NEW ZEALAND'S CRITICAL INFRASTRUCTURE RESILIENCE

A National Lifelines Infrastructure Vulnerability Study, 2020

New Zealand Lifelines Council

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RNC & QuakeCoRE Infrastructure Monthly Meeting

12 October 2020

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National Emergency Management Agency
Te Rākau Whakamarumaru

TRANSPOWER
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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

WAKA KOTAHI
NZ TRANSPORT AGENCY

GNS SCIENCE
TE PŪ AO

Firstgas

Vector

Land Information New Zealand
Toitū te whenua

National Lifelines Infrastructure Vulnerability Assessment

- What is nationally significant infrastructure?
- What is our national Infrastructure's vulnerability and resilience to hazards.

http://www.nzlifelines.org.nz/ to:

- Download the Summary
- Download the Full Report

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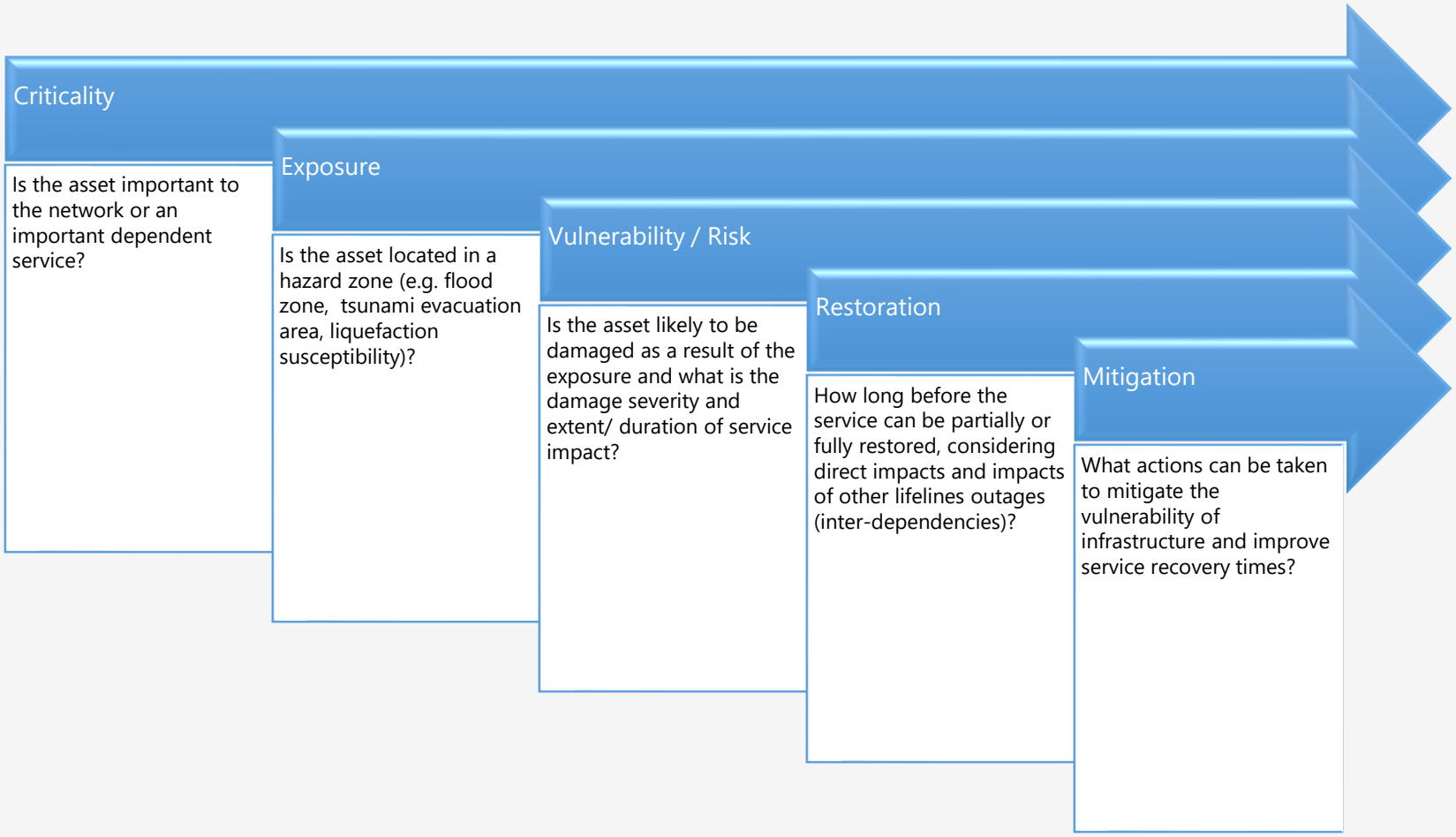
Regional 'Lifelines 'Vulnerability" Studies

- 'To assess the potential impacts of hazards on lifelines infrastructure and identify mitigation strategies to reduce that risk.'

