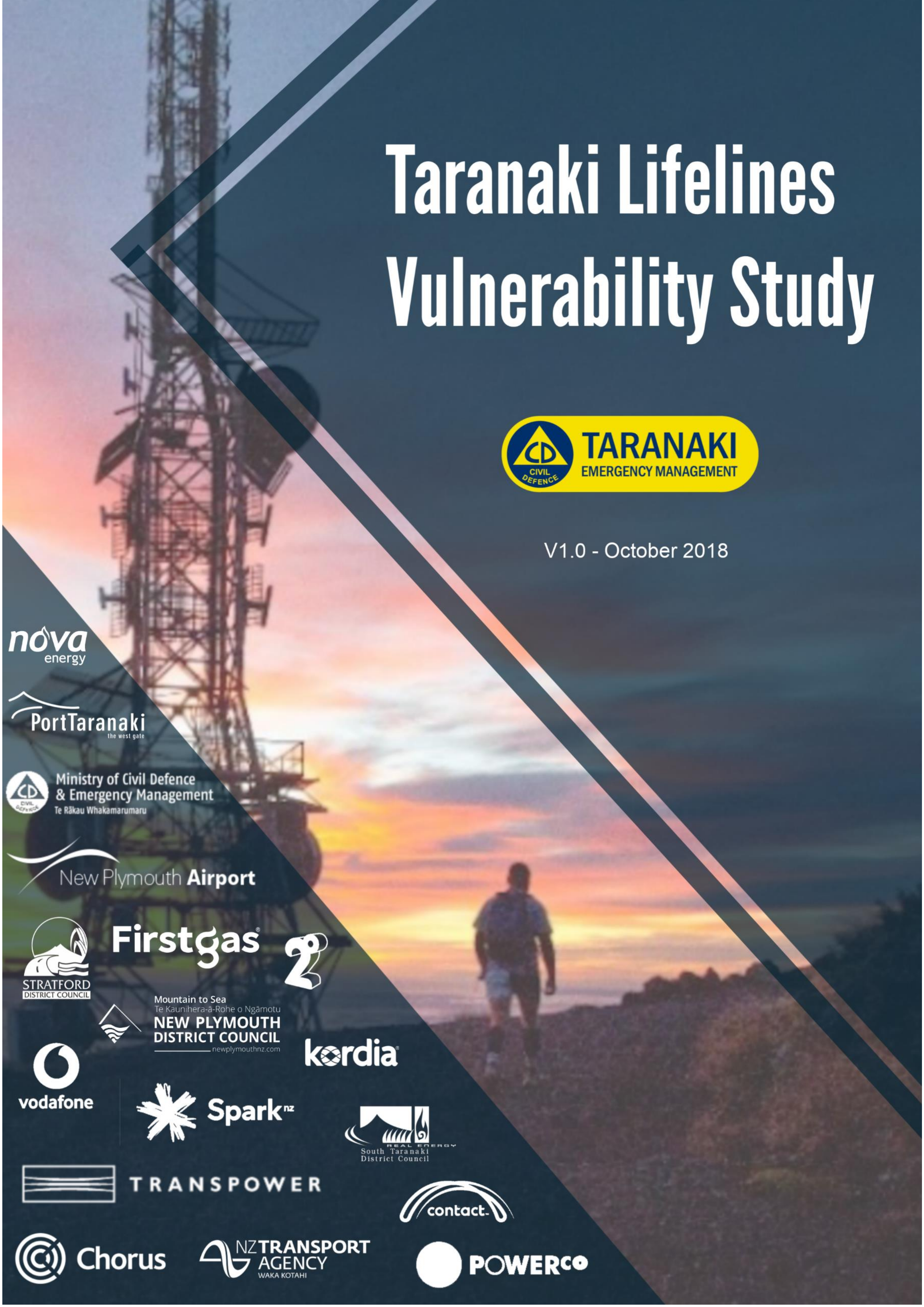

Taranaki Lifelines Vulnerability Study

TARANAKI EMERGENCY MANAGEMENT

V1.0 - October 2018

nova energy

PortTaranaki the west gate

Ministry of Civil Defence & Emergency Management Te Rākau Whakamarumaru

New Plymouth Airport

Firstgas

Stratford District Council

Mountain to Sea
Te Kaunihera-ā-Rohe o Ngāmotu
New Plymouth District Council
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kordia

vodafone

Spark nz

South Taranaki District Council

Transpower

contact

Chorus

NZ Transport Agency Waka Kotahi

Powerco

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Spark
Stratford District Council
Taranaki Regional Council
Transpower
Vodafone

DISCLAIMER

This report is general in its application and subjective in its recommendations. While every effort has been made to ensure the accuracy of the report, no liability whatsoever can be accepted for any error or misprint.

Most of the hazard information used for this project has been prepared at a regional scale and does not replace any requirement for detailed site-specific geological, geotechnical or other investigation. Readers of the report are advised to consult with Taranaki Regional Council as to the suitability of hazard information used in this report for other applications.

Infrastructure information in this report is current at the time of application but ongoing changes will occur. Information in this report may not necessarily indicate the current state of hazard vulnerability or preparedness of the lifeline utilities described other than on the date this report was issued.

The lifelines infrastructure information in this report was provided by lifelines organisations themselves and the Taranaki Emergency Management Office is not responsible for the disclosures made or withheld. The decision as to which information to disclose was the responsibility of each individual utility.

Contents

1. Summary

1.1 Project Overview

Lifelines infrastructure includes the transport, energy, communications and water services sectors that are fundamental to New Zealand's communities and economy.

This report presents the potential impacts on Taranaki's infrastructure from major natural hazard events. Potential measures to improve resilience to hazards in the lifelines sector are identified.

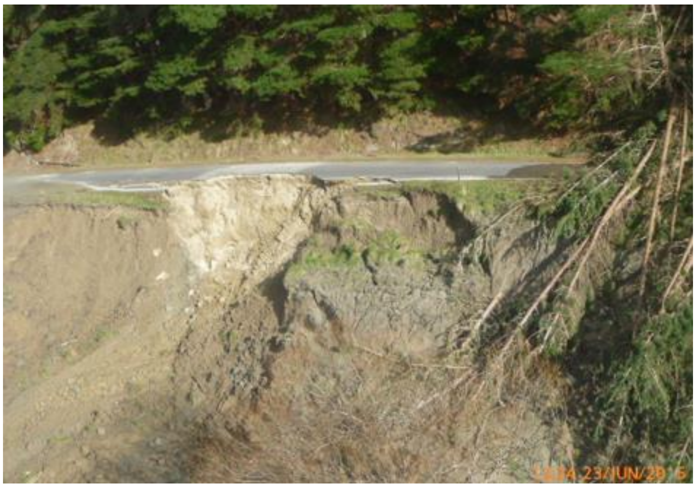
The approach has been to take a strategic, qualitative assessment of hazard-related lifelines risk focused on the region's most critical assets. The vulnerability assessment is based on the expert knowledge of lifeline utility and hazard representatives participating in the project. Quantitative, risk-based modelling has not been undertaken for this regional-scale project. However, hazard information is available to individual lifelines organisations to undertake more detailed assessment and mitigation option development.

1.2 Taranaki's Hazardscape

Four hazard types have been assessed for this project – volcano, earthquake, severe weather and tsunami. These are selected as the hazards having potentially a regional or national scale impact on the region's infrastructure.

The volcanic hazards to the region include both a Mt Taranaki eruption and potential ash impacts from another major North Island eruption. The impact of a large Mt Taranaki eruption is the most devastating scenario with widespread impacts on lifelines infrastructure either directly from the volcanic hazard or indirectly from loss of other lifelines services. Ashfall from a distal volcano would affect electricity, water supplies, roads and air transport to varying degrees depending on ashfall depth.

The earthquake hazards include a local fault rupture or shaking from a fault rupture on a major out-of-region fault (e.g. Wellington Fault, Alpine Fault or the Hikurangi subduction zone). In terms of faults within the region, the Waverley faults have the most potential for infrastructure damage, intersecting with gas and electricity transmission lines as well as State Highway 3. Port Taranaki appears to be the most significant infrastructure asset at risk from liquefaction, with potential consequences for the national petroleum and gas production supply chains.



The infrastructure impacts from a tsunami scenario with a 6m wave height were assessed. Port Taranaki is also vulnerable to this hazard, along with low lying coastal bridges and roads.

Severe weather events with high winds and heavy rain are not uncommon, with Cyclone Gita in early 2018 being the most recent significant event. The electricity network (winds) and road network (slips) are most vulnerable but, as seen in Cyclone Gita, there are consequential impacts on other infrastructure services.

1.3 Taranaki's Critical Infrastructure

This project uses a criticality assessment approach developed by the New Zealand Lifelines Council which identifies lifelines infrastructure as nationally, regionally or locally significant. Nationally significant assets are usually where there are 'pinchpoints' in networks where failure can affect the national supply chain.

The purpose of identifying critical infrastructure is to provide focus on assessing the region's most strategic assets. It also provides information to support other lifelines-related projects and CDEM activities, such as prioritisation of restoration efforts. The tables on the following page summarises the region's critical infrastructure and key vulnerabilities to hazards. More detailed information is included in Section 3.

Electricity

Key Critical Infrastructure Facts	Hazard Vulnerabilities
- Taranaki produces around 1/5th of NZ's electricity, mostly from gas fire generation plants. The largest is Contact's Stratford plant (577MW). - Nova McKee is the second largest electricity producer in Taranaki at 100MW. An additional plant of the same size is due in 2020. - The generators rely on gas production sites which in turn require electricity to produce gas. - The transmission grid does have some diversity (supplying from the south via Bunnythorpe and the north east via Huntly-Stratford). However, supply would be constrained if the Bunnythorpe link failed.	- A volcanic eruption or earthquake could potentially cause widespread power outages for weeks to months. - There would be significant knock on effects causing service failures of varying degrees to all other lifeline utility services and many large industrial customers. - For the distribution network, high winds have the highest likelihood of causing widespread service failures. Volcanic ash would also be very disruptive to the network and localised hazards (e.g. lahars) could cause damage taking months or years to fully restore.

Gas

Key Critical Infrastructure Facts	Hazard Vulnerabilities
- As noted above, gas-fired electricity generators in the region have national significance. - LPG is a critical fuel for households and industry in the South Island as well as key users in Taranaki. - There is no redundancy in the gas transmission lines feeding north and south. The system relies on being able to reduce demand during a disruption to maintain pressure. - The Critical Contingency Operator oversees the management of this process – if a minimum pressure is not maintained it can take weeks to months to bring the system up again.	- The gas system is highly vulnerable to volcanic events – both because volcanic ash will likely disrupt electricity supply, and possible direct damage from lahars where the Maui gas line crosses major rivers around the mountain. - The gas system is designed to withstand seismic events (again, if its key supply feeds are operational). - Land slips and third-party damage to pipelines are other key hazards for the sector.

Fuel

Key Critical Infrastructure Facts	Hazard Vulnerabilities
- Fuel to meet Taranaki's requirements comes into Port Taranaki by ship from Marsden Refinery. Fuel can be brought in by truck if Port Taranaki operations are disrupted and roads are open. - An important part of the Taranaki economy is the production of high-quality petroleum products which are sold into the international market. - Retail outlets rely on electricity to operate and there is limited or no backup generation.	- Any hazard that significantly impacts road and Port Taranaki operation will disrupt fuel supply. - There are also many scenarios outside the region that can affect fuel supply (Marsden Refinery outage, international supply disruptions, etc). - A regional fuel contingency plan is being prepared to outline how fuel shortages would be managed.

Transport

Key Critical Infrastructure Facts	Hazard Vulnerabilities
- Taranaki's road network includes several places where critical routes and bridges have limited alternate routes and long detour times. Weight	- There are several low-lying coastal bridges vulnerable to tsunami. - Recent storms continue to highlight the vulnerability to flooding, tree fall and slips – the

posting on many bridges further constrains availability of alternate routes. □ Mt Messenger (north) and SH 3 at Waitotara, Patea and Waverley are notable pinchpoints in the network, all vulnerable to two (or in some cases all) of the four natural hazards investigated. □ Port Taranaki is a critical facility for the region, with the Newton King Terminal being the most critical asset and a key part of the petrochemical export market. □ In a major disaster, the Port and Airport could potentially be important for evacuating people and bringing in emergency resources.	eastern hill areas are known to be particularly high risk for slips. □ Volcanic ash will cause widespread travel delays while clean-up occurs. Lahars/lava flows can potentially isolate New Plymouth and other towns by road in the large eruption scenario considered. □ A volcanic event and high wind events are mostly likely to disrupt air traffic (ashfall). □ The low-lying Port Taranaki is highly vulnerable to storm surge and tsunami. Also, 80% of the port is on reclaimed land with associated high risk of liquefaction.

Note: Kiwirail did not participate in this project, but while the rail is an important economic link, road alternatives can be used if they fail.

Telecommunications

Key Critical Infrastructure Facts	Hazard Vulnerabilities
□ The most critical site in the region is the New Plymouth Exchange (which requires water for cooling, and electricity). □ There are levels of redundancy for most assets – for example, the trunk fibre routes to the region have 'loop' redundancy and cellsites provide some overlapping coverage. □ The telecommunications network is highly dependent on electricity. Cellsite battery backups can be expected to last 4-24 hours depending on traffic and battery capacity, after which they would need recharging with generators. Some key exchange sites have standby generators with fuel sufficient for 2-3 days.	□ Earthquake, storm and volcanic hazards all create scenarios where fibre/landline routes could be isolated in multiple locations, causing major telecommunication service failures. □ Volcanic ash is likely to significantly impact cellular services, due to likely electricity failures plus clogging of air filters at key sites. □ High wind storms will also cause disruption because of electricity disruption and experience has shown that repairs can be delayed due to road conditions.

Three-Waters and Waste

Key Critical Infrastructure Facts	Hazard Vulnerabilities
□ Many drinking water supplies have a single source creating key points of vulnerability (critical assets) upstream of the distribution network. □ Water supply treatment plants and pump stations rely on electricity; some key sites have backup generation but not all have full capacity and there are many sites that have none. □ Wastewater treatment plants and pump stations generally don't have backup power, some have a switch for a generator, others have plans to truck effluent to the plant. There would be many raw sewage overflows in a widespread power outage lasting more than 2 days. □ Solid waste management can be a critical issue in a disaster (debris, volcanic ash, etc). A plan is in place to use closed landfills if required.	□ All the major drinking water supplies in the region are surface water supplies. They are highly vulnerable to volcanic ash and there is limited bore water backup. □ In the large eruption scenario investigated, Inglewood water supply would be damaged or destroyed and some trunk mains are also at risk (e.g. supply east of Waitara). □ Lahars / lava flows could cause damage to many other assets – stream intakes, pipes crossing rivers, etc.

1.4 Critical Community Sectors and Major Industry

As part of the project, discussions were also held with key community sectors and industry representatives to understand the impact of failure of lifeline utility services on these sectors. It was found that:

- Critical Community services such as police, fire and health have backup power and water to maintain essential functions. However, there are limited stocks of water at the hospitals and limited fuel stock for generators.

- Major industrial sites such as the region's meat and dairy processors, are vulnerable to loss of electricity, water supply and gas. In many cases, loss of supply would cause a shutdown of operations within 1-2 days of a key supply failure.
- The poultry and dairy sectors have multiple points along the supply chain requiring electricity, water and fuel to operate. Backup generation capability is improving (more farms are installing generators) though the actual extent is unknown.

1.5 Building Resilience in Taranaki's Infrastructure

This is the first multi-hazard infrastructure vulnerability assessment completed for the Taranaki region. It has highlighted several areas for further consideration, including:

- Improving understanding of available hazard information (for example, potential impacts from a Wellington or Alpine Fault rupture).
- Investigating upgrades to lifeline utility networks (for example, increasing backup generation on key facilities, increased fuel / LPG storage at the Port).
- Reviewing local resourcing of lifeline repair supplies (e.g. location and type of spares).
- Specific contingency planning (for example, targeted response plans by hazards).

It is recommended that the Lifelines Group:

1. Prioritise the potential actions identified in Section 5 (those that can potentially be undertaken as a Lifelines Group) and use this as a basis for development of a work programme for the group.
2. Identify and carry out further assessment of risks associated with infrastructure hotspots areas.
3. Maintain and further develop the Lifelines GIS viewer as a tool both for lifeline utilities and CDEM to use for strategic hazard assessment and potentially as an operational tool to support response.
4. Review the vulnerability assessments as and when new hazard information is produced.
5. Annually review lifeline utility mitigation actions – those listed in Section 5.1 plus others that are undertaken.

1 Introduction

1.1 Scope and Purpose

Lifelines projects aim to assess the vulnerability of lifelines infrastructure to the region's hazards and identify mitigation strategies to reduce that vulnerability. Over the last 25 years, lifelines projects have been carried out in many regions in New Zealand. This project covers the jurisdiction of the Taranaki Region.

The term vulnerability is used to refer to the susceptibility of lifelines networks to service outages when events occur and the inability to recover quickly. Vulnerability and resilience can be regarded as opposite ends of a continuum.

The project includes all infrastructure owned by 'lifeline utilities' as defined in the CDEM Act 2002, including water, wastewater, telecommunications, gas, electricity, fuel, road, rail. Other lifelines specified in the Act include TVNZ, Radio NZ and, in the Taranaki region, New Plymouth Airport and Port Taranaki.

The scope of the project also considers critical community services that may require lifeline utility services to function, such as hospitals, welfare centres and major industrial sites. Supply to these sites is considered when determining which lifeline utility assets are critical.

The collaboration that occurs between lifelines organisations during the project is invaluable in terms of better understanding each other's networks and establishing 'pre-event' relationships. In the words of the mission of the New Zealand Lifelines Council, this over-arching purpose of this lifelines project is to:

> *"Enhance the connectivity of lifeline utility organizations in order to improve critical infrastructure resilience."*

Taranaki – An Overview

Population 120,000 (2018), increasing at around 1.5%pa.

