Multi-billion-dollar benefits identified by improving Wellington and New Zealand’s infrastructure resilience to earthquake damage — *Reaching Resilience Faster by Working Together*

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Thursday, March 7, 2019
Wellington

- Political and cultural capital of NZ
- 350,000 people in metro area
- Workforce heavily weighted to public service activity
- Centre of the NZ film industry
- Principal transport link to South Island
- Region produces ~ 15% national GDP
- Region particularly exposed to earthquake, tsunami, wind and flood hazards
- Geographically challenging location
Wellington Infrastructure Programme Business Case (PBC)

- PBC to identify where investment could be made in Wellington’s infrastructure to enhance resilience
- Joint programme of work across all WeLG infrastructure providers to help build a more resilient Wellington – key aspect is identifying interdependencies
- Main thesis: improving the resilience and undertaking infrastructure risk reduction works is a better option than simply responding to outages or disasters
- The main aim of this project is to identify where the investment should be made (including consideration of policy changes to help enable investment)
- The NZ Treasury’s Better Business Case Framework is being followed
Scenario Event

- M7.5 earthquake on the Wellington Fault
- ~5% probability in next 50 years
- Close to probable maximum loss event for NZ
- Infrastructure impacts only

Perils considered

- Fault Rupture
- Shaking
- Liquefaction
- Landslide
- Co-seismic subsidence
Earthquake Impact Model Framework

Define Event → Hazard Intensity → Exposure/Asset → Fragility → Impact → Restoration → Temporal outage → Economic Impact

What, where, how big → PGA, Sa(x), MMI, LSN... → Buildings, people, lifelines, agriculture → How hazards damage assets → Deaths, Dollars, Downtime → How asset recovers → Time stamped outage → GDP, Sector, Region

Damage modelling → Outage modelling → Economic modelling
Modelled Infrastructure

- Roads
- Rail
- Electricity
- Fuel
- Telecommunications
- Potable Water
- Waste Water
- Gas
- Port
- Airport

and their interdependencies
Example: Electricity Network Assets & Configuration

- 33 kv Cables
- Zone Substation
- Grid Exit Point (GXP)
- Transmission Structures
Electricity Fragility

Low Voltage Substation with Anchored Components

Transmission Structures

Peak Ground Acceleration (g)

Pr(DS ≥ Ds)

Peak Ground Acceleration (g)

Pr(DS ≥ Ds)
Electricity Outage & Restoration

1) Establish Connectivity

2) Apply Intra-dependent Restoration Times

3) Apply Inter-dependent Restoration Times

→ Key dependency is road access
Electricity Intervention Projects

**Increase 160MW interconnectedness between substations**
Interconnection between The Terrace and Moore St substations in WE* network

**Central Park Substation improved resilience**
Creation of new CPK2 site close to the existing substation

**CPK - Frederick St cables replaced**
Under ongoing cable replacement programme

**Seismic upgrade of 33kV buried cables**
Eastern Wellington 33kV ring (Frederick, Hataitai, Evans Bay, Ira St) and Lower Hutt 33kV ring

**Replacement of all fluid filled cables in network**
Co-creation of Outage Maps with Lifeline Agencies

Network Data (providers) → Outage Maps

Hazard/Vulnerability (direct losses) → Damage Results

Recovery Strategy

(socio-economic impact)
Physical Damage and Infrastructure Disruption

- Habitability
- Liveability
- Business Operability
- Business Viability
- Market Accessibility
- Tourism Attraction
- Transport provision/substitutability

Socio-Economic disruption

- People relocations
- Supply of goods and services
- Business relocations
- Altered supply/demand relationships
- Altered tourism demands
- Altered mode/service providers and transportation costs
MODELLING THE ECONOMIC RESILIENCE OF INFRASTRUCTURE TOOL

• **Fully dynamic.** The model is able to show transition pathways under various post-impact scenarios.

• **Sectoral and commodity coverage.** The model has between 40 and 60 aggregate economic sectors/commodities included.

• **Spatial.** The model allows economic impacts to be differentiated spatially in an area or community.

• **Multi-regional.** Covers all regions in New Zealand. This allows cross-boundary economic impacts associated with infrastructure failure to be accounted for including impacts in labour markets, capital markets, housing markets and infrastructure provisioning.

• **Based on General Equilibrium principles.** The model uses prices to equilibrate supply and demand.
A coordinated approach improves overall resilience sooner

- Road & Fuel are the greatest enablers
- Water is a crucial lifeline but is the most dependent on other lifelines

A prioritised spend of ~$2 billion over the next 20 years can save 3 times this is reduced future losses and faster recovery

and this is a minimum resilience dividend
A key aspect of the ‘value added’

- Resilience is ‘socially defined, but technically delivered’ through good policy, best practice investment planning/prioritisation and effective collaboration.
- Need to understand the make up and expectations of the community with regard to better delivering on resilience outcomes.

The benefits...

- People
- NZ Inc
- Government & Lifelines Organisations