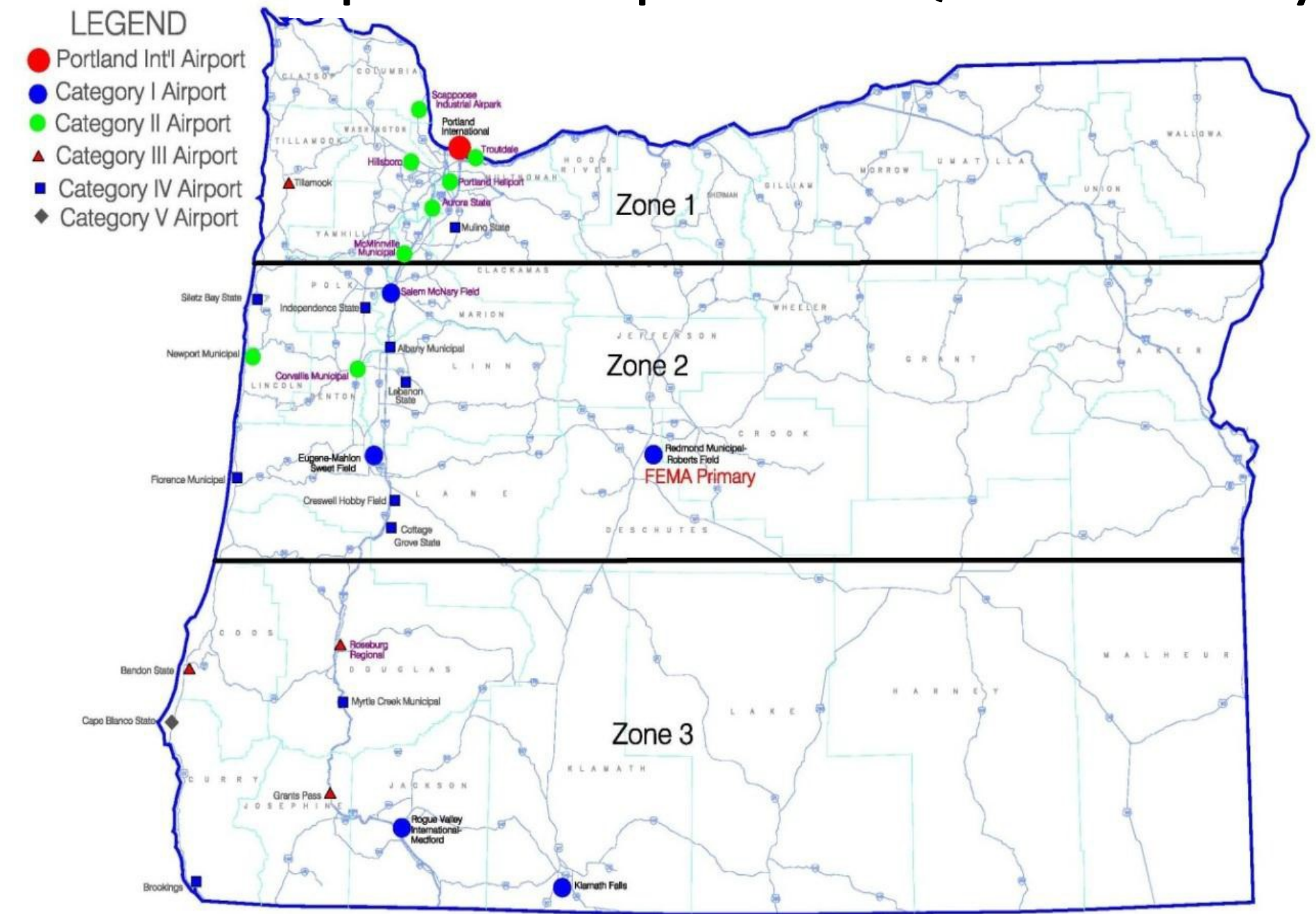
- **Goal is to complete Phase 1 in 25 years**
    - **Study Triage Approach using lower cost alternative local routes for Phases 2-5**
- **Earmarked funding for Southern Oregon Triage and Center Street Bridge in Salem**