There are four main geological types: volcanic zone and ring plain, marine terraces, coastal environment, eastern hill country. 530 named rivers, many steep, short and narrow.

One of the highest areas of rainfall in NZ but also experiences periods of drought. Its location by the Tasman sea means high winds, tornadoes and cyclones are a regular occurrence and expected to increase with climate change

Taranaki is NZ's largest and most important oil and gas-producing region.

A number of gas-powered electricity generation plants are important to the national grid.

Other key industries include agriculture, meat and dairy processing, manufacturing and tourism.

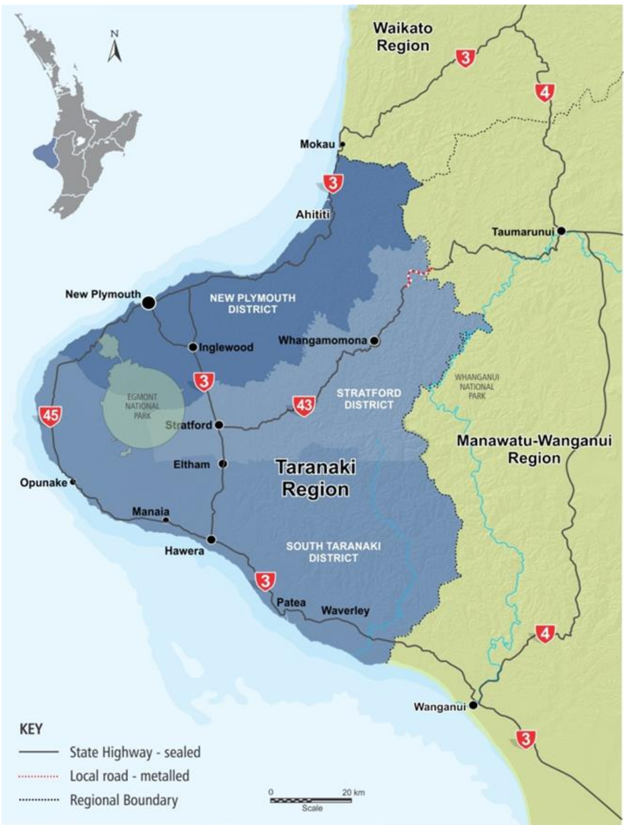


Figure 1-1: Area Covered in this Study

1.2 Project Benefits

Through participation in this project, lifelines infrastructure providers achieve the following benefits - they:

- have the latest regional hazard information available (in GIS files where available);
- have maps of critical lifelines and community sites in the region (to enable them to consider supply to these sites when prioritising their response and recovery);

- understand the likely impact of natural hazards on their assets and services; as well as on other utilities that they rely on (interdependency impacts);
- gain knowledge of potential mitigation measures to reduce vulnerability to hazards that can feed into long term asset management plans; and
- can facilitate communication with other lifelines organisations and critical community service providers about hazard mitigation and to establish 'pre-event' relationships.

The project also provides information to CDEM and other agencies involved in disaster response, as to the potential infrastructure impacts and recovery times in major disaster scenarios to assist in planning for these events.

Finally, participation in the project helps lifeline utilities in meeting the requirements of the CDEM Act 2002, which include that each lifeline utility organisation must:

- ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency;
- make available to the Director in writing, on request, its plan for functioning during and after an emergency; and
- participate in the development of the national CDEM strategy and CDEM plans.

1.3 Project Methodology

Figure 1-2 illustrates the broad approach taken to assessing the vulnerability of Taranaki's lifelines infrastructure to natural hazards.

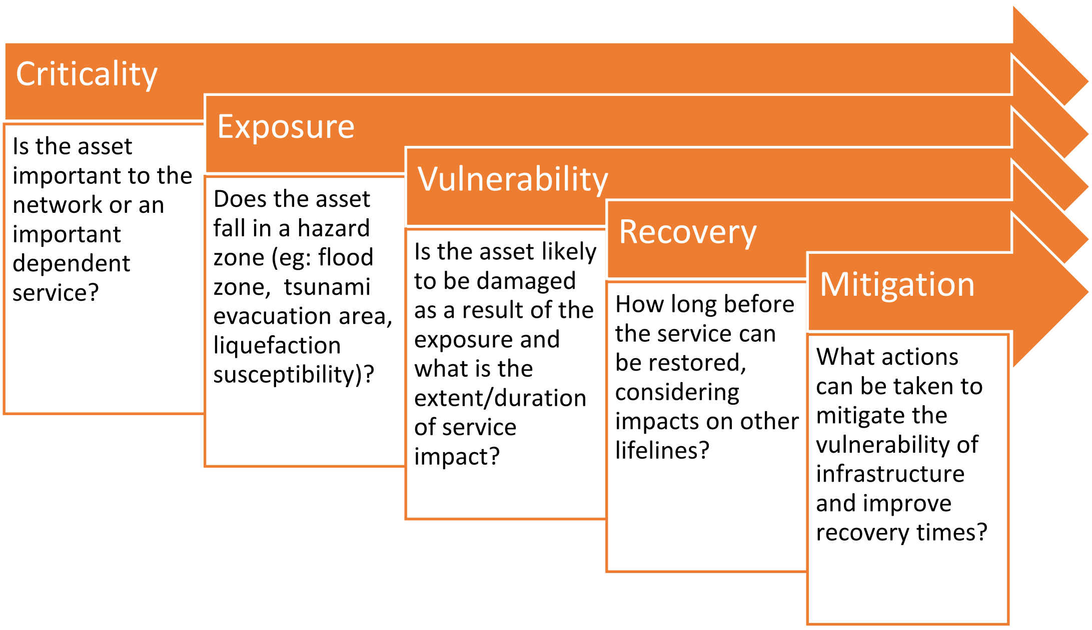


Figure 1-2: Overview of the Vulnerability Assessment Process

The methodology followed is summarised below:

1. **Identification and mapping of critical lifelines infrastructure**

   Each lifeline was asked to provide information on its critical infrastructure using the methodology described in Section 1.4, rating assets as nationally, regionally and locally significant.
   As a minimum, the data provided included spatial (locational information), asset type and a criticality rating. At the first project workshop, the criticality assessment process was discussed so that a reasonably consistent approach was taken across the lifelines sector.

2. **Collection of regional hazard information**

   The most accurate and recent hazard information was sourced as regional GIS layers, including tsunami evacuation zones, earthquake hazards such as liquefaction risk areas and active faults and modelled and historical flood inundation areas.

3. **Development of a GIS Viewer**

   Infrastructure and hazard information was collated into a set of regional GIS layers which were made available to lifeline utilities in a password-protected GIS viewer.

4. **Assessment of infrastructure interdependencies**

   An assessment was made of the dependency that each lifelines type had on other lifelines for its service to function, using a rating system described in Section 1.4. This information also informed the vulnerability assessment described in the next step, in that each lifeline recovery times were assessed considering service outage impacts of other lifelines they depended on.

5. **Assessment of infrastructure exposure and vulnerability**

   The GIS viewer enabled lifelines to identify where critical infrastructure assets fell within hazard areas. An assessment of the likely extent of damage arising from the hazard was made by lifelines representatives using a rating system described in Section 3 (ranging from minimal impact to total asset failure requiring full reconstruction). The lifelines further considered the extent of service area outage and recovery times arising from the asset failures.

6. **Identification of Regional 'Hotspots' and 'Pinchpoints'**

   The GIS viewer was used to overlay critical assets from all infrastructure sectors to identify where a number of them were co-located and in a hazard risk area, creating areas of particularly high vulnerability. Knowledge of lifelines representatives was also valuable for this assessment.

7. **Identification of Potential Mitigation Options.**

   Lifelines sectors identified potential mitigation options to improve infrastructure resilience (part of a workshop in August 2018).

1.4 Critical Lifelines Infrastructure Assets

Each lifelines organisation in the region has categorised its assets as Criticality 1, 2 or 3 (***nationally*, *regionally*** or ***locally*** significant).

The approach is summarised in Figure 1-3 and further explained below.

In general, the criticality approach considers the number and type of customers affected, both directly and indirectly, if an asset fails.

The criticality rating reflects the consequences of failure, not the likelihood of failure under various hazard scenarios, i.e., just because it is in a flood prone area does not make an asset 'critical'.

If alternative arrangements can be put in place before serious financial and/or social problems emerge (e.g. within 4 – 8 hours) then the criticality can be reduced down one level. These alternatives might be either made available:

- by the utility themselves, through network reconfiguration, or
- by critical customers with alternative supplies on-site such as generators or water tanks that enable substantial functioning for longer than 2-3 days.

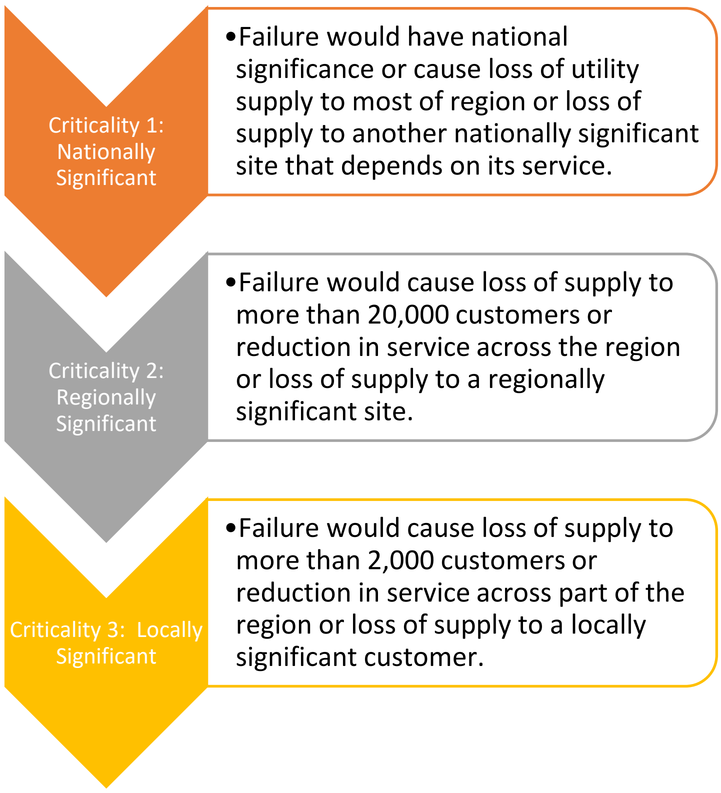


Figure 1-3: Critical Infrastructure Rating Approach

Note the term 'customer' refers to 'connections', 'households', or vehicles depending on the relevant sector.

2. Taranaki's Hazardscape

This Section presents information on the four major natural hazards assessed in this study. It provides an overview of the hazard; the source of hazard information used and summarises the probable impact of the hazard on lifeline utility services. A more detailed description of the impacts of the hazards for each lifeline utility sector is contained in Section 3.

2.1 Overview

The following sections summarise information on the 'big 4' natural hazards that are most commonly the focus of regional lifelines studies, but further work on other hazards will be considered as part of the recommended work programme (Section 5).

There are a number of features of hazards that make them challenging to understand (*source, National Infrastructure Vulnerability Assessment, 2017*).

The ***composite, cascading, cumulative*** nature of hazards is not always well captured in lifelines project analyses. The focus is often on direct impacts such as tsunami wave damage and landslips, not necessarily the cascading impacts such as increased flooding risk arising from ground movement. Cumulative impacts can occur such as when a light rain accompanies volcanic ashfall increasing 'flashover' risks on electrical systems.

There is a ***limited hazard event history*** within living memory and the low frequency events are not all well understood.

Availability of national hazard maps. For some hazards there are national datasets such as 'active faults', earthquakes (Geonet), tsunami and soil types. For others, hazard information has been developed at a regional or local scale and not always on a consistent basis. The challenge is often how to transfer raw data into usable form / product for studies such as lifelines projects.

Damage impacts cannot be accurately predicted. There are huge range of contributing factors and damage / loss assessments at best can be only expected to provide a broad-brush estimate.

Highlights

- **The regional volcanic hazards include a Mt Taranaki eruption and ash impacts from another major north island eruption.**
- **The impact of a large Mt Taranaki eruption is the most devastating scenario with widespread impacts on lifelines infrastructure either directly from the volcanic hazard or indirectly from loss of other lifelines services.**
- **Ashfall from a distal volcano would have the most impact on electricity, water supplies, roads and air transport.**
- **The earthquake hazards include shaking arising from local faults or from a fault rupture on a major out-of-region fault (e.g. Wellington Fault, Alpine Fault or Hikurangi subduction zone).**
- **The Waverley faults have the most potential for infrastructure damage, intersecting with gas and electricity transmission lines and SH 3.**
- **The major tsunami impact would be Port Taranaki and subsequent impacts on petroleum and gas production.**
- **Severe weather events – with high winds and heavy rain are not uncommon. The electricity network (winds) and road network (slips) are most vulnerable.**

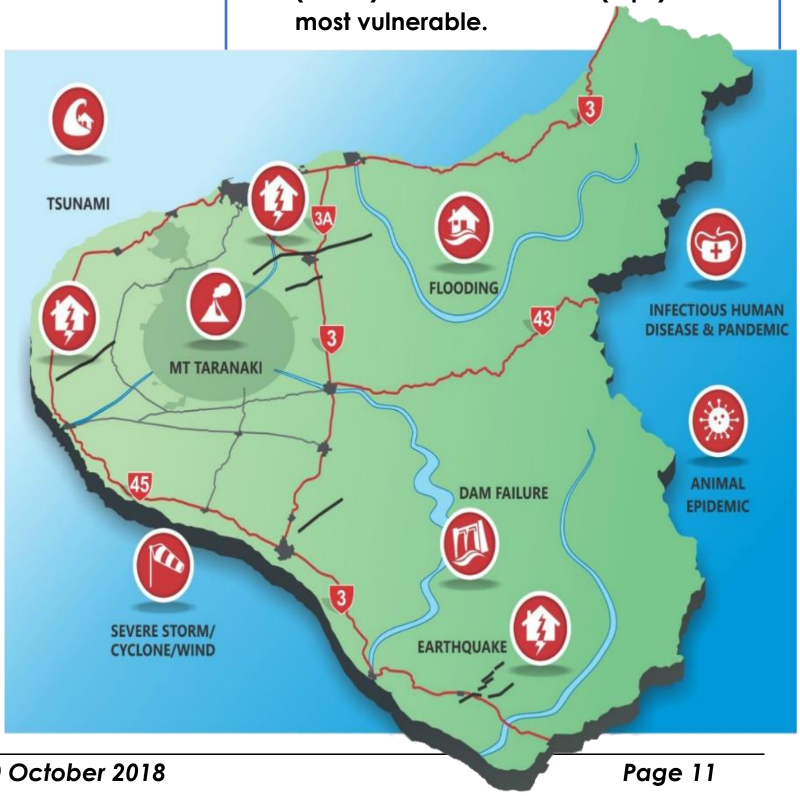


Figure 2-1: Taranaki Hazards (Source: CDEM Group Plan for Taranaki 2018-23)

2.2 Volcano

The Hazard

Taranaki could be impacted by eruption of its own volcano, or ash fall from a more distant volcano (known, existing volcanic areas are shown in Figure 2-2). The CDEM Group Plan for Taranaki 2018-23 provides the following information about a Mt Taranaki Eruption.

- Mt Taranaki is an active volcano in a current state of inactivity. Moderate to large eruptions of the mountain have occurred on average every 500 years with smaller eruptions occurring about 90 years apart.
- The latest research in 2013 has led to an increase in the forecasted probability of Taranaki erupting. The new data and modelling increased the estimate of an eruption in 2014 from 1.6 to 3.1 percent in any year.
- The Geonet volcanic-seismic network monitors all earthquakes in the Taranaki region. During volcanic unrest these may indicate magma movement within the earth's crust below the volcano. Three GNSS (Global Navigation Satellite System) sites are located on or near Mt Taranaki to monitor ground deformation that may indicate volcanic activity.
- A volcanic eruption today has the potential to affect Taranaki for a long period of time, both because of its after-effects and the potential for intermittent or ongoing volcanic activity.
- An eruption of Mt Taranaki could produce volcanic hazards such as tephra falls, pyroclastic density currents, lava flows, lahars, flooding, debris avalanches, sector collapses, lightning and volcanic gases. During unrest and eruption significant earthquakes and ground deformation can also occur.

Figure 2-2: Known Volcanic Areas in New Zealand

Figure 2-4 shows the 'combined' hazard layer whilst Figure 2-5 shows the lava and lahar flows for a large eruption scenario. The reduced risk to the north/north-west of the mountain is due to the Pouakai and Kaitake ranges creating a physical buffer.

Volcanic ashfall modelling for this scenario predicts up to 500mm of ash in New Plymouth in a southerly wind direction (similar amounts could be expected in Stratford, Opunake depending on wind direction.