- The national assessment builds its base from the regional work and supplements it with a 'top-down' view.

Assessing Infrastructure Risk to Hazards



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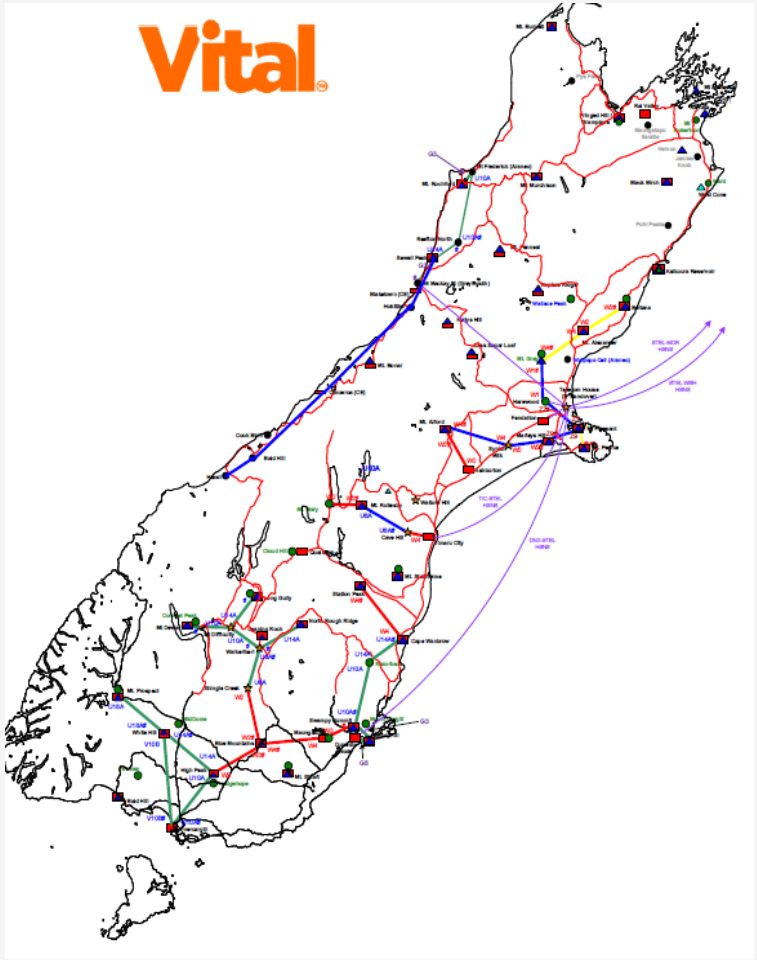
What's new in the 2020 Edition?

- New information on nationally significant critical infrastructure gathered mainly through national lifeline utilities.
- An overview of resilience investment programmes for each sector.



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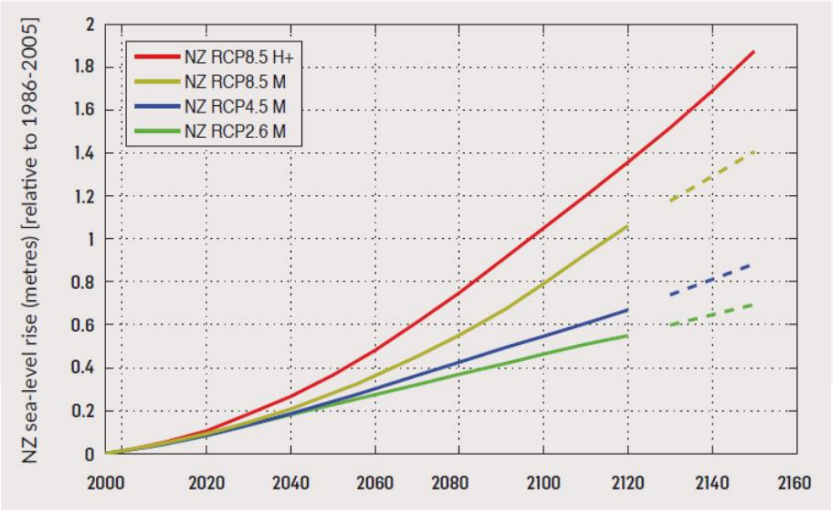
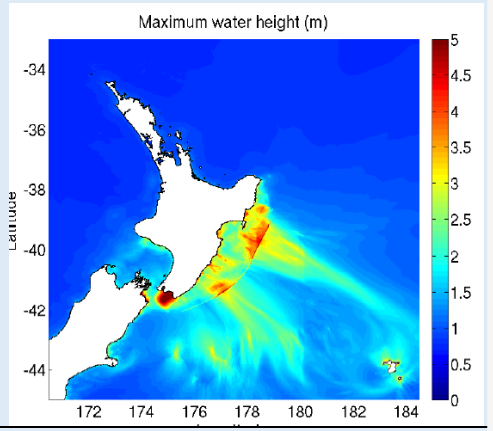
What's new in the 2020 Edition?