Rogue Valley Triage Lifeline Routes





Operational Airports After EQ-Tsunami – Valley



Columbia River Ports

Port of Portland Facilities

Coastal Ports

PORT OF GARIBALDI 1910 100 2010

PORT OF TILLAMOOK BAY

Port of Newport

PORT OF TOLEDO OREGON

PORT OF ALSEA

PORT OF SIUSLAW CAMPGROUND & MARINA

PORT OF BANDON CORNELIUS AND BANDON EST. 1913

OREGON INTERNATIONAL Port of Coos Bay

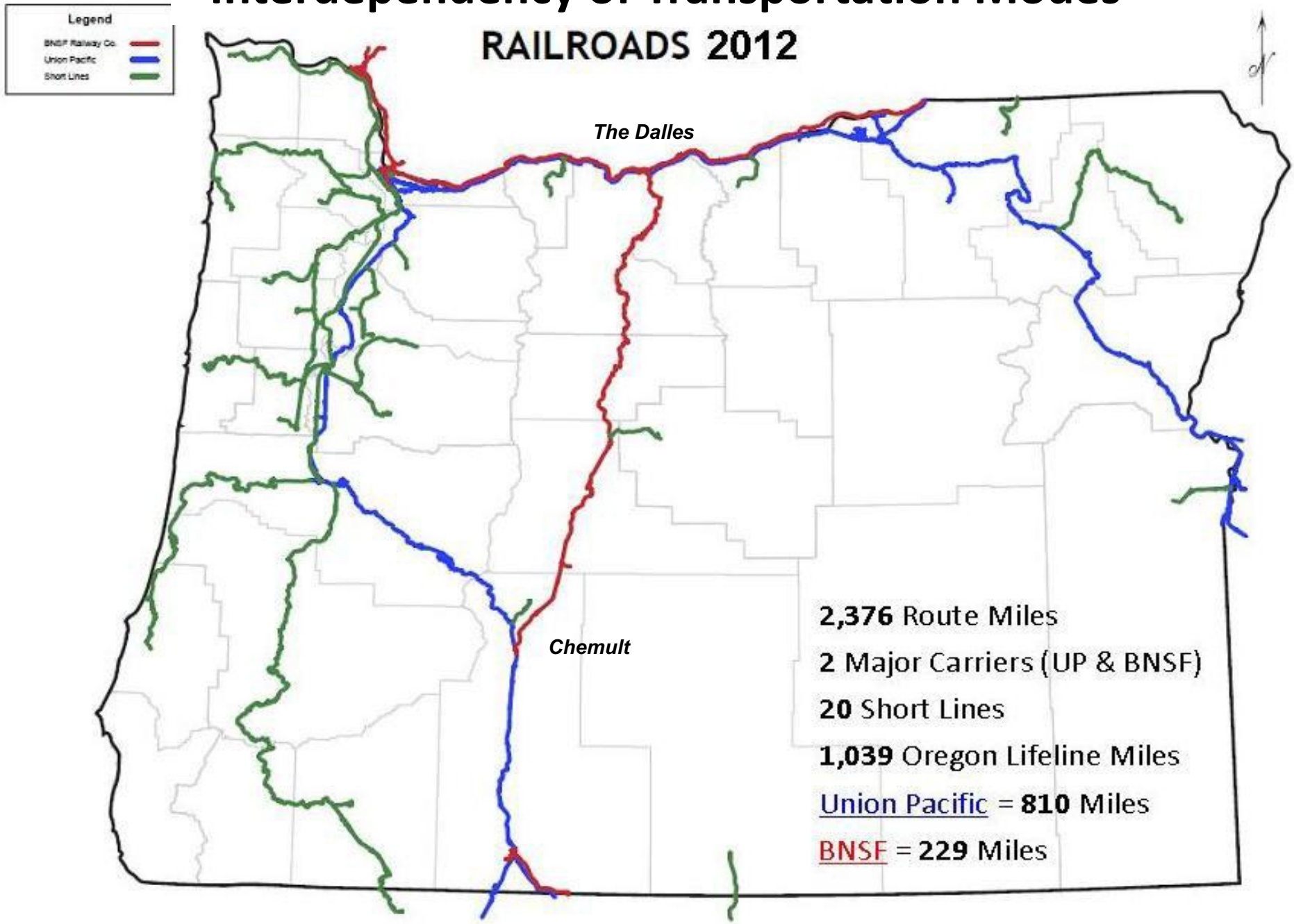