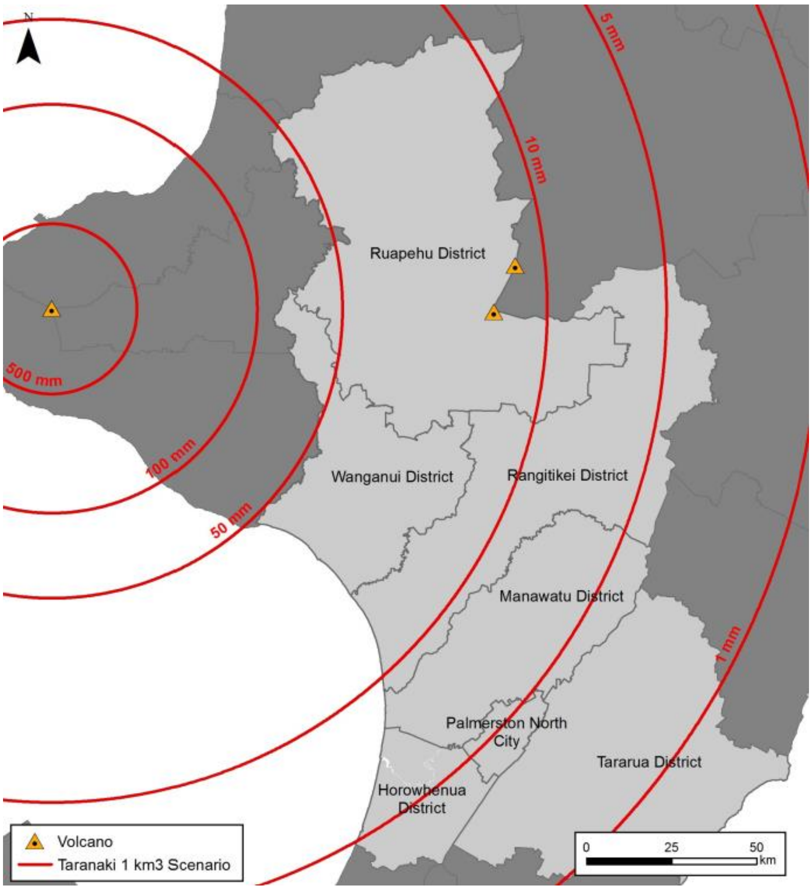


Figure 2-3: Volcanic Ash Modelling, Mt Taranaki (westerly, 1:2,500 yr event). Source: GNS for Manawatu-Wanganui Lifelines Project 2016.

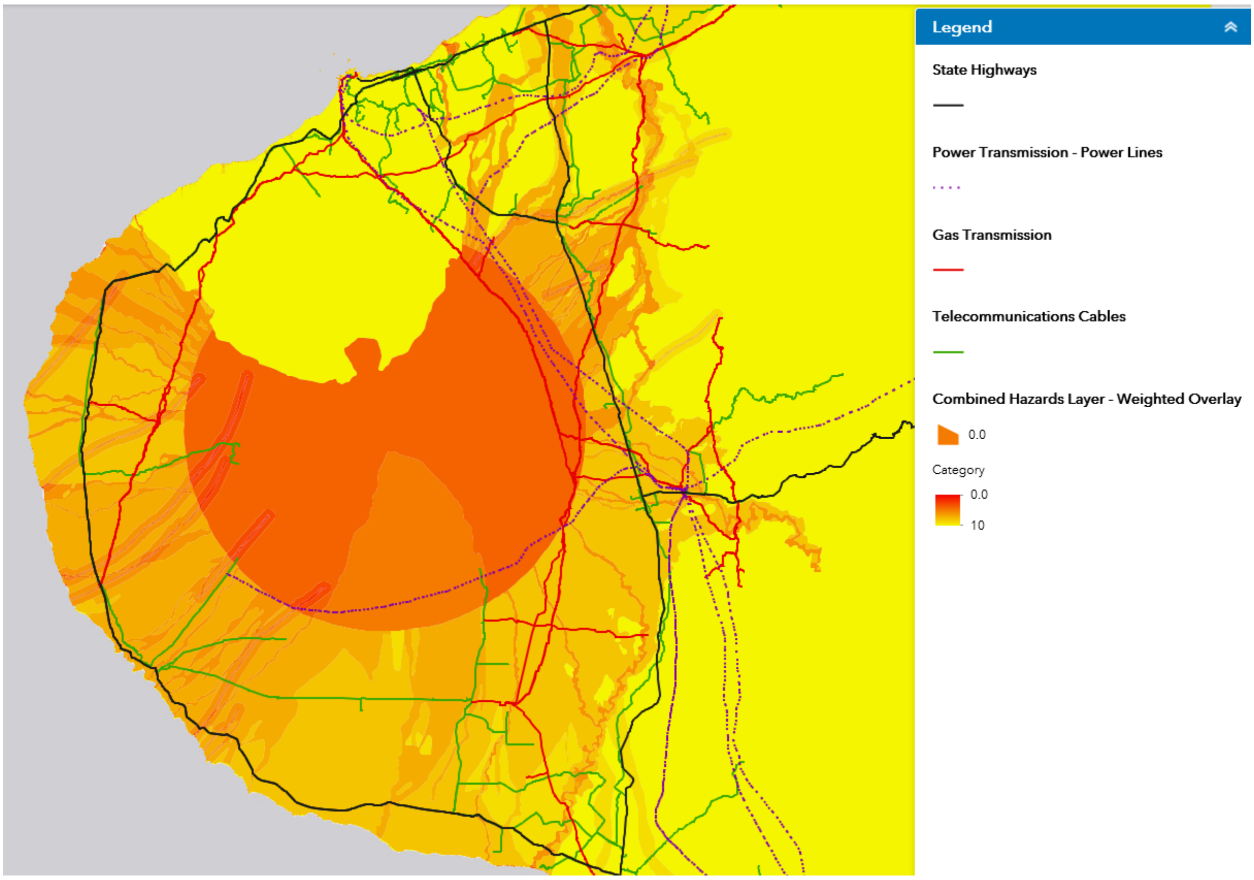


Figure 2-4: 'Combined Hazards' (Volcanic Hazards of Taranaki: 1996. Neall, VE; Alloway B.V., Massey University and Department of Soil Science Occasional Report.

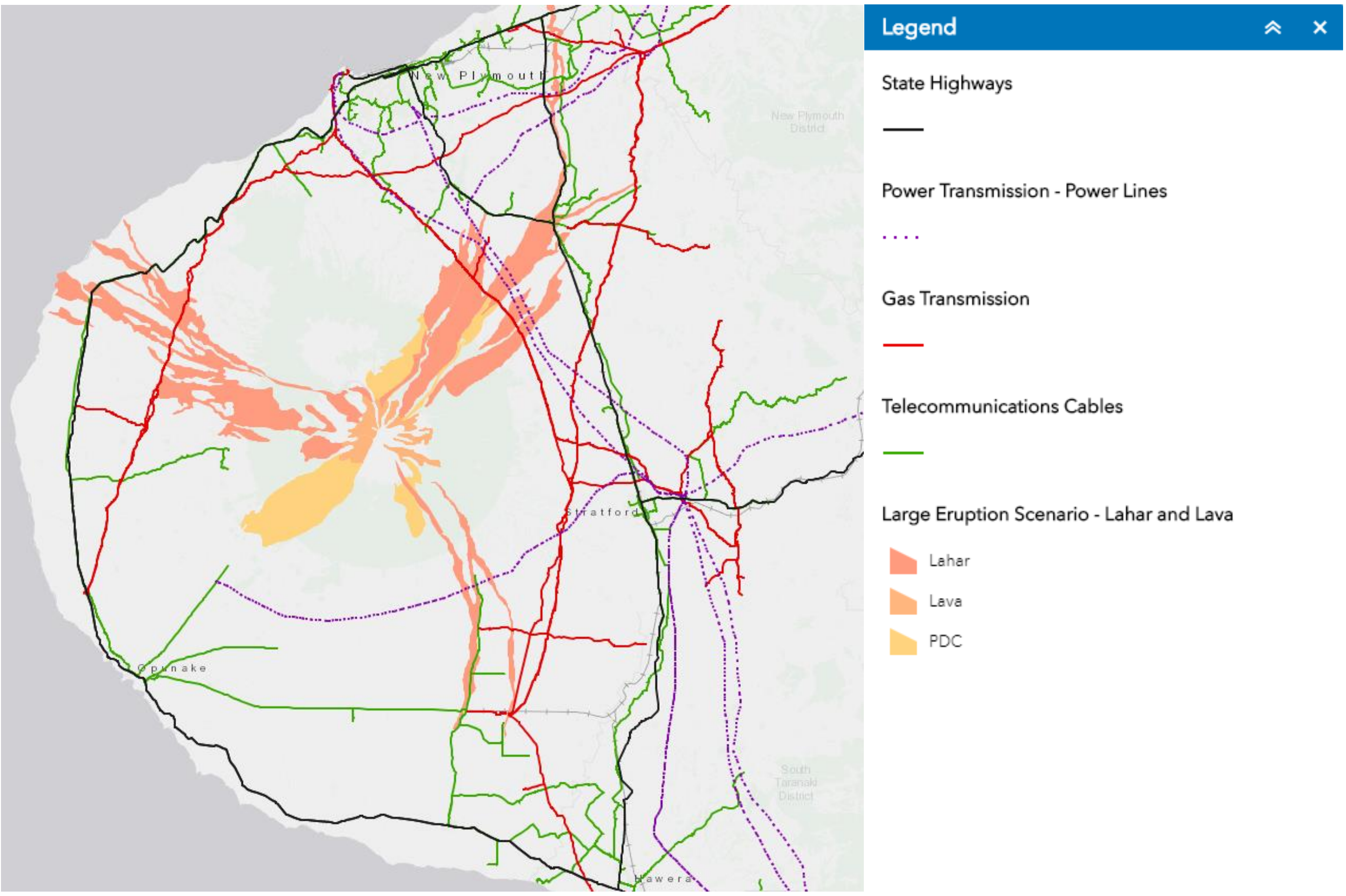


Figure 2-5: Large Eruption Scenario – Lahar, Lava Flows (Source …)

The Impacts

Near source impacts such as lava flows and lahars are the most destructive impacts of a volcanic eruption, potentially destroying infrastructure in its path such as pipelines and bridges crossing rivers. However, these near source impacts are more geographically contained than ashfall. Potential unmitigated impacts of volcanic ash include:

- Buildings rendered uninhabitable due to ash environment, impacts on air conditioning systems and, in the worst case, roof failure due to ash loading.
- Reduction in air cooling performance has the biggest potential impact in the telecommunications sector which requires cooling for equipment to operate.
- Intake of ash into plant and equipment can damage (directly or via water sources) and impact operations of facilities such as power generation plants and water/wastewater treatment plants – hydro-electric turbines in the Tongariro Power Scheme were destroyed in the 1995 Ruapehu eruption.
- The potential for air transport disruption is significant, particularly as some volcanoes have a history of erupting for long periods of time.
- Roads will be unsafe to drive – both in terms of skid and visibility risks – and clean-up and disposal operations will be significant.

The impact of a 'large scenario' volcanic eruption on Taranaki's infrastructure may include:

- Damage and/or curtailment of national oil and gas production.
- Significant and ongoing affects to North Island air transport.
- Electricity failures to specific areas due to transmission line / site damage from lava / lahars (at risk electricity sites feed New Plymouth CBD and treatment plants, Bell Block, Waitara, Inglewood and many other areas.
- Widespread electricity failures due to closure of electricity generation sites both within and near the region, 'flashover' failure from ash on overhead electricity lines and loss of transmission lines from Bunnythorpe (which cross lahar/ lava flows).
- Isolation by road (lava flows / lahars crossing SH 3 in a number of places).
- Roads not damaged by near source impacts are likely to be extremely difficult to drive on due to ash.
- Damage to the country's gas production facilities and transmission lines to the north from lahars / lava flows.
- Significant damage to wastewater and stormwater pipes from ash entering the network, potentially blocking pipes and even hardening.
- Subsequent major impacts on national poultry and milk supplies (both directly from volcanic impacts and from lifeline utility disruption).

Further detail of impacts by sector are presented in Section 3.

Large Eruption		Damage Impact	Service Impact
Wastewater	Ash	3	5
	Lava Flow	3	3
Water Supply	Ash	3	4
	Lava Flow	2	3
Electricity	Ash	1	4
	Lava Flow	3	3
Gas	Ash	1	4
	Lava Flow	3	3
Stormwater	Ash	3	3
	Lava Flow	3	3
Roads	Ash	1	5
	Lava Flow	2	4
Airport	Ash	1	5
	Lava Flow	1	1
Port	Ash	1	5
	Lava Flow	1	1
Rail	Ash	1	5
	Lava Flow	2	5
Telco	Ash	3	4
	Lava Flow	2	4

Damage Impact Rating	Service Impact Rating
1) Unlikely to cause damage.	1) Minimal impact
2) Possible damage, short term disruption.	2) Localised failure
3) Possible damage, longer term repairs (weeks/months).	3) Widespread localised failures
4) Complete failure, full reconstruction required.	4) Sub-regional loss
	5) Regional loss

Figure 2-6: Assessed Impacts of a Large Mt Taranaki Eruption

(Assessed by Sector Representatives during project workshops in 2018.

2.3 Earthquake

The Hazard

The Taranaki Region is not considered a high earthquake risk (relative to other areas in NZ at least). However, there are some known, active faults in the region, notably Inglewood, Waverly and Oaonui areas as well as offshore.

Earthquake monitoring since 1994 shows 20 earthquakes centred in Taranaki that are over Magnitude 4 and less than 5km deep, mostly to the west of Mt Taranaki. Deep earthquakes typically occur in the Hawera area and east of Taranaki.

The Alpine Fault, the Wellington Fault and Hikurangi Subduction Zone are believed to pose the highest seismic risk to the country from a potential damage perspective and each of these could cause some movement in Taranaki, though the extent or magnitude is not known.

Figure 2-8 shows the liquefaction susceptibility hazard layer. In terms of lifelines infrastructure, the biggest impact is expected to be at Port Taranaki. However, there are a number of other areas of liquefaction susceptibility shown in the eastern and southern areas.

Figure 2-8 also shows the areas of known, mapped faults. Some of these faults do bisect a number of critical assets as illustrated. The area around Waverley shows several faults and liquefaction areas which cross SH 3, the Chorus western fibre and Transpower's transmission lines from the south.

Impacts on Lifelines Infrastructure

The expected effects from earthquakes that create a potential hazard to infrastructure includes:

- Surface fault rupture – can range in length from a few metres to hundreds of kilometres and with ground displacements of several meters possible. Shearing of assets can result where ground displacements occur.
- Land movements – in a moderate to large earthquake the ground in nearby areas maybe uplifted, dropped or tilted – again ground displacement can be several meters as experienced in the Edgecumbe earthquake (where a large part of the ground in the Rangitaiki Plain dropped by up to 2m) and more recently in Kaikoura.
- Strong shaking can cause damage to structures – the extent of damage can be mitigated through modern seismic design.
- The combination of ground-shaking and earth movement can produce secondary effects including rockfall / landslides, tsunami, ground settlement and liquefaction.
- Liquefaction was shown in the Canterbury earthquakes to be particularly devastating to underground, brittle assets due to the associated differential ground subsidence and lateral spreading. Liquefaction can occur in high risk soils at MM7.

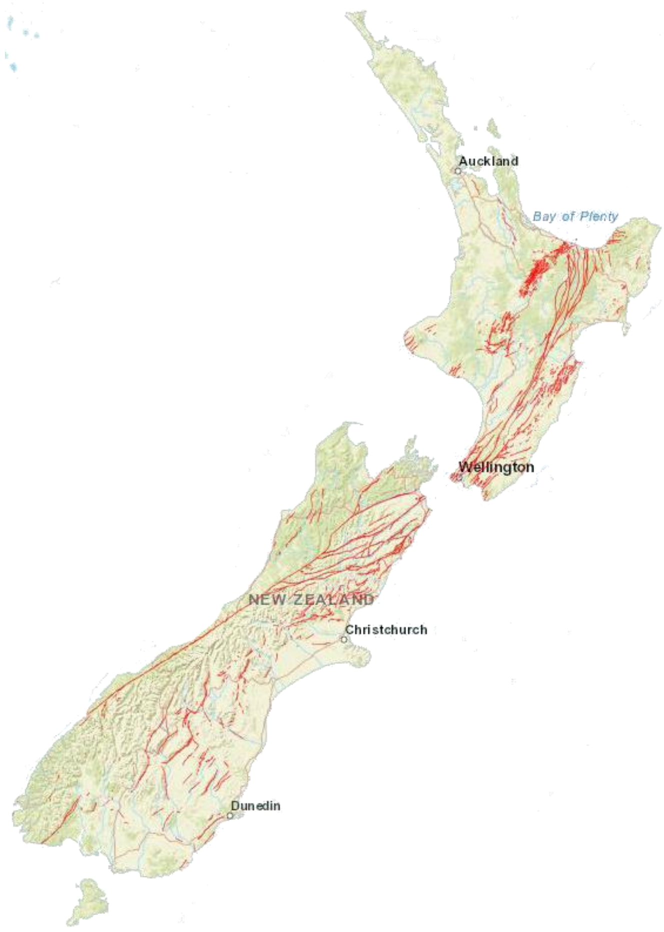


Figure 2-7: Active Fault Database (GNS)

Distributed, lineal assets are at most risk from seismic hazard and recovery times can be years.