- New information from a number of major studies relating to significant New Zealand hazards.
- A new section on climate change risk and additional material on fire and pandemic hazards.



Case Study: Hikurangi Subduction Zone – Earthquake and Tsunami

Scenario and Context	▪ The Hikurangi plate boundary, located off the East Coast of the North Island, is where the Pacific tectonic plate subducts the Australian tectonic plate. ▪ The Hikurangi subduction zone is potentially the largest source of earthquake and tsunami hazard in New Zealand, but there is still much to learn about it. A large team of scientists are studying the Hikurangi plate boundary to better understand risks (project 2016-2021). ▪ The base scenario developed for the Hikurangi Project is slightly less than the maximum credible event: a Mw 8.9 earthquake on the southern portion of the subduction zone (*Hikurangi Response Plan Scenario Development, GNS 2018*). ▪ Earthquake shaking is expected to be intense in Hawkes Bay (around MMI 9.0 in Napier, Wellington/Hutt Valley (MMI 8.0-9.0) and Eastbourne/Rimutakas (MMI 9.0-10.0). ▪ The base scenario is expected to generate tsunami up to around 8m with the worst impacts on the south eastern coast of the North Island and top of the South Island (refer Figure to right). 
Infrastructure and Human Impacts	A detailed infrastructure impacts assessment is yet to be carried out for the Hikurangi Response Plan base scenario. However, some key assumptions in the initial base scenario development include: ▪ Wellington: Widespread loss of electricity (7-10 days restoration), water and wastewater (several months), gas pipeline damage (connection points to buildings could provide a fuel source for post-earthquake fires) and telecommunications. Port is unusable. Telecommunications failures once batteries run down (around 8 hours). Around 500 fatalities and 5,000 injuries. ▪ Napier: Severe damage to the Port and Airport (possibly permanent due to land uplift/subsidence), as well as some critical SH2 bridges and major slips on both SH2 and SH5 isolating Napier by road. Extensive damage to water pipes and electricity cables and highly limited electricity transmission into the region. Telecommunications failures once batteries run down (around 8 hours). The rail line to Woodville will take weeks to repair. Around 200 fatalities (most due to tsunami) and 700 injuries. ▪ Gisborne: Widespread tsunami damage to the south side of the CBD, isolation of the city by road, weeks of water, wastewater and electricity outages. Telecommunications failures once batteries run down (around 8 hours). Around 20 fatalities and 200 injuries. ▪ Elsewhere in the North Island, shaking of around MMI 7-8 is expected in Tauranga and Auckland. SH1 in Marborough is closed by slips. Airports and ports around the country will be coping with additional flights and ships diverted from their original locations.
Identified Mitigations	▪ Wellington Lifelines Group Programme Business Case (developed around the Wellington Fault) is a general reference for that region. ▪ More specific mitigations for this hazard are likely to be developed as the Hikurangi Project progresses.

Key Learnings from NZ Studies

Alpine Fault (AF8)

- Electricity throughout the South Island will be affected with likely blackouts within at least 150 km of the Alpine Fault and intermittent supply in areas considerably distant. The supply to the North Island may be affected.
- Most hydro generation plants will shut down with some damage expected. Many substations will be heavily damaged.
- Landslide dams can form and then fail, creating risks to downstream facilities.

Wellington Quake/ Wellington Lifelines Group

- Wellington Electricity networks will be impacted for weeks to months following a major Wellington earthquake.
- The Wellington Lifelines Resilience Programme Business Case (2019) identified three major Wellington Electricity projects ($205m).
- A $30m programme of strengthening of key assets, and the procurement of equipment to restore services faster is underway (to be completed in early 2021).

