Lifeline Interdependencies: Landslides and Liquefaction Impacts on Lifeline Systems

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November 2016, M7.8 Kaikoura Earthquake

- Struck close to midnight on 14 November 2016
- M7.8, making this the second largest earthquake recorded in NZ
- Unusual ground motions with ~2 minutes of shaking affecting the NE portion of New Zealand's South Island

Sources: Google maps, USGS Shakemak
Kaikoura Earthquake

**Surface Fault Rupture**

Co-Seismic Landslides

Liquefaction at the Port of Wellington

Sources: Dominion Post, GNS Science, Aristotle University of Thessaloniki
"My business is in tatters and our house is upside down. But what matters is we are all safe and alive"
Kaikoura jewelry store owner Cezanne Lyons (via Facebook)

Sources: EOC Geoservice of the Earth Observation Center (EOC), NZTA
Fault rupture impacts on transportation network (highway and rail)
Landslide impacts on transportation networks (highway and rail)
Embankment failures

Bridge Foundation Failures
Impact on Lifelines

- SH1 will be closed for 1 year (4k to 11k veh/d)
- Kaikoura town completely isolated
- Water supply: “fragile state” with boiling required following 6-person gastrointestinal outbreak
- Sewer systems: “severely damaged” and unusable
- Power outages: 7000 homes without power the night of the quake; 2000 by the end of the day
Actions and Policy Responses

• Caravan access to Kaikoura via "Inland Road"

• North Canterbury Transport Infrastructure Recovery alliance (NZTA and KiwiRail)

• Currently considering new sea vessel lines from North Island to Christchurch ("port is operating far below pre-quake capacity")

• Double airline offerings between Blenheim and Christchurch

• Hurunui/Kaikoura Earthquakes Recovery (Emergency Relief) Bill 2016, which allows for ocean disposal of landslide debris

"The challenge is to establish who is ‘in charge’ as quickly as possible. Once established, command and control must operate and transition smoothly from one phase of the response to the next" *(SR 530 Landslide Commission Final Report)*
Implications for the Pacific Northwest: Context

Sources: EOC Geoservice of the Earth Observation Center (EOC), Google Maps
Implications for the Pacific Northwest: "Cascadia Rising" Exercise

• “exercise demonstrated the need to also manage expectations within our own emergency operations center stakeholder groups ... there were instances of frustration by leadership .... on the estimated times provided for route clearance....WSDOT was instructed that the initial estimate of three days to clear a landslide on I-90 was unacceptable.”

• “the timelines for repair were also challenged for.... the collapsed or severely damaged bridges, which would take months to years to repair"

• “recommendation: more focus needs to be placed on the reality of recovering from a Cascadia-type incident with Emergency Management stakeholders in order to do a better job of managing expectations post-disaster” (WA State Cascadia Rising Exercise After Action Report, 2016)

• NZ Resident said some people were now "very close to the edge... It's not rocket science. They just need to get a big dozer in there, the slips just need to be benched.”

• (Recommend that we) "assess current societal expectations of acceptable lifeline performance levels and restoration times informed by the phases of response and recovery"

*Earthquake-Resilient Lifelines: NEHRP Research, Development and Implementation Roadmap, 2014*