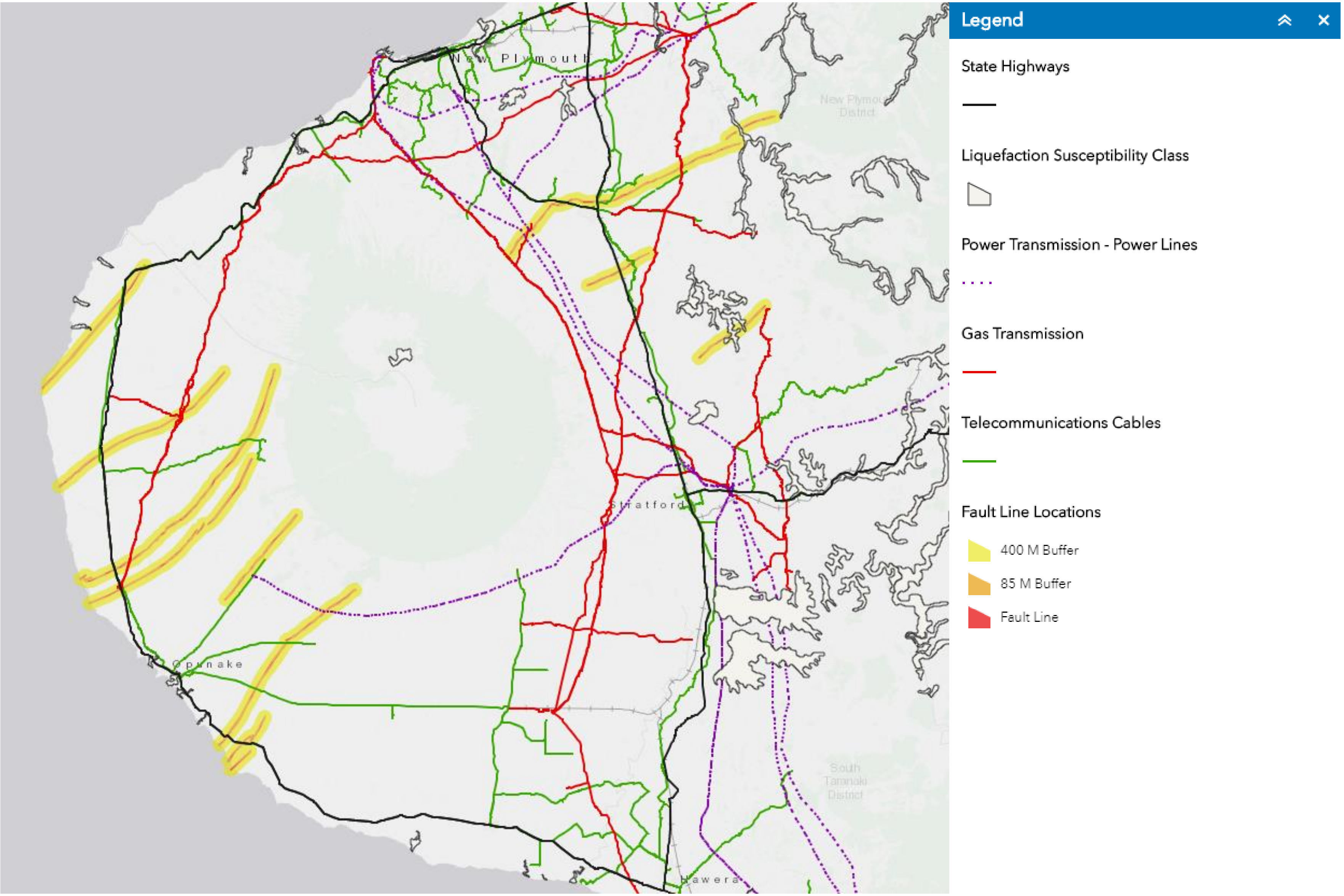


Figure 2-8: Fault Lines and Liquefaction Susceptibility

The impact of an earthquake on Taranaki's infrastructure will clearly depend on the fault rupture location, but may include:

- Damage to electricity transmission lines from Bunnythorpe where they cross faults in the Waverley area.
- Damage to gas transmission lines feeding south to Wellington (also from faults in Waverley area).
- Damage to SH bridges and roads (particularly in Patea, Waverley and Inglewood).
- Widespread slips in at risk areas – roads in the Eastern Hill country considered vulnerable.

Further detail of impacts by sector are presented in Section 3.

Earthquake	Damage Impact	Service Impact
Wastewater Liquefaction	2	4
Ground shaking	3	3
Landslip	3	3
Water Supply Liquefaction	3	3
Ground shaking	3	3
Landslip	2	3
Electricity Liquefaction	3	3
Ground shaking	3	3
Landslip	3	3
Gas Liquefaction	1	2
Ground shaking	3	1
Landslip	3	5
Stormwater Liquefaction	2	4
Ground shaking	2	2
Landslip	3	3
Roads Liquefaction	3	2
Ground shaking	3	2
Landslip	3	2
Airport Liquefaction	3	5
Ground shaking	3	5
Landslip	1	5
Port Liquefaction	2	5
Ground shaking	3	5
Landslip	1	5
Rail Liquefaction	3	2
Ground shaking	3	2
Landslip	3	2
Telco Liquefaction	3	3
Ground shaking	2	3
Landslip	3	3

Damage Impact Rating	Service Impact Rating
1) Unlikely to cause damage.	1) Minimal impact
2) Possible damage, short term disruption.	2) Localised failure
3) Possible damage, longer term repairs (weeks/months).	3) Widespread localised failures
4) Complete failure, full reconstruction required.	4) Sub-regional loss
	5) Regional loss

Figure 2-9: Assessed Impacts of an Earthquake

Assessed by Sector Representatives during project workshops in 2018.

2.4 Tsunami

The Hazard

Tsunami are typically generated as a result of displacement of ocean water due to landslides, earthquakes, volcanic eruptions and meteorite impacts. Tsunami threats to New Zealand are broadly categorised as:

- Distant source; > 3 hours travel time (up to 18 hours) to Taranaki from sources such as South America.
- Regional source; 1-3 hours travel time to New Zealand from sources such as the Solomon Islands, Vanuatu and the Tonga-Kermadec trench.
- Local Source < 60 minutes travel time to the nearest New Zealand coast. Local area source tsunami for Taranaki may occur as a result of earthquakes in the Western Cook Strait and offshore Taranaki areas. A locally sourced tsunami may have a travel time of less than 30 minutes.

Tsunami evacuation zones have been mapped for Taranaki in accordance with the Director's Guideline *MCDEM DGL 08-16* based on a 'level 2' rule-based methodology with a 6m wave generated from a regional source.

This method models the height of the wave with GIS-calculated attenuation rules for open coast, harbours and rivers. Evacuation zones represent an envelope around all possible inundation from all known tsunami sources, considering all of the ways each of those sources may generate a tsunami (and therefore no one event is expected to inundate the majority of a zone). The zones have a significant factor of safety applied, reflecting the accuracy of the relatively simplistic empirical approach.

The availability of LIDAR digital elevation datasets is a key enabler of more accurate tsunami modelling and the quality and completeness of these varies around the country.

The tsunami modelling shows that while most of Taranaki's steep coastline is not susceptible to tsunami, some low-lying communities, and areas on the coast or in river estuaries do have a higher risk. Those communities include Tongaporutu, Urenui, Onaero, and parts of Waitara, Bell Block, New Plymouth, Oākura, Opunake and Pātea.

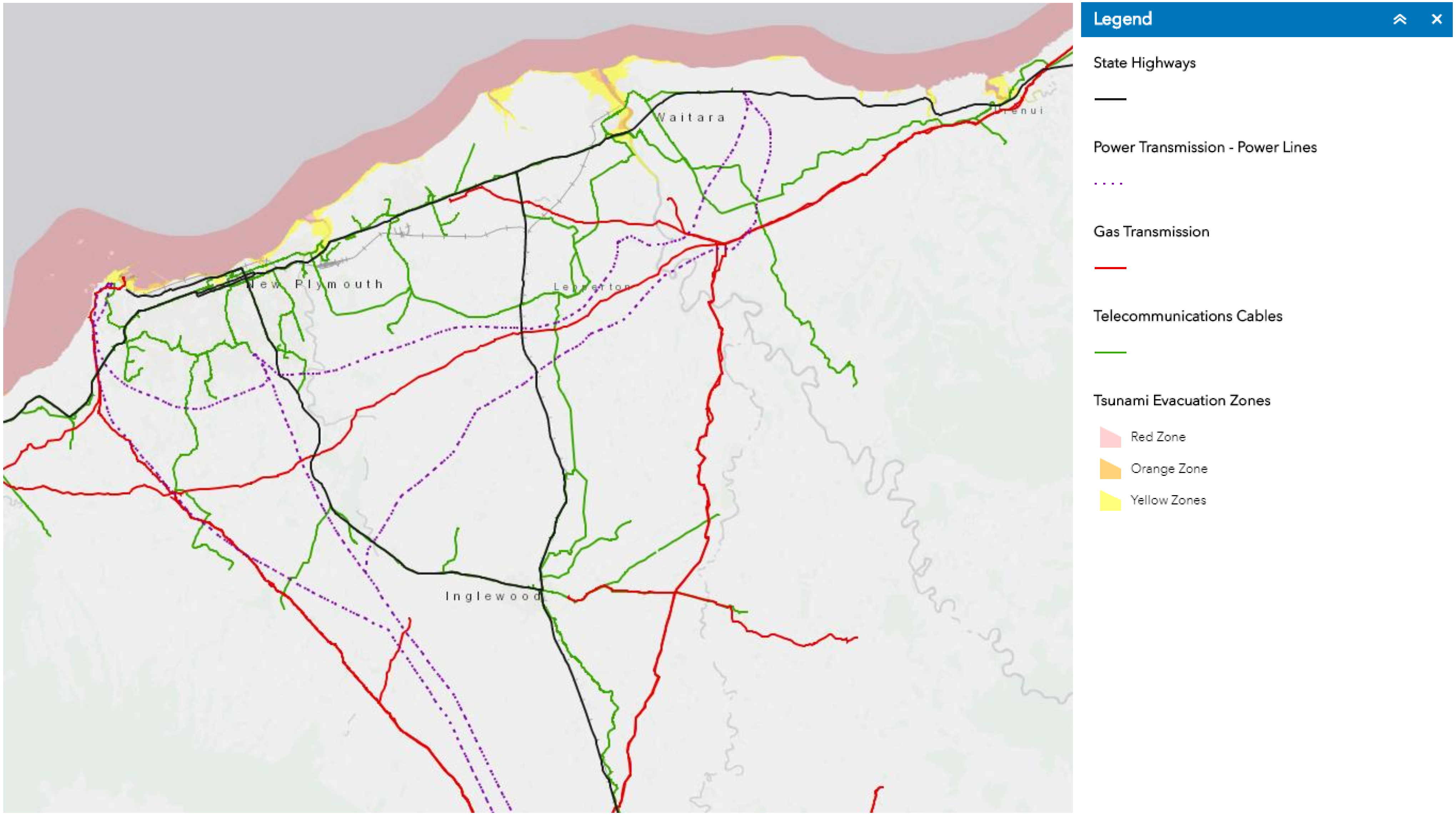


Figure 2-10: Tsunami Evacuation Zones

Impacts on Lifelines Infrastructure

The Wellington and Auckland Lifelines Group (WeLG and ALG) collaborated on a project in 2015/16 to review knowledge of tsunami impacts on infrastructure drawing from research on recent events[1]. Briefly, the study found that:

- Transportation networks will likely be damaged by even small tsunami (tsunami depths ~ 1m) due to scouring and deposition of debris.
- Wastewater and potable water networks are particularly vulnerable to tsunami at their facility buildings and pipe intake and outflow sites. Contamination of drinking water supplies, or sewerage containment ponds can occur with even small amounts of intrusion of seawater from a tsunami.
- Telecommunications networks will most likely be disrupted locally due to damage to buildings and electrical equipment at exchanges and failure of cellular sites
- Energy networks, particularly electricity, will be impacted due to shorting of buried cables if they become exposed to the water and have pre-existing casing damage. Also, overhead lines are susceptible to failure by toppling of poles, which can be damaged by debris strikes. Petroleum and gas terminals, often located in coastal areas, may suffer damage to their pipe networks and tank farms in tsunami depths of 2m or greater.
- Back-up services, such as generators, are often located on the ground outside of buildings, on ground floors or in basements, putting them at risk.
- Bridges are a lifeline component that are vulnerable to tsunami and often have co-location of other lifeline services, which if damaged can cause failure of these other lifeline services.

Specifically, for Taranaki, the main assets potentially impacted by tsunami include:

- The Port – low lying, and recently experienced near inundation of the wharf facilities during storms in January 2018, with knock-on impacts for gas and petroleum production.
- LPG and fuel tank facilities at Port Taranaki.
- Potentially offshore gas facilities, those these are designed to high standards.
- Some low coastal bridges are potentially at risk, including at Patea, Waitotara and Brixton, potentially isolating parts of the region and/or causing long detour times.
- If gas production is impacted, that could disrupt electricity generation – though depending on a number of factors potentially demand can still be fully met from the National Grid.

Further detail of impacts by sector are presented in Section 3.

TSUNAMI	Damage Impact	Service Impact
Wastewater	2	3
Water Supply	2	1
Electricity	1	1
Gas	1	4
Fuel	1	4
Stormwater	2	1
Roads	2	3
Airport	3	4
Port	3	5
Rail	2	2
Telco	2	1

Damage Impact Rating	Service Impact Rating
1) Unlikely to cause damage.	1) Minimal impact
2) Possible damage, short term disruption.	2) Localised failure
3) Possible damage, longer term repairs (weeks/months).	3) Widespread localised failures
4) Complete failure, full reconstruction required.	4) Sub-regional loss
	5) Regional loss

Figure 2-11: Assessed Impacts of a Tsunami

Assessed by Sector Representatives during project workshops in 2018.

[1] N.A. Horspool S. Fraser, An Analysis of Tsunami Impacts to Lifelines, Report 2016/22 May 2016

2.5 Severe Weather

Hazard Overview

Hazard information is drawn from the CDEM Group Plan for Taranaki 2018-23, as follows:

Flooding

- Although Taranaki's 530 or so named waterways are relatively small in size and length and flood plains are small, high rainfall often results in frequent high flows.
- Taranaki is prone to high rainfall and storms, particularly ex-tropical cyclonic storms, which periodically cause localized flooding problems.
- Land use and increased urbanisation increases the likelihood of flooding, as it decreases the amount of land that water can drain into and increases the number of impervious surfaces (paving, road surfaces, hard landscaping).
- Climate change is predicted to make Taranaki's summers drier and winters wetter. This may mean more frequent extreme events, such as longer droughts, more intense rainfall, and an increased flooding risk.

Winds / Tornadoes

- Exposure is mainly from high winds, tornadoes and cyclones as a result of weather systems over the Tasman Sea.
- Weather systems of subtropical original are often accompanied by heavy rain.
- Several wind warnings are issued in Taranaki each year.
- New Plymouth City is a high wind-speed area, low wind speed areas are east and north of the mountain.
- A severe tornado occurs about once every four years.

Landslides

- Steep slopes with unstable geology that have been cleared of vegetation are more susceptible to landsides – in Taranaki the eastern hill country, slopes of Mount Taranaki and the Pouakai and Kaitake ranges.

The impacts of climate change are expected to be increased intensity storms (both wind speeds and rainfall intensity) and increased droughts.

Some work is being done to standardise methodologies for flood modelling. Further work is also needed to improve understanding of lower frequency events (most is limited to 1:100 yr events) and quantify the impacts of climate change.

There is a range of flood modelling datasets available from local authority modelling work as shown in Figure 2-12.

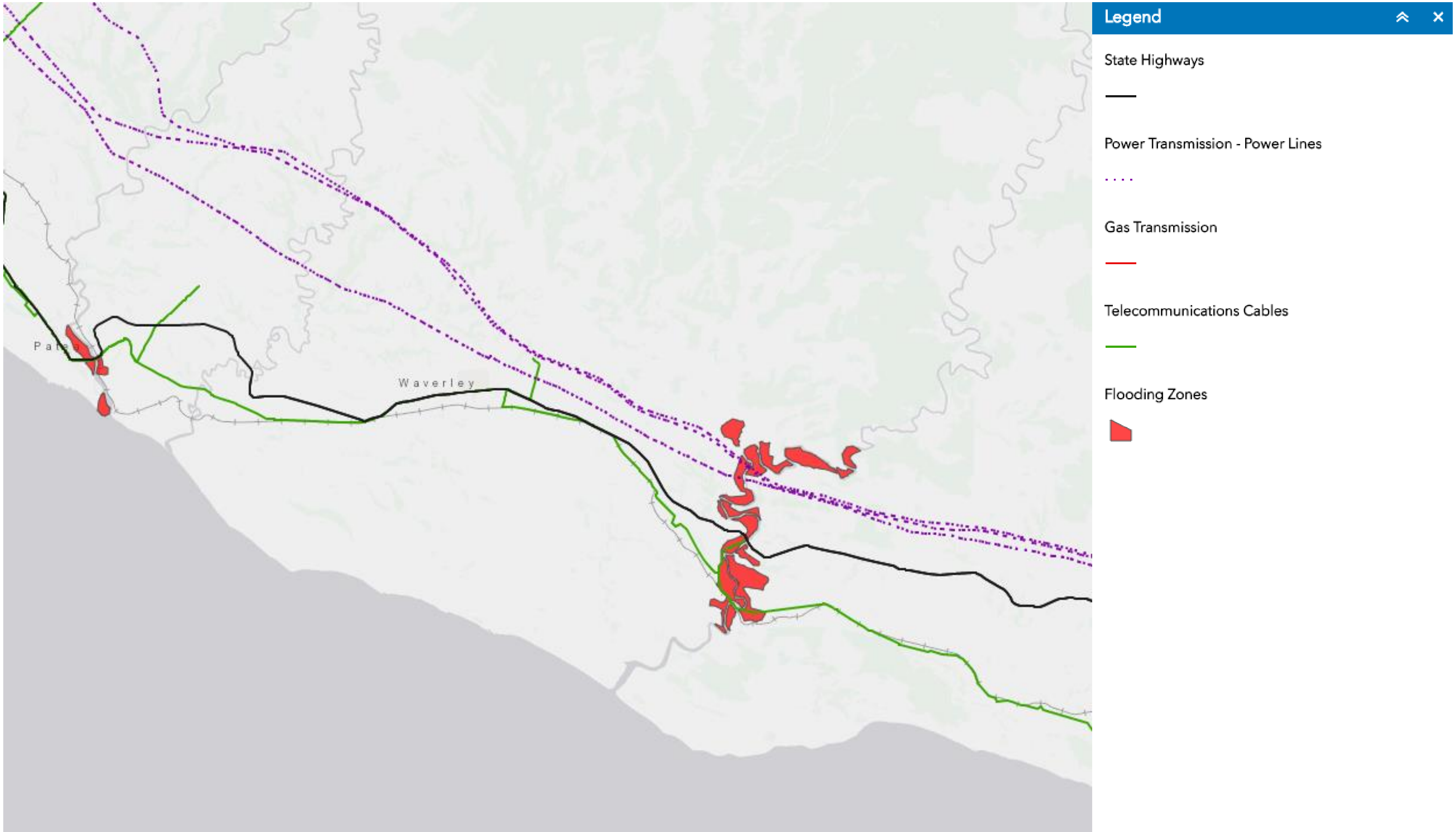


Figure 2-12: Flood Inundation Areas – South Taranaki area

Impacts on Lifelines Infrastructure

Broadly, the potential impacts from severe weather hazards to infrastructure can be categorised as:

- Flooding – the damage can depend on whether this is ponded or flowing water (e.g. rivers) but typically lifelines services are restored relatively quickly once flood waters recede, though in some cases damage can be more severe (floodwaters scouring bridges and attached pipes/cables). River / stream flooding and high turbidity can impact on the ability to treat water and infiltration of wastewater networks can cause overflows from the wastewater networks. Slash from the forestry sectors is also a risk during high rainfall events, damaging bridges and blocking stream beds.
- High winds – a particular risk to overhead electricity lines (especially where trees are not managed away from lines) and restoration times can be weeks to months if there are widespread rural line outages. In 2018, a tree fall damaged a water supply pipeline during Cyclone Gita.
- Rainfall induced landslides – typically closing roads (in some events in the last two decades single regions have counted thousands of slips) and recovery work may take years.
- Snow and ice – mainly a temporary hazard to roads though can damage overhead infrastructure if heavy.
- Drought – causing water supply constraints, increased fire risk.