DEVORA/Auckland Lifelines Group

- Worst case volcanic scenario is around the isthmus where all transmission lines from the south converge in a relatively small area.
- Ongoing outages caused by ash-induced flashovers, for the duration of the eruption.

Hikurangi Fault (Subduction Zone)

- Widespread outages in Wellington / East Coast for several days to weeks.

Central North Island Volcanic Zone

- Loss of central North Island generation sites and ash disruption to transmission lines would severely constrain electricity supply to the upper North Island.

Mt Taranaki (Taranaki Lifelines Vulnerability Study)

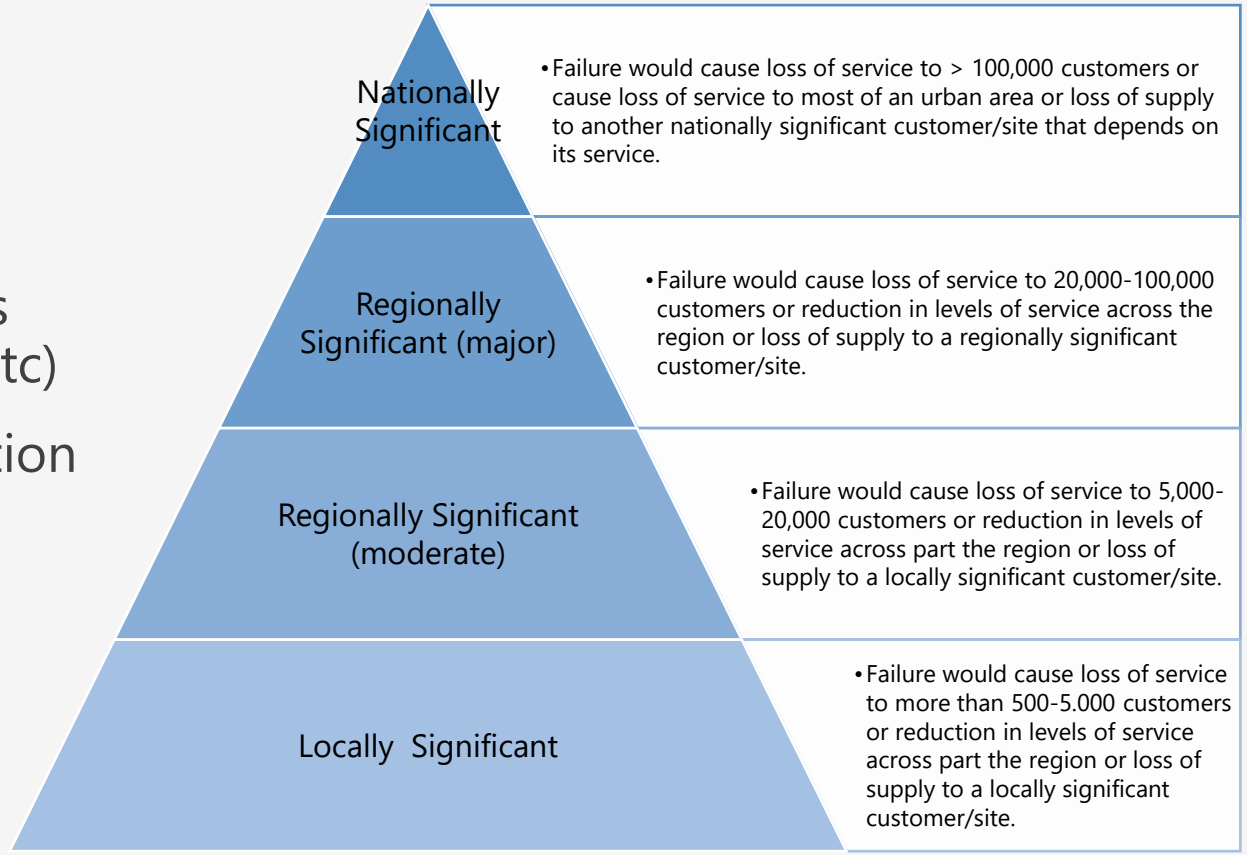
- Widespread outages due to transmission /distribution failures and closure of electricity generation sites both within and near the region. Service outages from 'Flashover' failure from ash.

Climate Change

- Risk of coastal inundation in a 1% storm is 122km of transmission lines and 182 sites, increasing to around 165km of transmission lines and 277 sites in a 0.6m sea level rise, predicted between 2070-2130 (MfE 2017).