PORT OF UMPQUA

Port of Port Orford
Port Orford, Oregon, USA

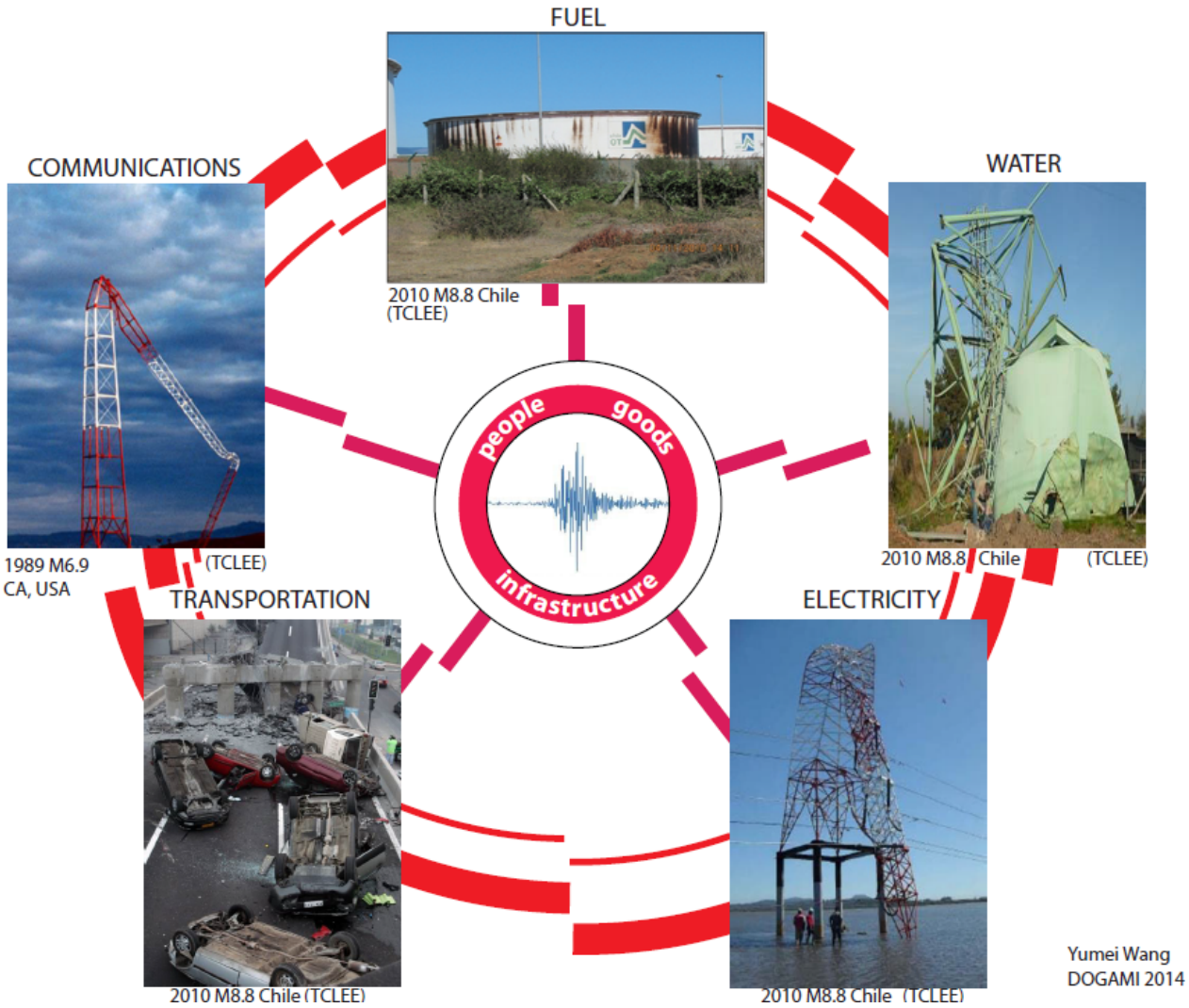
PORT OF BROOKINGS HARBOR

WELCOME PORT OF GOLD BEACH

Interdependency of Transportation Modes



Damage to Other Sector Lifelines and **interdependency** will slow restoration of services and rebuilding of the economy.



Key Finding – Liquid Fuel Dependency

- Liquid Fuel vulnerability is a key issue for transportation