Specifically, for Taranaki, the key infrastructure impacts assessed include:

- Damage to water supply trunk mains and gas transmission lines where they have above ground river crossings.
- Possible multiple points of damage along the trunk telco fibre lines resulting from slips and damage to above ground assets (e.g. bridge crossings).
- Widespread power failures causing consequential widespread failures in many other networks.
- Widespread slips in at risk areas – roads in the Eastern Hill country considered vulnerable. SH3 north also has a history of road closures for periods of time due to landslips and rock falls.

Further detail of impacts by sector are presented in Section 3.

STORM		Damage Impact	Service Impact
Wastewater	Wind	1	3
	Flood	3	3
Water Supply	Wind	1	3
	Flood	2	3
Electricity Trans/Dist	Wind	3	3
	Flood	3	3
Electricity Generation	Wind	1	2
	Flood	3	3
Gas Production	Wind	1	2
	Flood	1	2
Gas Transmission / Distr	Wind	1	1
	Flood	2	2
Stormwater	Wind	1	1
	Flood	3	3
Roads	Wind	2	3
	Flood	3	3
Airport	Wind	1	4
	Flood	1	4
Port	Wind	1	4
	Flood	1	4
Rail	Wind	2	2
	Flood	3	2
Telco	Wind	2	3
	Flood	2	4

Damage Impact Rating	Service Impact Rating
1) Unlikely to cause damage.	1) Minimal impact
2) Possible damage, short term disruption.	2) Localised failure
3) Possible damage, longer term repairs (weeks/months).	3) Widespread localised failures
4) Complete failure, full reconstruction required.	4) Sub-regional loss
	5) Regional loss

Figure 2-13: Assessed Impacts of a Severe Weather Event

Assessed by Sector Representatives during project workshops in 2018.

3. Taranaki's Critical Infrastructure

3.1 Electricity

New Zealand's electricity network broadly comprises:

- generation stations;
- national transmission grid;
- electricity lines distributors which connect to the national grid and distribute to consumers;
- electricity retailers - which buy wholesale electricity and sell to consumers; and
- main load centres.

The transmission grid and generation sources are illustrated in Figure 3-1.

Electricity Generation

In 2017, Taranaki produced nearly 1/5 of the country's electricity.

The region's largest electricity generation site is Contact's 575MW Gas Powered Plant in Stratford. It is considered a nationally significant generation site. The second largest (100MW) is the Nova McKee gas generation plant. Nova is constructing another 100MW plant due for commissioning in 2020. Both sites can provide base load or peaking capability.

Trustpower has smaller hydro generation plants including Mangorei, Motukawa and Patea.

Electricity Transmission – the 'National Grid'

The National Grid transmits electricity from generation sites to electricity distribution companies and some major consumers supplied directly from the grid. The region's electricity feeds in from two main lines:

- from the north east, Huntly-Stratford;
- from the south east (connecting via Bunnythorpe and Haywards substations to the South Island).

This latter circuit is considered nationally significant as it supplies Stratford and Opunake substations which in turn service New Plymouth and the onshore gas fields. Hawera substation also brings Patea generation into the National Grid and supplies some major industry sites including Fonterra and Kupe.

While the north-eastern circuit provides some backup, there would be significant load constraints in the region if the Stratford-Bunnythorpe line failed.

Grid Exit Points (GXPs) are the transition stations from the national grid to Powerco's sub-transmission network and are also critical sites. The Huirangi GXP is shown right.

Highlights

- **Taranaki produces around 1/5th of NZ's electricity, mostly from gas fire generation plants. The largest is Contact's Stratford plant (577MW).**
- **Nova McKee is the second largest electricity producer in Taranaki at 100MW. An additional plant of the same size is due in 2020.**
- **These electricity generation plants rely on gas production sites which in turn require electricity to produce gas (the sectors are highly interdependent).**
- **A volcanic eruption or earthquake could potentially cause widespread power outages for weeks to months.**
- **There would be significant knock on effects causing service failures of varying degrees to all other lifeline services and many large industrial customers.**
- **The transmission grid does have some diversity (supplying from the south via Bunnythorpe and the north east via Huntly-Stratford). However, supply would be constrained if the Bunnythorpe link failed and the volcanic and earthquake scenarios can potentially impact both links.**
- **For the distribution network, high wind storms have the highest likelihood of causing widespread service failures. Volcanic ash would also be very disruptive to the network and localised hazards (e.g. lahars) could cause damage taking months or years to fully restore.**

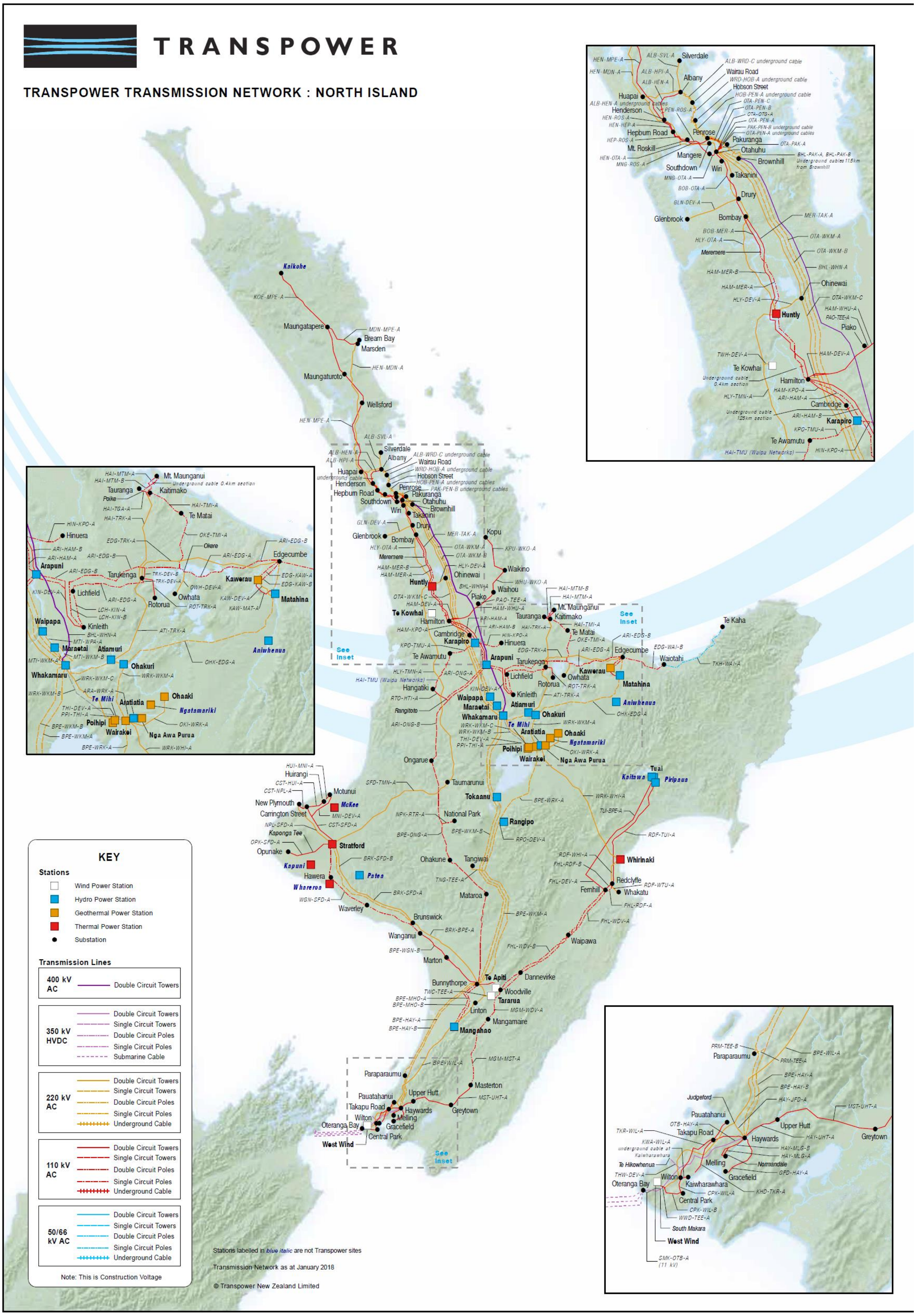


Figure 3-1: North Island National Grid

Electricity Distribution

Powerco's sub-transmission network (33k) is considered locally significant. Some specific lines are critical because they supply other critical sites that rely on a single electricity feed, including the New Plymouth wastewater treatment plant, Airport, Port, Base Hospital and Tank Farm).

For these reasons, Powerco have assessed the Carrington Street substation as criticality 1 (nationally significant) and Huirangi, Stratford and Opunake sites criticality 2 (regionally significant).

Major Dependent Customers

As well as the gas fields, other important regional sites that depend on electricity to function include:

- Hospitals – New Plymouth has a backup generator but only a couple of days fuel stored on site.
- Fire Service – most stations have generators, but the service relies on the operation of Rural Fuel.
- Methanex NZ Ltd, require power to run the methanol producing facilities at Motunui and Waitara Valley. Their tank farms at Port Taranaki and Omata also require power to operate.
- Water supply and wastewater plants and pump stations (though there is some backup generation, as discussed in Section 2.7).
- Telecommunications sites (typically have battery backup and some have on site generators, as discussed in Section 3.6).
- Agriculture and major industrial sites – for example the Tegel processing plant supplies around 1/3 of NZ's chicken products but does not have a backup generator.

These customers are further discussed in Section 4.

Resilience Considerations

Supply Dependencies:

The region's electricity and gas networks are highly interdependent. The major electricity generation plants require natural gas (and the major gas production sites require electricity). They also require a certain amount of load to enable start-up.

Communication networks are also critical for electricity network operation – Transpower and Powerco have their own communication networks but also rely to some extent on other telco networks.

In a major disaster, road access to electricity sites will be important, though helicopters provide an alternative.

Robustness:

The larger (220kV) transmission lines span lattice steel towers which are robust and not expected to incur damage from seismic or flood activity unless there is major ground rupture or landslip at the foundation. Transmission substations are subject to high design standards and are likely to survive an earthquake or at least be repairable, though distribution substations are more variable. The 110KV transmission lines are towers and poles which are less robust, but which has still shown to be resilient in NZ's recent hazard events.

The smaller distribution networks are a combination of overhead lines and underground cables – the former tend to be more resilient to seismic activity and faults are relatively easy to find whilst underground cables are more resilient to wind/flood risk but can break with seismic movement and take more time to repair. Some are older and less resilient to ground movements.

Redundancy:

As noted earlier, there is some diversity in the transmission and distribution network to provide (albeit possibly limited) supply to the region if individual circuits fail. There is less redundancy in the GXPs/ substations and a major failure would cause loss of service until back feeds are established.

Transpower stocks several spare towers in Bunnythorpe, Auckland and Islington, along with spare transformers and a mobile sub that could replace a major substation such as Opunake, though it would take around 3 weeks to get fully operational.

Specific Hazard Risks:

There are a number of critical assets in the near-source volcanic hazard zones, including Transpower Grid transmission lines supplying the following GXPs:

- Carrington Street, which feeds New Plymouth CBD, half of Bell Block, Egmont village, Kaimiro, Hurworth, Okato, Oakura and Moturoa and feeds a number of critical customers including the Port, Hospital, Tank Farm and the WWTP.
- Huirangi, which supplies the rest of Bell Block, Waitara, Urenui, Okoki, Motukawa, Kaimata, Ratapiko, Tariki, Inglewood, Lepperton and Brixton. Critical customers include the Airport, Powerco NOC backup, Mangati Road WWPS, Methanex, Pohokura Gas plant, McKechnie Aluminium Plant, Tegel, Mangahewa gas plant and McKee Production Station.

The Stratford GXP is not in the near-source hazard zone, but if it failed would affect supplies to Midhurst, Stratford, Toko, Douglas, Eltham, Kaponga and Cardiff with critical customers including STDC Water Pump Station, Waimati West WWTP, Riverland, Fonterra, Pastoral Foods, Mainland Cheese, Cheal Site and Waihapa Production Station.

Volcanic ash can cause flashover and disrupt above ground electricity supplies – and with the heavy loads forecast under a large volcanic eruption scenario the expectation is of low, intermittent or no electricity service across most of the region. This will occur throughout the duration of the ashfall.

The faults in the Waverley area could potentially damage the transmission lines from Bunnythorpe if there is major ground movement along the fault. These lines also intersect with lahar risks.

The only critical asset in a tsunami hazard zone is the New Plymouth substation, and due to network upgrades, this is expected to be closed in 2019.

Increasing Resilience in this Sector

The following initiatives have been identified by Taranaki lifelines electricity sector representatives as having the potential to improve the resilience of the region's electricity supply:

- Provision of black start capacity in the region (to enable electricity generation within the region if transmission links fail) and exploration of accompanying reverse livened island (NG and Dist) network configurations.
- Improved alternate road access routes for emergency response and repairs.
- Improved contingency planning (all sectors).
- Alternative communication methods.
- Additional provision of critical spares and strategic placement in areas that may be isolated.
- Planning for extra resources (including people) required for a long duration hazard event, e.g. >1month.
- Building awareness / self-resilience within the community.
- Better compliance and monitoring of vegetation control near lines by landowners.

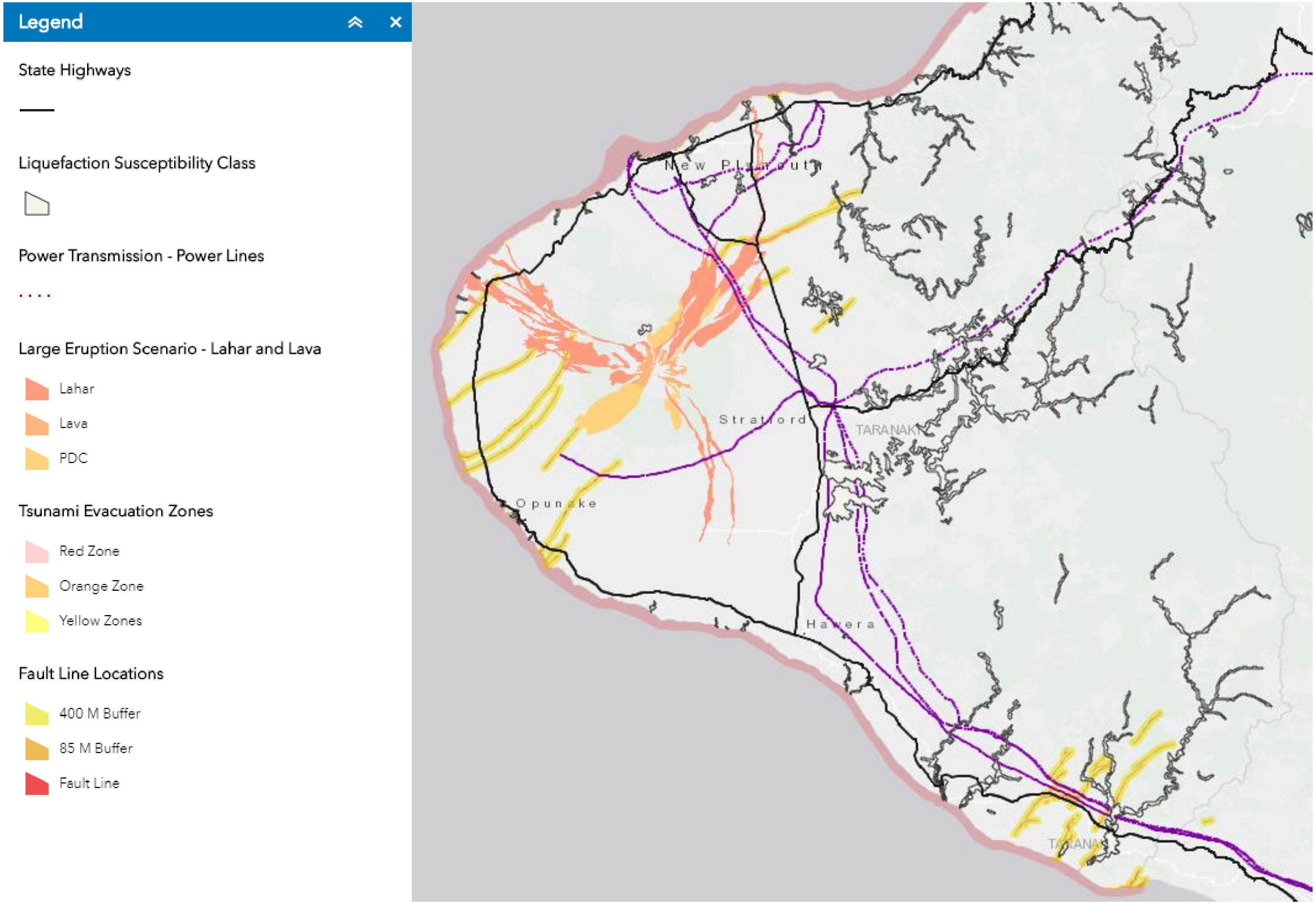


Figure 3-2: Electricity Transmission shown with Seismic, Near-Source Volcanic and Tsunami hazard layers.