A Revised Approach to Criticality Rating

- Intention is to have some national consistency (particularly across regional lifelines projects)
- Criticality relates to the consequence not probability of failure
- Assumes all lifelines services are equally important and the number of service outages have equal consequences (social, economic etc)
- Makes some simple assumptions about duration of outage and redundancy
- Has been tweaked for smaller versus larger regions



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Treasury Criticality Rating

Consequences		Insignificant	Minor	Moderate	Major	Extreme
	Scope	1	2	3	4	5
Human (life)	Human health and wellbeing, physical and mental. Includes impacts of illness, injury, income, skills, knowledge and the things that enable people to engage in society.	Mild impacts and inconvenience	Local/moderate illness or injury with no deaths, or serious hardship for <1000 people	Regional/serious illness or injury, 1 death likely, or serious hardship for >1000 people	National/serious illness or injury, up to 10 deaths, serious hardship for >10,000 people	more than 10 deaths, or serious hardship for >100,000 people
Social (&cultural)	Social and cultural structures and norms in NZ, law and order, cultural identity, communities, and community, social, and cultural facilities	Local public issue and sense of frustration or disadvantage	Regional public issue, loss of community facilities or impacts to social or cultural practices, sense of injustice within communities.	National sense of injustice, damage to many communities, social or cultural values challenged, public protests	Damage to social or cultural structures or values for up to 1 year, serious protests/disruptions, or loss of high value heritage	Long-term or permanent loss of social structures or key cultural values/identity. Civil disobedience and extended disruptions.
Governance (political)	Trust in government or management, maintaining credibility and a mandate to lead and/or continue to supply services. Includes international reputation.	Local issue (single region), stakeholder frustration	Issue for <1 month, with embarrassment for Govt or asset manager and some loss of confidence	Issue for <3 months, with loss of confidence in responsible ministers/officials/executives	Issue for >3 months, with loss of confidence and trust in Govt or organisation (asset manager)	long-term loss of trust in Govt or organistion (reputation), impaired ability to govern
Environment (natural env.)	All aspects of the natural environment to support NZ and the planet (biodiversity) and human wellbeing. Includes land, water, plants, animals, and other natural resources.	Minor, very localised impact <1ha, no residual effects	local area impact, recoverable, effects last <3 months	Local/regional impact, recoverable, effects last < 1 year	Regional impact, effects last > 1 year, some long-term residual impacts	Regional impact > 1 year, or long-term or permanent loss of ecosystem, species, or a natural resource
Economic (#people)	The economic impact to NZ (GDP). This is broadly indicated by the number of people impacted directly and indirectly, and may include customers, customers of impacted businesses, suppliers, and others.	Proxy= Total people impact, direct and indirect. # people <500	# people > 500	# people > 5000	# people > 50,000	# people > 500,000
Physical (asset value)	The value of the physical (or intangible) asset being assessed. An estimate of the replacement value of the asset (an indicator of impact to the asset owner).	Proxy= Total replacement value of asset. asset < $10m	asset > $10m	asset > $100m	asset > $1B	asset > $10B