3.2 Gas

Production

Natural gas is an important source of energy in New Zealand, supplying around 15% of energy demand (MBIE Energy Site 2016). Taranaki produces New Zealand's natural gas from Maui, Pohokura, McKee/Mangahewa, Kapuni and Kupe well sites.

From the production stations, condensate is piped or trucked to the Omata Tank Farm for shipping to Marsden and offshore refineries. Gas is also fed directly into the national transmission system.

LPG is produced at Kupe, McKee, Kapuni and Oaonui.

The gas transmission pipeline system and Omata Tank Farm are both rated as nationally significant assets.

All of these production stations rely on power supply from the national grid to operate, except for Kapuni that generates its own electricity.

Production Sites	Owner
Maui, Pohokura	Shell Taranaki and OMV
Pohokura, McKee and Mangahewa	Todd Energy
Kupe	Beach Energy
Kapuni	Todd Energy
Turangi, Kaimiro and Kowhai	Greymouth Petroleum

Table 3-1: Gas Production Sites in Taranaki

Transmission

The national transmission system owned by First Gas originates from the Taranaki gas fields. The main north-south line on the west side of the North Island supplies Auckland, Hamilton, Bay of Plenty, Northland, Manawatu, Hawkes Bay, Kapiti and Wellington and is considered a nationally significant asset.

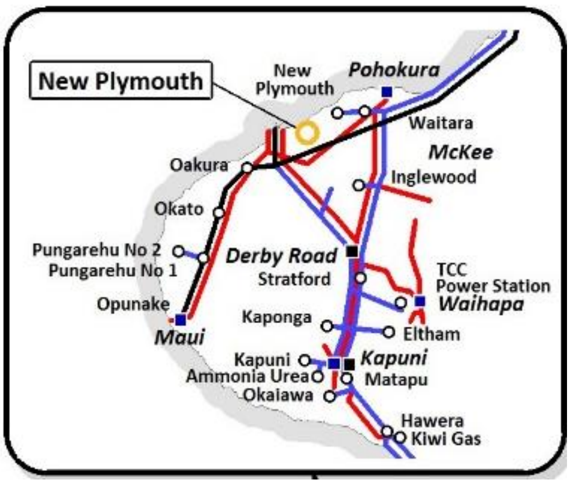


Figure 3-3 First Gas Network in Taranaki

Highlights

- Gas-fired electricity generators in Taranaki provide around 15% of New Zealand's electricity requirements.
- Gas production plants require electricity to produce gas.
- LPG is a critical fuel for households and industry in the South Island and several key users in the Taranaki region (including the largest dairy processing plant in the Southern Hemisphere).
- There is no redundancy in the gas transmission lines feeding north and south. The system relies on being able to reduce demand during a disruption to maintain pressure.
- The Critical Contingency Operator oversees the management of this process – if a minimum pressure is not maintained it can take weeks to months to bring the system up again.
- The gas system is highly vulnerable to volcanic events – both because volcanic ash will likely disrupt electricity supply, and possible direct damage from lahars where the Maui gas line crosses major rivers around the mountain.
- The gas system is designed to withstand seismic events (again, if its key supply feeds are operational).
- Land slips and third-party damage to pipelines are other key hazards for the sector.

Distribution

Powerco owns and operates 16 discrete gas distribution networks in the Taranaki region. Of these, five networks (New Plymouth, Hawera, Eltham, Stratford and Waitara) have been classified as critical in line with civil defence and critical contingency definitions.

LPG

Except for a small quantity that is imported, LPG is exported from Taranaki by ship, road and rail around the country. One of NZ's major bulk storage sites of LPG is at Port Taranaki (the other is in Wiri). Dunedin has a ship and rail receiving terminal to distribute to the South Island.

Major Dependent Customers

The major gas customers are the gas-powered electricity generation plants identified in Section 2.1, dairy factories and Refining NZ (Marsden Refinery).

LPG is a critical fuel source to the industry and to homes in the South Island. While households only use a small amount of the gas produced, it is important for hot water supply and heating to those households that use it).

The NPDC Wastewater Treatment Plant requires gas to process sludge – the maximum outage is 1-2 weeks before services would be affected.

Methanex NZ Ltd require large quantities of gas drawn from the main gas pipeline to run the methanol producing facilities at Motunui and Waitara Valley.

Fonterra is a key user and gas is required for fertiliser production. Fonterra's dairy processing plant in the region is the largest in southern hemisphere and requires gas for the generator.

Resilience Considerations

Supply Dependencies:
The critical resilience issue for the region's gas production sites is the reliance on electricity from the main grid, which is potentially impacted by many of the hazards assessed.

Port Taranaki is important for the export of LPG to the South Island and is vulnerable to tsunami, storm surge and seismic events. If the port is of out of operation, condensate will reach tank tops and the gas fields will shut in.

Loss of communications to First Gas's Bell Block Control room would require manning of numerous sites around the North Island.

Redundancy:
Unlike many other national transmission networks (roads, electricity, telecommunications), there is little or no loop redundancy in the natural gas network. Short term disruptions do not necessarily affect supply continuity as gas pressure is maintained in the pipeline that can be drawn down to a limited extent. There are contingency arrangements in place to reduce demand through demand curtailment measures and details for the critical contingency operation can be found at www.cco.org.nz . However longer-term disruptions (such as the Maui pipeline outage in 2011) can cause significant gas supply disruptions to consumers.

The primary focus of the contingency arrangements is maintaining a minimum pressure in the piped gas network. Once pressure drops below a certain level the process to restore supply can take weeks or months as it requires manual reconnection. There is backup generation for the key distribution sites.

Robustness:
The gas transmission network is a pressurised pipe network designed and operated to the AS/NZS 2885 suite of standards and can withstand significant seismic shaking, though there is a risk of loss of containment leading to loss of supply.

Production stations are designed for seismic stress, however noting that this relies on the electricity operating after the quake.

Specific Hazard Risks:

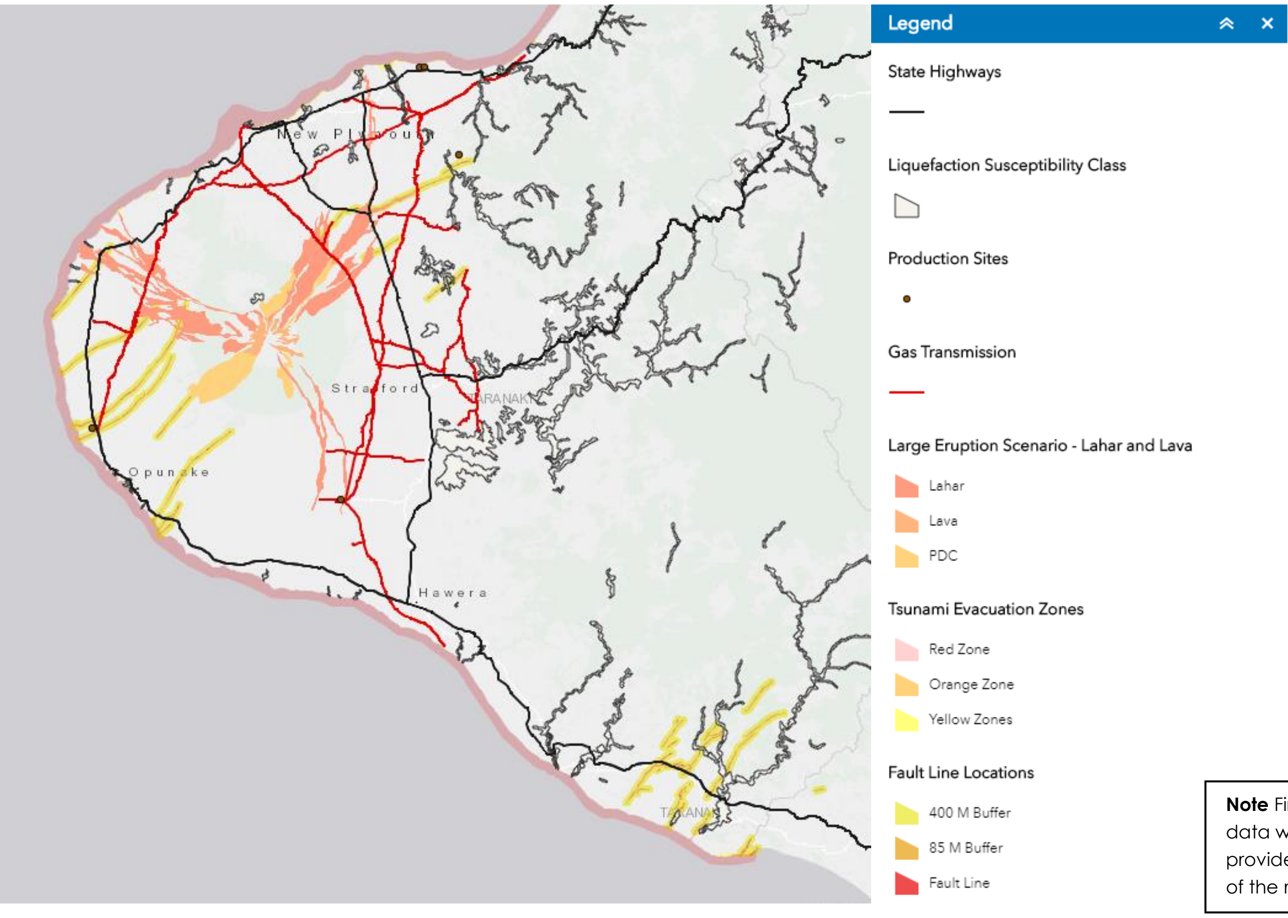
Direct damage risks mainly relate to:

- Volcanic lahars damaging or destroying gas lines at above ground locations – Kapuni, McKee or the Maui pipeline if lahars goes down the major rivers to the north of the mountain.
- Major land movement from land slips, noting that the eastern hills (where the McKee Production site is) is considered an at-risk area for slips.
- Major ground displacement along fault lines – notably around Waverley which could disrupt the First Gas line south.
- Flooding leading to pipeline damage at river crossings.
- Third party damage caused by a party responding to damage that has occurred.

Increasing Resilience in this Sector

The following initiatives have been identified by Taranaki lifelines gas sector representatives as having the potential to improve the resilience of the gas system in Taranaki:

- Provide redundancy in the electricity transmission supply to nationally significant gas production sites.
- Maui pipeline isolation east of the Waitara River to provide security of supply north from Pohokura and McKee Gas Plants (in the event that the pipeline is compromised).
- Earth moving equipment assurance supply contracts for critical infrastructure to remediate damage from ash, lahars and earthquake slips.
- More storage tanks at the Tank Farm and temporary ship loading equipment stored and available in the event of equipment failure.



Note FirstGas data was only provided for part of the region.

Figure 3-4: Gas Transmission shown with Seismic, Near-Source Volcanic and Tsunami hazard layers

3.3 Fuel

Overview of the National Supply Chain

Around 80% of New Zealand's fuel is refined at the Marsden Refinery, south of Whangarei, and distributed by ship to ports around the country (and by pipeline to Auckland) as illustrated in Figure 3-5. The remainder is refined overseas and shipped directly to ports from overseas sources.

Therefore, Marsden Refinery, though it is not located in the region, is a critical fuel site for Taranaki and all New Zealand.

Taranaki is an important region for the production and refining of petrochemicals. Currently, most of the high-quality petroleum products are sold into the international market while New Zealand imports and refines cheaper fuel for domestic use.

Most diesel and petroleum for regional needs are shipped into Port Taranaki. This hasn't always been the case - petroleum was trucked in from other Ports in the North Island for many years until 2018. The move to re-establish petroleum supply into Port Taranaki has increased the resilience of the fuel supply chain by providing two alternate methods of bringing in fuel (if either road or port access is disrupted).

Highlights

- **Fuel to meet Taranaki's requirements comes into Port Taranaki by ship from Marsden Refinery.**
- **There is some capacity to bring in fuel by truck from other ports if Port Taranaki operations are disrupted and roads are open.**
- **An important part of the Taranaki economy is the production of high-quality petroleum products which are sold into the international market.**
- **Retail outlets rely on electricity to operate and there is limited or no backup generation in stations in the region.**
- **There are many scenarios outside the region that can affect fuel supply (Marsden Refinery outage, international supply disruptions, etc).**
- **A regional fuel contingency plan is being prepared to outline how fuel shortages would be managed.**

Retail Outlets

Fuel is stored for supply at retail outlets supplied by the four oil companies (Mobil, BP, Gull, Z). Some retail outlets are owned and managed by those companies, others are independently owned and/or managed.

The re-fuelling rates vary, and it is impossible to give a definitive view on the amount of storage held at these sites, though it is typically in the range of 'days' during normal levels of use.

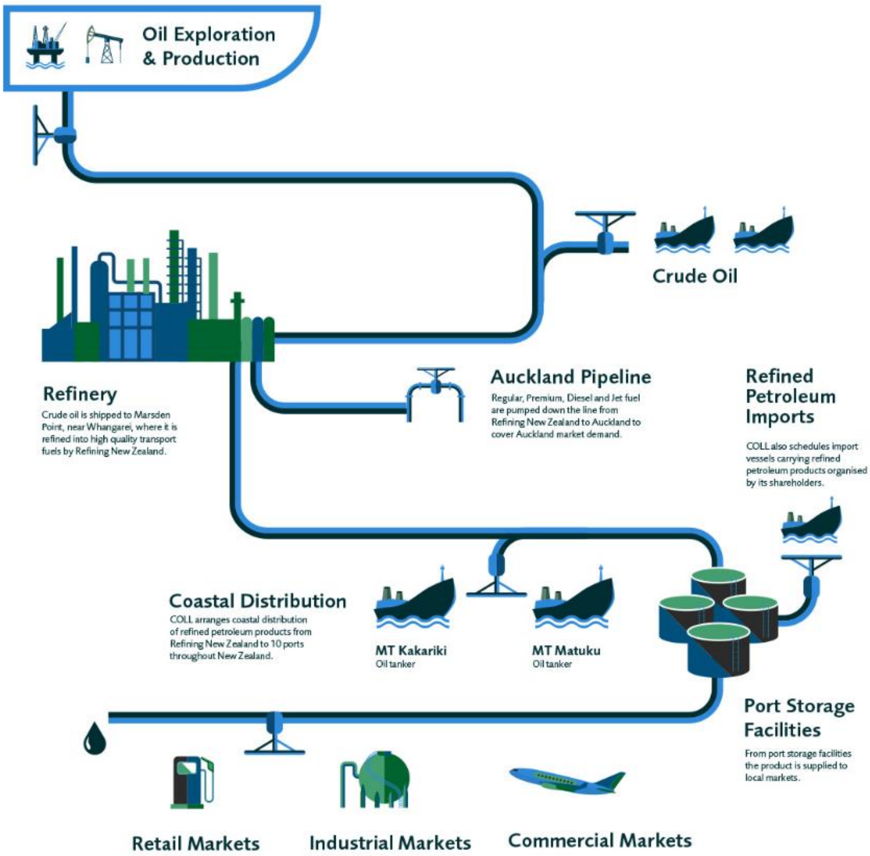


Figure 3-5: Fuel Supply Chain in New Zealand

Major Dependent Customers

Customers that rely on electricity also depend on fuel when the electricity fails (diesel for generators). Only the most critical lifelines sites have their own on-site fuel storage (such as Kordia's Mt Taranaki site and the New Plymouth Chorus Exchange).

Many farms and industries also have their own diesel storage, though there is no national picture of such stockholdings and there is some anecdotal information that on-site storage facilities are reducing due to the high installation and maintenance costs. The regional fuel contingency plan will address some of these knowledge gaps.

Emergency response operations, including contractors' trucks and machinery to clear /repair roads will have a strong short to medium term demand increase for diesel.

Resilience Considerations

Supply Dependencies:

Supply of fuel into the region requires:

- Road access (trucked petroleum products)
- Port access (diesel – road is a backup route).
- Electricity (to pump fuel at fuel stations).

Redundancy:

Now that both petroleum and diesel are brought in via Port Taranaki, this provides some redundancy in the supply chain. Trucking in by road provides an alternative, if the disruption is to the Port and not to the wider fuel supply chain.

New Zealand is highly dependent on the operation of the Marsden Refinery. The National Infrastructure Vulnerability Assessment 2018 provides an overview of the risks around this key pinchpoint. An outage of the Refinery has the potential to cause weeks of fuel shortages around New Zealand.

Robustness:

The robustness of the fuel supply to Taranaki largely relies on the robustness of the key infrastructure used to bring fuel into the Port and operate fuel stations. Therefore, the fuel network is vulnerably to all hazards that pose a risk to those networks.

Increasing Resilience in this Sector

Along with mitigations identified for the Port sector (which are critical to the fuel supply chain), the following initiatives have been identified to improve the resilience of fuel supply to Taranaki.

- Develop a regional fuel contingency plan (in progress).
- Additional fuel tank storage at Port Taranaki.

3.4 Roads

Network Overview

New Zealand road authorities use the One Network Road Classification (ONRC) system which divides New Zealand's roads into six categories. The categorisation is based on factors such as how busy they are (traffic volumes) whether they connect to important destinations or are the only route available.

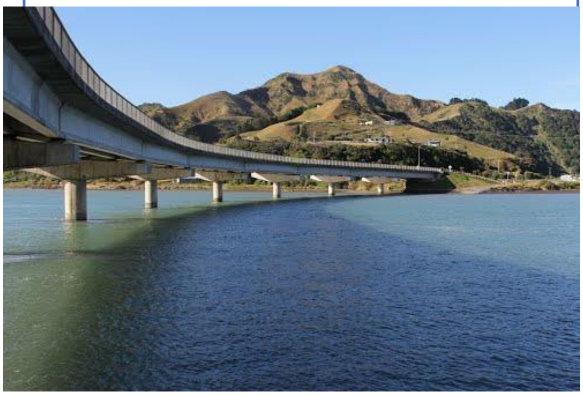
In Taranaki, SH3, 3a and 45 (regional highway) are rated as regionally significant. They are important as a means of bringing in food, fuel and freight and are the only land-based evacuation routes in the region.

Road authorities have also considered the criticality of roads providing sole access to key sites, for example, for Stratford District Council:

- Stratford Water Treatment Plant;
- The only access route from Stratford to the mountain;
- Patea River bridge crossings between north and south Taranaki including at Cardiff Road, SH3, Juliet Street, Swansea Road and Skinner Road;
- Access to the CDEM Centre in Stratford (Miranda Street and Portia Street);
- Esk Road leads to the Council's Wastewater Pump Station via SH43.
- SH 43 is a key link to areas prone to slips in the eastern country.

Highlights

- **Taranaki's road network includes several places where critical routes and bridges have limited alternate routes and long detour times.**
- **Weight posting on many bridges further constrains availability of alternate routes.**
- **Mt Messenger (north) and SH 3 at Waitotara, Patea and Waverley) are notable pinchpoints in the network, all vulnerable to two (or in some cases all) of the four natural hazards investigated.**
- **There are several low-lying coastal bridges vulnerable to tsunami (e.g. SH3 at Tongaporutu, Mohakatino and Mokau).**
- **Recent storms continue to highlight the vulnerability to flooding, tree fall and slips – the eastern hill areas are known to be particularly high risk for slips.**
- **Volcanic ash will cause widespread travel delays while clean-up occurs. Lahars/lava flows can potentially isolate New Plymouth and other towns by road in the large eruption scenario considered.**
- **Lack of communication on backcountry roads hinders emergency response coordination.**



Resilience Considerations

Supply Dependencies:

The road network itself has minimal dependence on other lifelines – other than electricity for traffic lights. However, users of the road network obviously require fuel to operate. In a major response situation, communications are required for coordination of roading staff, contractors and with other agencies.

Redundancy:

The road network generally provides for alternate routes where main ones are disrupted. However, there are some locations where the detour routes are long and/or have limited capacity. Also, some hazards provide a threat to both the main routes and alternates, for example:

- Volcanic lahars that threaten the coastal highway are also likely to bisect alternative inland routes (the upper mountain ring road).
- Similarly, for the known fault-lines to the west which run perpendicular to the coast.
- Major rainfall events can cause multiple slips, impacting all roads.

Robustness

Roads are designed to varying standards depending on category and location. The vulnerabilities around landslips (both rain and earthquake induced) have been well experienced. In the June 2015 rain events, there were many landslips varying in size, volume and complexity of repair.

Similarly, bridges are of different design and condition and have different capabilities to withstand shaking, ground movement, flood flows and tsunami. Older, wider, lower bridges in coastal river areas as a general rule are often less robust from this perspective.

Specific Hazard Risks:

The potential for physical asset damage arising from the hazards covered in this project include:

- State Highway tunnels at SH3 Mt Messenger and SH 43 Moki are at risk in an earthquake and the proposed Mt Messenger bypass will also have a tunnel. The Awakino Gorge Tunnel, while outside the region provides important access in/out of the region (NZTA is progressing a bypass project along a similar timeframe to Mt Messenger).
- Volcanic lahars modelled for a 'large eruption' (refer Section 4) will potentially cross SH3a and the older, smaller Waioranga Bridge.
- SH bridges at Patea and Waitotara are at risk of damage from floodwaters.
- The SH bridge at Waitara is at risk of damage from tsunami and lahar.
- The SH bridge at Patea is old, low lying and with no viable alternate route (the east-west route is not completed) and at risk from tsunami and lahar.
- The Waitotara Bridge is higher but has a soft bank (prone to erosion in flood waters/tsunami).
- Waverley and Inglewood faults could damage the SHs at these locations and the alternatives are long, 'hill country' roads.
- Many areas of the road network are prone to slipping arising from heavy rain or earthquake. The eastern hill country more generally, and specific known risk areas are SH 43 Moki and SH3 Mt Messenger as well as SH 3 south of Hawera.

In the Taranaki region, the key resilience issues are:

- The most at-risk areas for slips are north of Urenui and east of Tarata.
- Large culverts not classified as bridges;
- Tunnels - Okau Rd (alternative route from Mt Messenger), Otaraoa Rd, (alt route out to Tarata). Tunnels (Moki Rd and Kiwi Rd)
- Low lying areas prone to flooding in Onaero, Uruti, Waitara, Omata.
- Livestock underpasses.
- Egmont Village - Pedestrian underpass to school

- Local roads with no alternate access.

Specific issues for Stratford include:

- SH43 access to the east is required over four saddles - Strathmore, Pohokura, Whangamomona and Tahora Saddles.
- Pembroke Rd and Upper Manaia Rd (access to the mountain).
- Eastern Hill country beyond Douglas are prone to large slips occurring.
- Roads alongside watercourses suffer from erosion during storm events as a result of trees that have fallen into these watercourses and are not removed by adjoining land owner or TRC.
- Large galvanised steel culverts which are classed as bridges which need to be replaced.
- Tunnels - Raupuha Rd, there is no other alternative route to properties beyond the tunnel. Moki Tunnel (SH43) prevents access into Ruapehu District if blocked or collapsed.
- Low lying roads along watercourses are prone to flooding – e.g. Puniwhakau Rd.
- Upper Mangaehu Rd - no alternative access for residents along this 23km long road.
- Many no-exit roads throughout the district.
- 32 bridges which do not meet 50Max load carrying capacity.

Increasing Resilience in this Sector

The following initiatives have been identified by Taranaki lifelines road sector representatives as having the potential to improve the resilience of the region's road network:

- Further investigation into vulnerability of State Highway bridges to all hazards.
- General upgrades to the road network including road widening, bridge strengthening / raising.
- Building alternate routes where there are currently no viable options – including for State Highways between Waitotara and Patea, Mount Messenger and at Awakino.
- Increase availability of resources in the region – skilled labour, critical stock, spare Bailey Bridge.
- Increase resilience of SH43 for heavy vehicles.

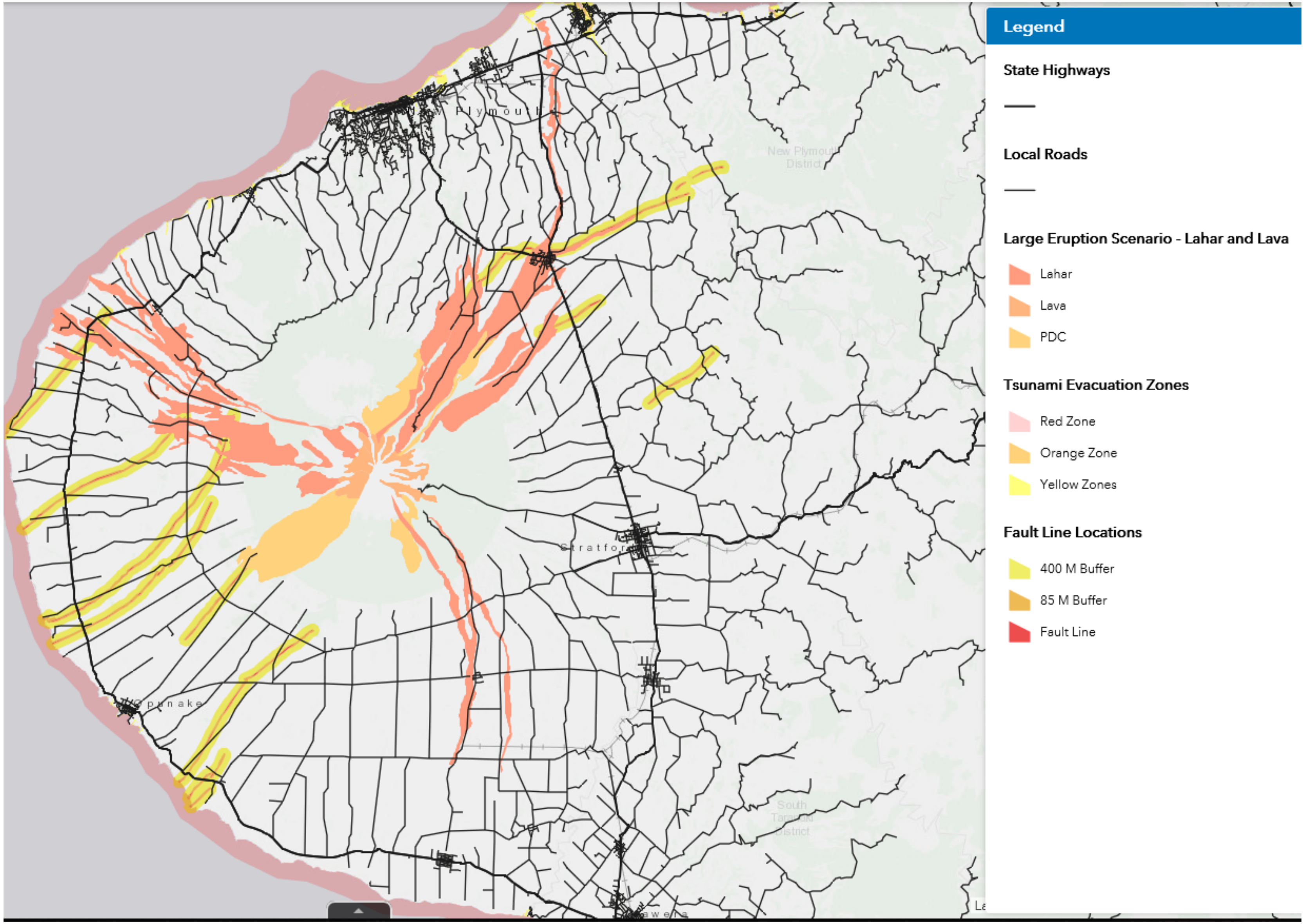


Figure 3-6: Road Network shown with Seismic, Near-Source Volcanic and Tsunami hazard layers

3.5 Other Transport

Port Taranaki

Overview

The main export product from Port Taranaki is petrochemical (oil, methanol, condensates). Other export products include logs and farming products (powders). Fonterra does not use Port Taranaki – its products from the region are sent by rail directly to Port Tauranga.

Both diesel and petroleum are shipped to the Port, piped to the Omata Terminal and distributed by truck to outlets.

The Newton King Wharf is the most critical asset – this is where ships berth for petroleum imports and exports.

The Omata Fuel Tank Terminal is owned by Port Taranaki, leased by BP and operated by NZOSL. A number of other petrochemical products are stored in tanks at or near the Port, owned by various other owners and operators (Z, Methanex, Shell, OMV, Beach Energy, etc).

Resilience Considerations

The Port has backup electricity to maintain operations, however it is not known whether other parts of the supply chain do (e.g. pumping / tanks / pipes).

Resilience

80% of the port area is reclaimed land – creating a higher risk of damage in an earthquake event.

A major tsunami is also potentially damaging. While the West Coast is not thought of as high risk for tsunami, models predict up to 6m tsunami which could be highly damaging to the Port (even in Cyclone Gita the storm surge caused waters up to building floor levels on Newton King). Logs will make the tsunami waves even more damaging.

Highlights

- **The Port is a critical facility for the region, with Port Newton King being the most critical asset and a key part of NZ's petrochemical export market.**
- **Petroleum and diesel are brought into the region through Port Taranaki, though there is alternative delivery by road if roads are open.**
- **In a major disaster impacting road access, the region's port and airports could potentially be important for evacuating people and bringing in emergency resources.**
- **There are (limited) backups to water supply, gas and electricity at the Port and Airport.**
- **A volcanic event and high wind events are mostly likely to disrupt air traffic (ashfall).**
- **The low-lying Port Taranaki is highly vulnerable to storm surge and tsunami.**
- **Also, 80% of Port Taranaki is on reclaimed land with associated high risk of liquefaction.**
- **Kiwirail was not involved in this project, but while the rail is an important economic link, road alternatives can be used if they fail.**

The Port could become very critical in a mass evacuation situation, such as following a major earthquake or eruption – both of which have the potential to isolate New Plymouth by road.

Redundancy
In a long-term disruption, logging exports and farm product imports could be moved by rail or road to other Ports for export (Taranaki, Wellington).

The loss of the Newton King Terminal Wharf infrastructure would stop the export of most petrochemicals as these are transferred by pipeline in large quantities making it unviable to transport by road or rail.

Airports

The main regional airport in New Plymouth is primarily passenger transport with limited freight. The critical assets are the runway seal, terminal and tower. There is 30,000l maximum fuel storage capacity and Avgas on site.

The airport relies on electricity, water (for firefighting), fuel (by truck approximately once per week.

Three hazards assessed in this report have the potential to disrupt airport operations – volcanic ash, high winds and earthquake damage to assets.

Rail

The rail network access is only from the south via the Marton to New Plymouth line (MNPL) which brings freight to and from the Port.

Increasing Resilience in this Sector

The following initiatives have been identified by Taranaki lifelines port and airport sector representatives as having the potential to improve the resilience of the region's facilities:

- Moving pipeline to other wharves.
- Floating discharge or import process.
- Condensate storage and production rates.

3.6 Telecommunications

The telecommunications sector is one of the most complex of the lifelines sectors – technology changes rapidly and there is a high level of inter-connectedness between the various providers which share parts of the network and exchange (voice and data) messages between networks.

Network Overview

Mobile Networks:

Cell sites typically provide overlapping coverage such that a cell site failure may only cause partial loss of service to the normal supply area. A number of cell sites rated as regionally or locally significant, as illustrated in Figure 3-8.

Fixed Line Networks:

The Chorus trunk fibre network in the North Island includes three main north-south cables – broadly described the 'eastern', 'central' and 'western' cables (the latter runs through Taranaki). These are considered as nationally significant assets, though they do provide redundancy for each other if one fails, through the 'ladder network' concept illustrated in Figure 3-7.

The major site in the region is the New Plymouth Exchange pictured below (regionally significant) and the Hawera Exchange (locally significant).

Vodafone also has several fibre networks that traverse the Taranaki and Waikato regions and are part of the West Coast diverse route incorporating an underwater component (Aqua-Link) between Raglan and New Plymouth as well as terrestrial base fibre systems. (the

Broadcasting

Kordia's main site in the region is on Mt Taranaki, which is rated nationally significant and is a critical hub for services in the lower North Island. It also provides important communication services such as Maritime. The site is unmanned and is monitored from the Transmission Control Centre (TCC), located in Avalon, which is a 24/7 operation.

Kordia provides a managed environment (watertight, ventilated, and powered) with associated towers (antenna aperture) for others to locate their transmission equipment such as Police, Ambulance, Transpower, Vodafone and Spark cellular). Kordia's other (regionally) critical sites include the Chorus Exchange (important point of interconnect) and Mahoe. (a key transmission and linking site).

Highlights

- **Telecommunication services are critical for agencies and communities to coordinate emergency response.**
- **There are levels of redundancy within the telecommunication networks – for example, trunk fibre routes have alternate routes, cellsites provide some overlapping coverage.**
- **However, earthquake, storm and volcanic hazards all create scenarios where fibre routes could be isolated in multiple locations, causing major telecommunication service failures.**
- **The telecommunications network is highly dependent on electricity. Battery backups can be expected to last 4-24 hours depending on traffic and battery capacity after which they would need recharging with generators. Some key sites have standby generators with fuel sufficient for 2-3 days.**
- **The main exchange in New Plymouth requires water supply for cooling.**
- **Volcanic ash is likely to significantly impact the telecommunications service, both because of likely electricity failures plus clogging of air filters at key sites.**
- **High wind storms will also cause disruption because of electricity disruption and experience has shown that repairs are delayed due to road conditions.**
- **The region is not well resourced locally for disaster events and relies on transport routes to bring in staff and equipment from other regions.**

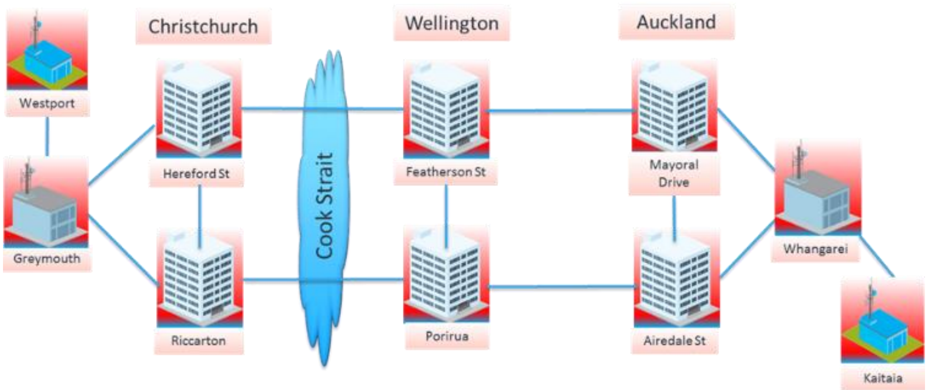


Figure 3-7: Ladder Network Diversity – courtesy of Chorus

Radio

TeamTalk is the major provider of analogue and digital mobile radio in the country and provides services to several lifeline utilities and emergency services including Ambulance Services and the Ministry of CDEM.