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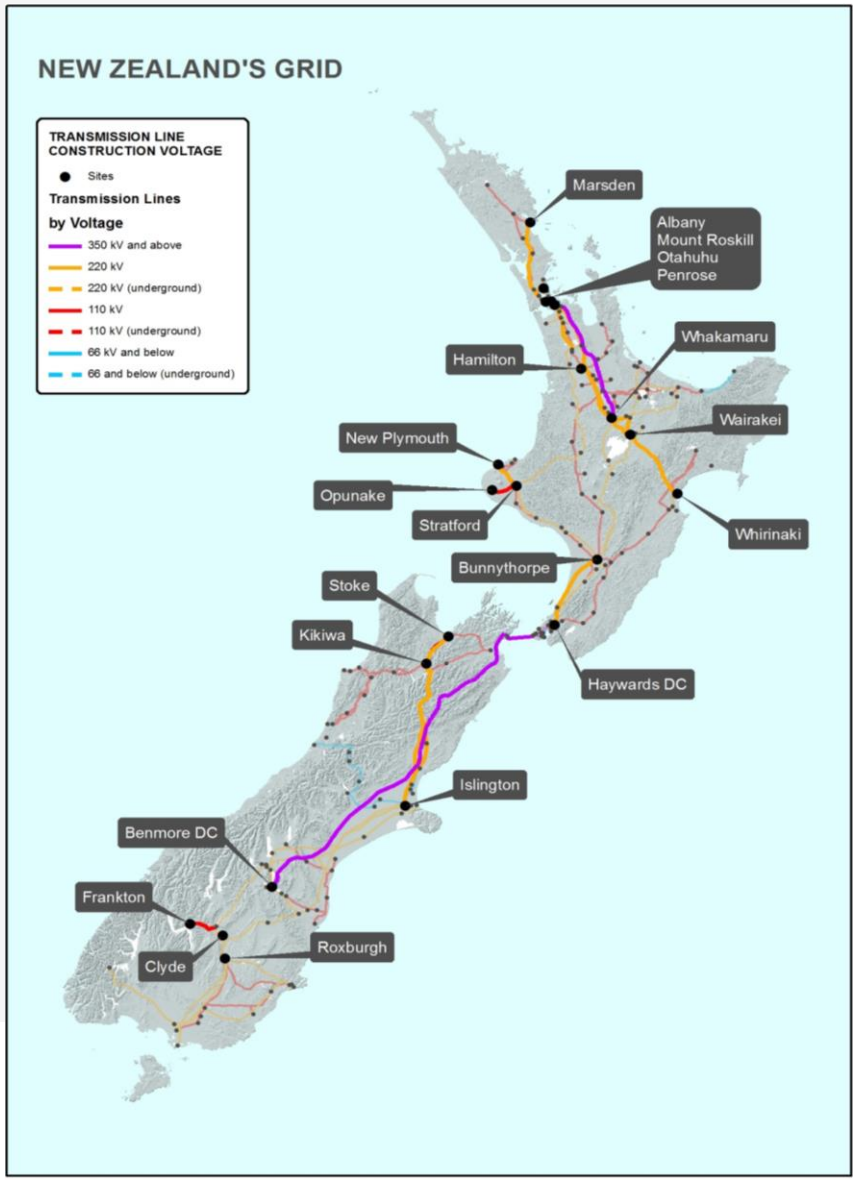
Key Sector Resilience Findings - Electricity

- **Changing generation sources** affecting the resilience profile of the overall national network.
- **Small distribution networks:** Typically less resilient design and less resources to manage and renew networks – network condition and reliability is a concern for some communities.
- **Climate Change**: More frequent high-wind storm events impacting distribution system reliability and managing 'dry-year' risks are going to be an increasing focus for the electricity sector.



Key Sector Resilience Findings - Gas

- **Criticality of key transmission lines**: Main vulnerabilities are coastal erosion, land slips, and third-party damage (e.g. accidental damage by diggers). The 2019 *Government Fuel Inquiry* made several recommendations relating to establishing higher levels of control and enforcement when working near fuel and gas lines.
- **Reducing national production:** Ceasing new permit issue for offshore gas exploration will likely result in a reduction in national gas production over time.

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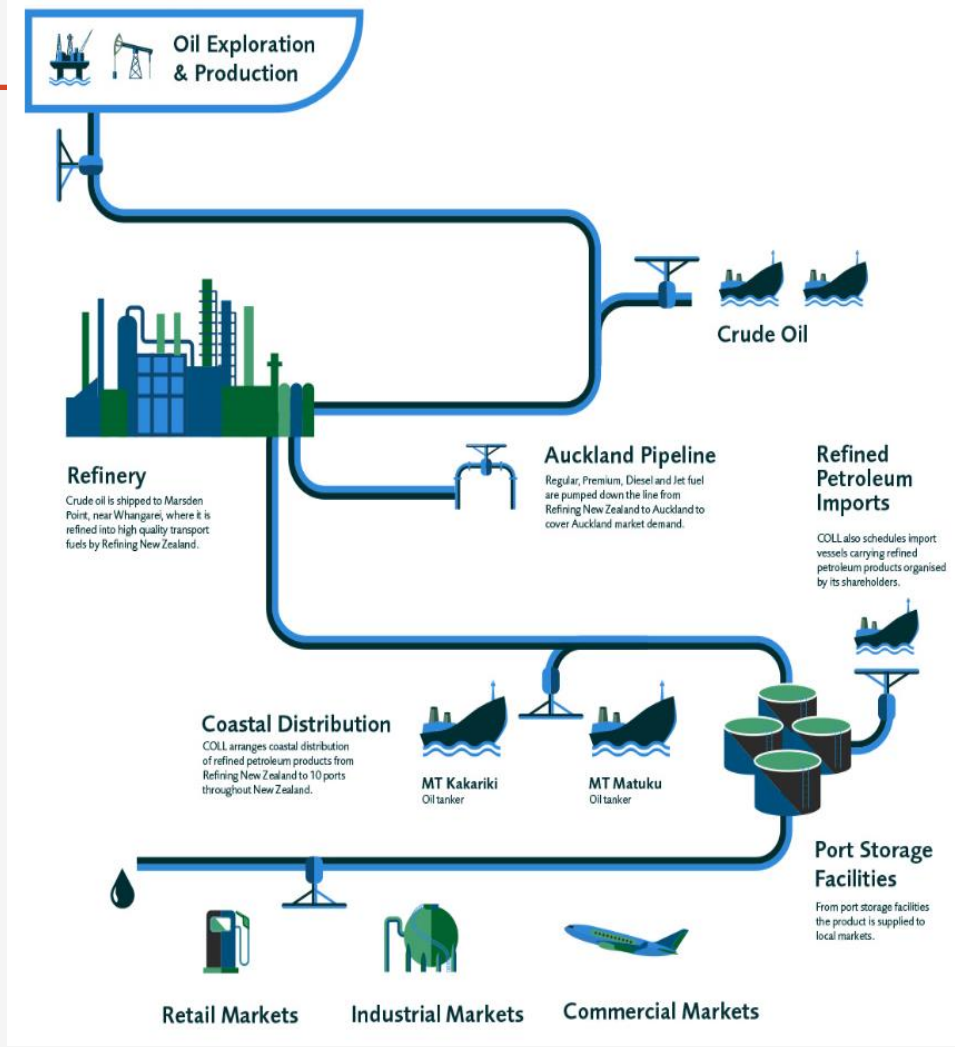
Key Sector Resilience Findings - Fuel

- **Tight supply chain and dependence on road network:** Fuel distribution within NZ is heavily dependent on the road network and limited storage around the regions. Capacity to fly in fuel to an isolated area is very small.
- **Jet fuel storage at Auckland Airport:** No logistical options if supply through the Marsden-Wiri pipeline fails.
- Most **regional fuel storage tanks** are on the east coast and are potentially exposed and vulnerable to tsunami. Damage to multiple ports would have devastating impacts on the fuel sector.



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Key Sector Resilience Findings – Land Transport

- **Weather and climate change impacts** - evidence of increasing emergency response costs higher frequency high impact storms. Climate change studies are indicating significant mitigations are likely to be needed in the medium-long term.
- **Slope instability and landslides** are an ongoing issue, with often inadequate local road alternate routes.
- **Developing evidence-based mitigation programmes**: Many road resilience improvement projects occur reactively when major damage occurs, such as in storms. The Wellington Resilience Programme is a good example of how the lifeline utility sector collectively agreed mitigation investment priorities and many in the sector are keen to expand these programmes across the country. ,

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Key Sector Resilience Findings – Air and Sea Transport

- **Volcanic ashfall can cause prolonged air traffic disruptions** and there is ongoing work to improve ashfall modelling following an eruption to try and minimise airspace closures (while remaining safe).
- **Vulnerability to earthquakes:** Most NZ ports are located to some extent on reclaimed land that varies both in age and construction quality.
- **Ports** are vulnerable to tsunami, particularly on the east coast, and sea level rise is a key issue for this sector.
- **Climate change** is an emerging vulnerability for airports; 13 of the 28 international or domestic airports are potentially exposed to extreme coastal flooding, groundwater rise and sea-level rise up to 1 m.

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Key Sector Resilience Findings – 3-Waters

- **Highly variable levels of resilience and preparedness between water authorities:** Major industry changes are underway to address and balance sector capacity and capability issues.
- **Climate change and increasing drought conditions:** A number of urban water supplies ran out of water in the summer of 2019/2020.
- **Climate change and increasing high intensity rainfall:** Stormwater networks will flood more frequently and intensively over time without upgrades.
- **Dependence on electricity with limited backup capacity**
- **Pipe networks vulnerable to land movement**:

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Key Sector Resilience Findings – Telecommunications

- **Dependence on electricity with limited backup capacity:** Critical sites have on-site generators and fuel storage but most others rely on battery backups.
- **Commercial drivers do not incentivise capital investment in resilience:** The 2019 government review of telecommunication network resilience found the sector focused on preparedness and response arrangements with little investment in risk mitigation.
- **Increased isolation risk for some communities:** as traditional local switching exchanges are progressively being shut down

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Understanding Infrastructure Interdependencies

Business as Usual

The degree to which the utilities listed to the right are dependent on the utilities listed below	Roads	Rail	Sea Transport	Air Transport	Water Supply	Wastewater	Stormwater	Electricity	Gas	Fuel Supply	Broadcasting	VHF Radio	Telecomms	**Total Dependency**
Electricity	2	2	3	3	3	3	2		2	2	3	3	3	**31**
Roads		3	3	3	2	2	2	2	2	3	2	2	2	**28**
Fuel	2	3	3	3	2	2	2	2	2		2	2	2	**27**
Tele-comms	2	2	2	2	2	2	2	2	2	2	2	3		**25**
Water Supply	1	1	1	2		3	1	1	1	1	1	1	2	**16**
VHF Radio	2	2	2	2	1	1	1	1	1	1	1		1	**16**
Stormwater	2	1	1	2	1	1		1	1	1	1	1	1	**14**
Wastewater	1	1	1	2	1		1	1	1	1	1	1	1	**13**
Rail	1		1	1	1	1	1	1	1	1	1	1	1	**12**
Sea Transport	1	1		1	1	1	1	1	1	1	1	1	1	**12**
Air Transport	1	1	1		1	1	1	1	1	1	1	1	1	**12**
Gas	1	1	1	1	1	1	1	2		1	1	1	1	**13**
Broadcasting	1	1	1	1	1	1	1	1	1	1		1	1	**12**

3: Required for Service to Function,
2: Important but can partially function and/or has full backup,
1: Minimal requirement for service to function.

During / Post Disaster

The degree to which the utilities listed to the right are dependent on the utilities listed below	Roads	Rail	Sea Transport	Air Transport	Water Supply	Wastewater	Stormwater	Electricity	Gas	Fuel Supply	Broadcasting	VHF Radio	Telecomms	**Total Dependency**
Fuel	3	3	3	3	3	3	3	3	3		3	3	3	**36**
Roads		3	3	3	3	3	3	3	3	3	2	2	3	**34**
Tele-comms	3	2	2	2	3	3	3	3	3	2	2	3		**31**
Electricity	2	2	3	3	3	3	2		2	2	3	3	3	**31**
VHF Radio	2	2	3	3	2	2	2	2	2	2	2		2	**26**
Broadcasting	2	2	2	2	2	2	2	2	2	2		2	2	**24**
Air Transport	2	1	1		2	2	2	2	2	2	2	2	2	**22**
Water Supply	1	1	1	2		3	1	1	1	1	1	1	2	**16**
Stormwater	2	1	1	2	1	1		1	1	1	1	1	1	**14**
Wastewater	1	1	1	2	1		1	1	1	1	1	1	1	**13**
Rail	1		1	1	1	1	1	1	1	1	1	1	1	**12**
Sea Transport	1	1		1	1	1	1	2	1	1	1	1	1	**13**
Gas	1	1	1	1	1	1	1	1		1	1	1	1	**12**

Understanding Critical Customer Resilience

- Emergency Services
- Health Services
- Government
- Food and Grocery
- Banking
- Corrections
- Solid Waste
- Major Industry

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Infrastructure Hotspots

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Regulation and Funding Arrangements

- A variety of business models and regulatory frameworks.
- A large number of agencies involved in policy development, regulation and funding lifeline utilities (summarised in Section 6.1)
- CDEM Act has over-arching requirements for all lifelines but has not been monitored or enforced.
- Commercial incentives do not always align with long-term resilience goals.
- It is difficult to get a national view of planned resilience investment and funding.
- The assessment focuses on physical infrastructure resilience, but organisational resilience aspects are important too.

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Next Steps

- Improve understanding of risk (e.g., critical community sector resilience, supply chains, economic impacts, organisational resilience)
- Addressing knowledge gaps (eg., coverage of other hazards, improved coverage of sectors such as flood protection and solid waste, impact of new technologies).

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Recommendations

- The New Zealand Lifelines Council (NZLC) continues it efforts with others to act as a conduit for improved community outcomes from infrastructure services.
- Lifeline Utilities use the information in this report to review and update their own risk mitigation and preparedness programmes.
- The NZLC specifically engage with new stakeholders such as the Infrastructure Commission, the Climate Commission and the Water Services Regulator.
- The NZLC work with the research sector to identify which knowledge gaps are being addressed in current research programmes and where there are opportunities to progress remaining gaps.
- Regions in New Zealand undertake programmes similar to the Wellington Lifelines Resilience Programme Business Case.

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Any Questions?