Telco 101 – How the National Networks Operate

Cellular network assets:

- The **Cell Site** provides the local coverage and a mobile phone will connect to the cell site with the strongest signal, usually, but not always the nearest cell site.
- **Transmission** links connect the cell site to the Aggregation Node and the Aggregation Node to the Exchange. The transmission links are fibre, copper or microwave radio (increasingly fibre).
- The **Aggregation Node** is a Base Station Controller (BSC) for a 2G (GSM) phone or a Radio Network Controller (RNC) for a 3G phone. Transmission links then connect the aggregation point to the exchange.
- The exchange (**Mobile Telephony Exchange, or Strong Node**) is the brains of the operation; it makes the connection between the caller and the called. If the transmission links are broken, the call cannot be completed (it is not possible for a cell site to work in local mode). Exchanges/strong nodes are connected by fibre transmission links. If these links are broken, the network functionality will be severely impacted, and they are therefore heavily protected with redundant links and automatic failovers.

Fixed Line Networks:

Roadside Cabinets are the first aggregation point for Digital Subscriber Line (DSL) broadband connections and connection point for landline phones. Roadside cabinets have the ability to connect to standby generators.

Telephone exchange buildings (**Fixed Line Exchanges**) operate direct copper pair connections to customer premises. If an exchange becomes isolated from the nationwide network of exchanges, it will in some cases continue to operate in local mode, meaning that local phones will be able to call local phones from the same network. 111 service may be rerouted to a local number, such as the local police station or answered by a technician at the exchange building.

Links between exchanges are used for carrying long distance traffic such as tolls, fixed to mobile, international, 0800, 111 services etc. These links may be fibre cables, copper cables or microwave radio links.

Increasingly, other operators are installing fixed line exchange equipment as local loop unbundling becomes the norm.

Resilience Considerations

Supply Dependencies

The dependence on electricity for telecommunications networks is generally well understood. Most telecommunication sites (cell sites, exchanges, etc) require mains electricity to operate. Major sites – the main exchanges and broadcasting sites - have backup generators and fuel on site (though at varying levels – Kordia's sites can generally operate for days/weeks without fuel re-supply, major exchanges for hours/days).

Therefore, the other critical dependency is fuel for re-stocking generators.

The performance of the backup batteries was tested in Ex-Cyclone Gita in February 2018, where some sites did not last as well as expected.

All sites have battery backup, which can be expected to run for hours or days depending on criticality (more important sites have longer standards, such as Chorus's chore sites which target 7 days), traffic and other factors. Many cell sites also have generator plugs to enable deployment of mobile generators.

Each provider has their own stock of mobile generators around the country, but not enough to power all sites in, say, a major regional outage.

Redundancy

The main Chorus national fibre networks have 'loop' redundancy which means that they would need to be damaged in more than one location to have a significant effect on services. However, several of the hazards (major slips caused by rain or earthquake) and volcanic lahars have the potential to impact in more than one location, potentially isolating New Plymouth and other areas.

Robustness

Fibre links are more ductile and generally perform better under seismic conditions than copper links. As a general principle, the major sites are designed to higher standards.

Specific Hazard Risks:

The hazards that the telecommunications assets may be vulnerable to include:

- Volcanic lahar – potential loss of Chorus fibre both north and south, isolating New Plymouth (cable crossings potentially intersect with lahars at Lepperton and Wainganga Bridge).
- Where cables cross faults lines in the Inglewood area there could be potential loss of service to the fibre links if a major seismic event occurs.
- Volcanic ash – Chorus note they have emergency filters but would need re-supply.
- Chorus's Waitara Exchange is in an identified tsunami and flooding zone – potentially impacting ~ 10,000 customers.
- Cables on low lying bridges potentially at risk from tsunami include Patea Bridge and Waiwhakaiho Bridge.
- Cyclones will have both a direct impact on above ground asset as well as the impact of likely power outages and disrupted road access.

Increasing Resilience in this Sector

The following initiatives have been identified by Taranaki lifelines telecommunications sector representatives as having the potential to improve the resilience of the region's telecommunication services:

- Increase local spares holdings – filters, gensets, electronics, cable.
- Improve communications with power companies to manage generator deployment in power outages.
- In-house UPS for critical customers (e.g. medical register).
- Increase local resources – both people and equipment.
- Increase standby battery capacity.

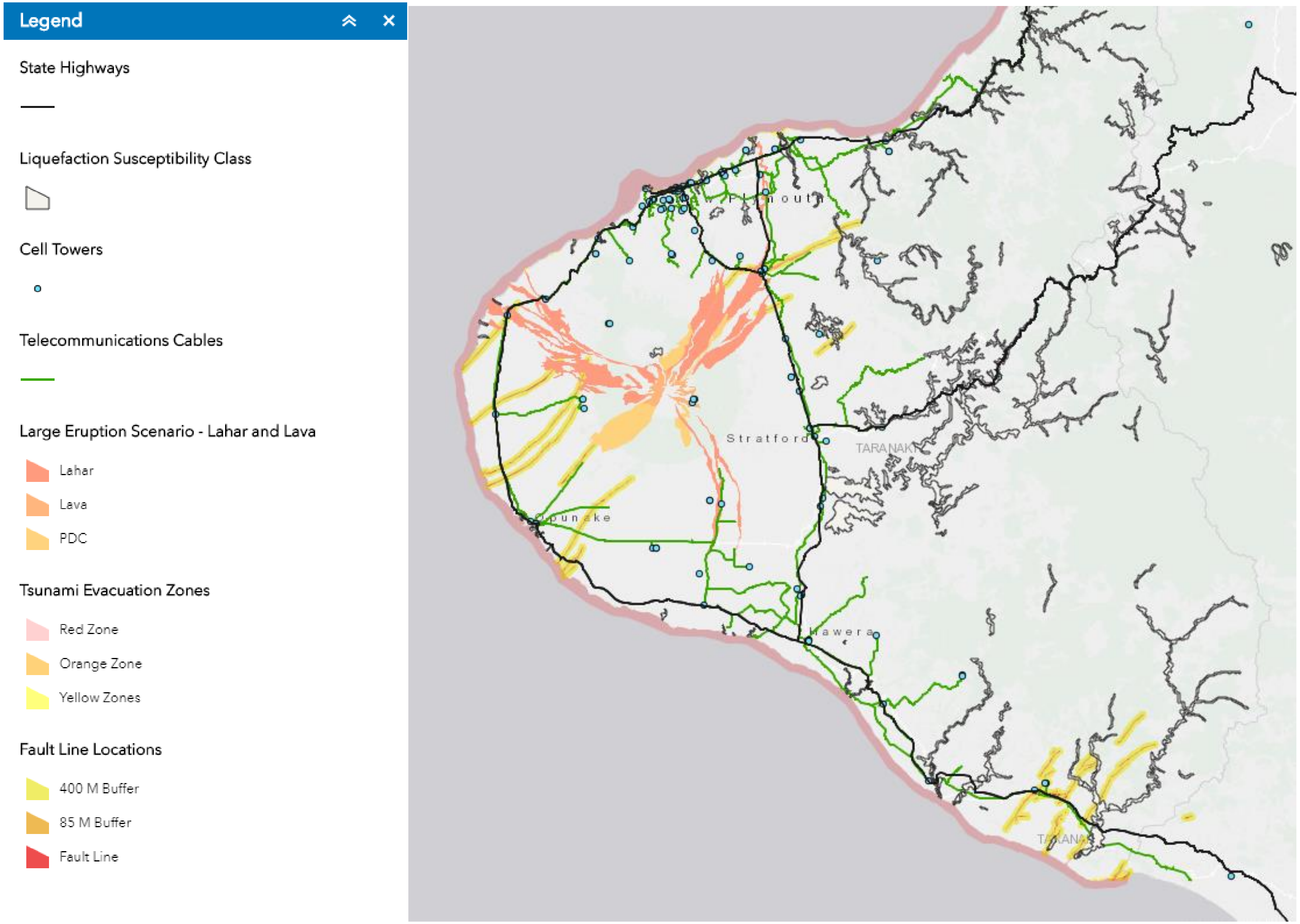


Figure 3-8: Taranaki's Telecommunications and Broadcasting Assets (only Chorus fibre cable available at time or preparing map)

3.7 Water / Waste Sector

The Networks

Water Supply

The six main public water supply schemes are shown in Table 3-2. Key points of vulnerability are summarised in the box to the right.

Wastewater

The three main public wastewater schemes are shown in Table 3-3. Key points of vulnerability are summarised in the box to the right.

Stormwater and Flood Protection

Taranaki Regional Council owns and maintains flood protection schemes on the Waiwhakaiho and Waitara Rivers and undertakes channel maintenance and management on the Waitotara River jointly with South Taranaki District Council.

New Plymouth District Council controls and manages the detention dams on the Waimea, Huatoki and Mangaotuku Streams and two tributary detention dams, together with diversion tunnels, culverts, and earth embankments (the New Plymouth detention dam scheme).

NPDC has one stormwater pump station in Waitara capable of pumping approx. 4m3/s into the river if gravity outlets are blocked by high river level. It operated in June 2016 when TRC estimated a 16-year ARI river flow.

Solid Waste

The region's waste is disposed at the Colson Road landfill in New Plymouth with a new landfill being built in Eltham.

Transfer stations around the region provide redundancy in the network if a small number are closed.

Closed landfills can be used for emergency debris (*Ref: Emergency Debris Management Plan 2016).*

Highlights

- **All the major water supplies in the region are surface water supplies. These are highly vulnerable to volcanic ash and there is limited bore water backup.**
- **In the large eruption scenario investigated, Inglewood water supply would be damaged or destroyed and some trunk mains are also at risk (e.g. supply east of Waitara).**
- **Lahars / lava flows could cause damage to many other assets – stream intakes, pipes crossing rivers, etc.**
- **Water supply treatment plants and pump stations rely on electricity; some key sites have backup generation but some of those do not have full capacity and there are many sites that have none.**
- **Many supplies have a single source creating key points of vulnerability upstream of the distribution network.**
- **Wastewater treatment plants and pump stations generally do not have backup power, some have a switch for a generator, others have plans to truck effluent to the plant. There would be many raw sewage overflows in a widespread power outage more than 2 days.**
- **Solid waste management will be a key issue in a major disaster (debris, volcanic ash, etc). A plan is in place to use closed landfills if required.**
- **Further work needs to be done to understand the hazard impacts on flood protection assets in the region.**

	Approx. connections	Source / Treatment	Storage / backups
New Plymouth	60,000	Lake Mangamahoe Conventional treatment (coagulation, sedimentation, filtration, chlorine).	2 weeks raw water storage. 12-24hrs treated water storage. Backup generator, 3 days fuel.
Hawera	10,000	Source: Kapuni stream 80%, groundwater 20% Treatment: membrane filtration	Standby generation at sources / treatment plants. Storage: 18,000m3 of which 9000m3 is within Hawera.
Inglewood	4,000	Source: Ngatoro Stream Treatment: Clarifiers, filters, residual disinfection chlorine gas.	Changeover switch for generator. No raw water storage. 36 - 48 hours treated water storage.
Stratford	2,800	Source: Patea River; secondary intake from the Konini Stream Treatment: Full Membrane WTP.	Storage: 8,500 m^3 of storage - up to 2 days' supply. No backup generation for WTP apart from for compliance monitoring.
Oakura	1,700	2 secure bores (status likely to change and upgrade req'd). No treatment Residual disinfection sodium hypochlorite solution.	Changeover switch for generator. No raw water storage. 24 - 48 hours treated water storage.
Okato	500	Mangatete Stream Treatment cartridge filters and UV Residual disinfection sodium hypochlorite solution	Back-up generator plus fuel for 3 days. No raw water storage. 26 - 72 hours treated water storage.

Table 3-2: Public Water Supply Schemes in Taranaki

	Approx. connections	Treatment/ Disposal	Pump stations
New Plymouth (incl. Inglewood, Oakura, Te Henui, Bell Block)	65,000	Activated sludge plant. Disposal to sea outfall. Sludge dried/sold as fertiliser	Waitara, 6000 customers, Changeover switch for generator. Approx 4 days storage. Inglewood – 4500 customers – no generation. Changeover switch for generator. Approx. 10 days storage. Oakura – 1600 customers – no generation. Approx. 2 days storage. Bell Block (Mangati) 10,000 customers inc major industrial. – generator currently being installed. No storage Te Henui 4,500 customers - generator installed with 3 days fuel storage. No storage.
Hawera	9,000	Anaerobic lagoon and oxidation ponds (standby generator scheduled for 2018/19). Gravity ocean outfall shared with Fonterra.	4 major pump stations, none with backup generator.
Stratford	2,500	Gravity fed to treatment plant. Oxidation Pond System, gravity fed and discharged into the Patea River. No backup generation.	Key pump station Esk Road, 3 days of storage, no generator but effluent can be trucked to the WWTP when storage is full. Other minor pump stations for on Cordelia Street; Miranda Street and Maria Place.

Table 3-3: Public Wastewater Schemes in Taranaki

Major Dependent Customers

Potable water supply is critical to the entire community and individual households are encouraged to store bottled water for emergencies. Larger, 'regionally critical' customers are summarised below – the dependencies of each sector are further detailed in Section 3.

- New Plymouth Hospital (3 days water stored on site but concerns about quality).
- Fire Service (firefighting).
- Kapuni gas processing facility.
- Nova McKee's new plant will require mains water supply to operate.
- Fonterra's dairy processing plant (largest in southern hemisphere).
- Telephone exchanges (water for cooling/air con).
- Methanex NZ Ltd is reliant on both potable drinking water and effluent disposal infrastructure.
- Silver Fern Farms meat works in Hawera requires water to operate.
- Tegel's processing plant requires mains water – would shut down in an outage longer than 2 days. Also discharges effluent to NP WWTP which needs to be operational.
- On other water supplies Yarrows bakery in Manaia. Fonterra cheese plants and ANSCO freezing works in Eltham.

Local authorities also consider locally critical customers in supply prioritisation, including rest homes, schools, medical centres, dentists, food outlets, hairdressers and CDEM centres.

Resilience Considerations

Supply Dependencies:

Refer tables on previous page. In summary:

- Treatment Plants, pump stations and some water sources require electricity to operate, and the availability of on-site generators is limited, as detailed on the previous page.
- Telecommunications is required for some control and monitoring functions, and for coordinating response in an emergency – notably at New Plymouth WTP for remote monitoring (relies on radio and cell phone network).
- Road access is required to operate and repair sites.
- New Plymouth WWTP needs power, gas and water to operate. Most water is recycled on site, but some potable water is required.
- Some wastewater pump stations need mains water for screens.

Redundancy:

- Critical assets are generally those that have limited redundancy – such as the single water source supplies at Stratford, Hawera, Inglewood, Okato and New Plymouth
- NPDC's has critical trunk mains supplying Inglewood, Oakura, Okato and New Plymouth.
- STDC's most critical assets include Kapuni WTP, Kapuni and Hawera reservoirs, trunk main Kapuni to Hawera.
- SDC's most critical assets are the Cardiff Rd WTP, Victoria St WWTP, the water and wastewater trunk mains from and into the treatment plants and the Esk Road pump station.

Robustness:

- Water and wastewater facilities have been designed to varying standards over time, however most critical assets have been, or are being, upgraded for seismic resilience (for example, the Stratford water reservoir, Kapuni WTP and Kapuni Reservoirs).
- All New Plymouth reservoirs have been seismically upgraded except Oakura No. 1 reservoir. Not all meet current standards, but none are considered "earthquake prone" (does not include pipe-bridges).

Specific Hazard Risks:

- Volcanic ash is likely to impact water source and treatment plant operation, potentially across the whole region depending on wind direction and amounts. Lake Mangamahoe is a key issue.
- Volcanic ash will also impact wastewater plant – air blowers, etc, and can cause major damage.
- Lahars will potentially damage or destroy the Inglewood water and wastewater facilities even in the small eruption scenario. In the large eruption scenario, damage is also likely to:
    - the trunk main crossing at Waitara (loss of service east of Waitara).
    - Okato WTP
    - Waiwhakaiho (rendering water supply to New Plymouth unusable).
    - Potential damage to New Plymouth intake structure or blocking of tunnel entrance.
    - Two NP water trunk main aerial crossings of Waiwhakaiho, one under the river.
    - Lava flows indicated down the Waiongana Stream which could damage pipe crossings and cut-off all of Lepperton, Waitara and further east
    - Kapuni steam can have possible Lahars (source water for Kapuni WTP).
- Tsunami could cause damage to:
    - The trunk main on the Waitara Bridge.
    - New Plymouth WWTP.
    - Waitara and Marine Parade pump stations and several others near the coast/low rivers.
    - Te Henui pump station is also at risk.
    - Additional minor pump stations at the port Ngamotu and Lee Breakwater, Oakura - Messenger Terrace, Motor Camp, the key and Shearer Reserve
- Flooding – at risk assets in New Plymouth include Waitara transfer pump station, Richmond St, West Quay (on the river side of the stop bank), East Quay, Queen St and McNaughton St.

Increasing Resilience in this Sector

The following initiatives have been identified by Taranaki lifeline water/wastewater sector representatives as having the potential to improve the resilience of the region's services:

- Consider future water supplies outside the volcanic hazard zones and/or less vulnerable to volcanic ash.
- Install backup generators at all water / wastewater sites (or at least extend the coverage).
- Review generator capability to operate in ash environment.
- Provide fuel storage at sites with generators.
- Alternative water supply distribution routes for Stratford, Inglewood, Oakura, Okato and Hawera trunk mains.
- Building awareness / self-resilience within the community to cope with disruptions in supply.
- Ensure adequate resources to test water for human consumption (e.g. during volcanic ashfall).
- Increase treated water storage where there are vulnerabilities in the source / raw water supply chain.

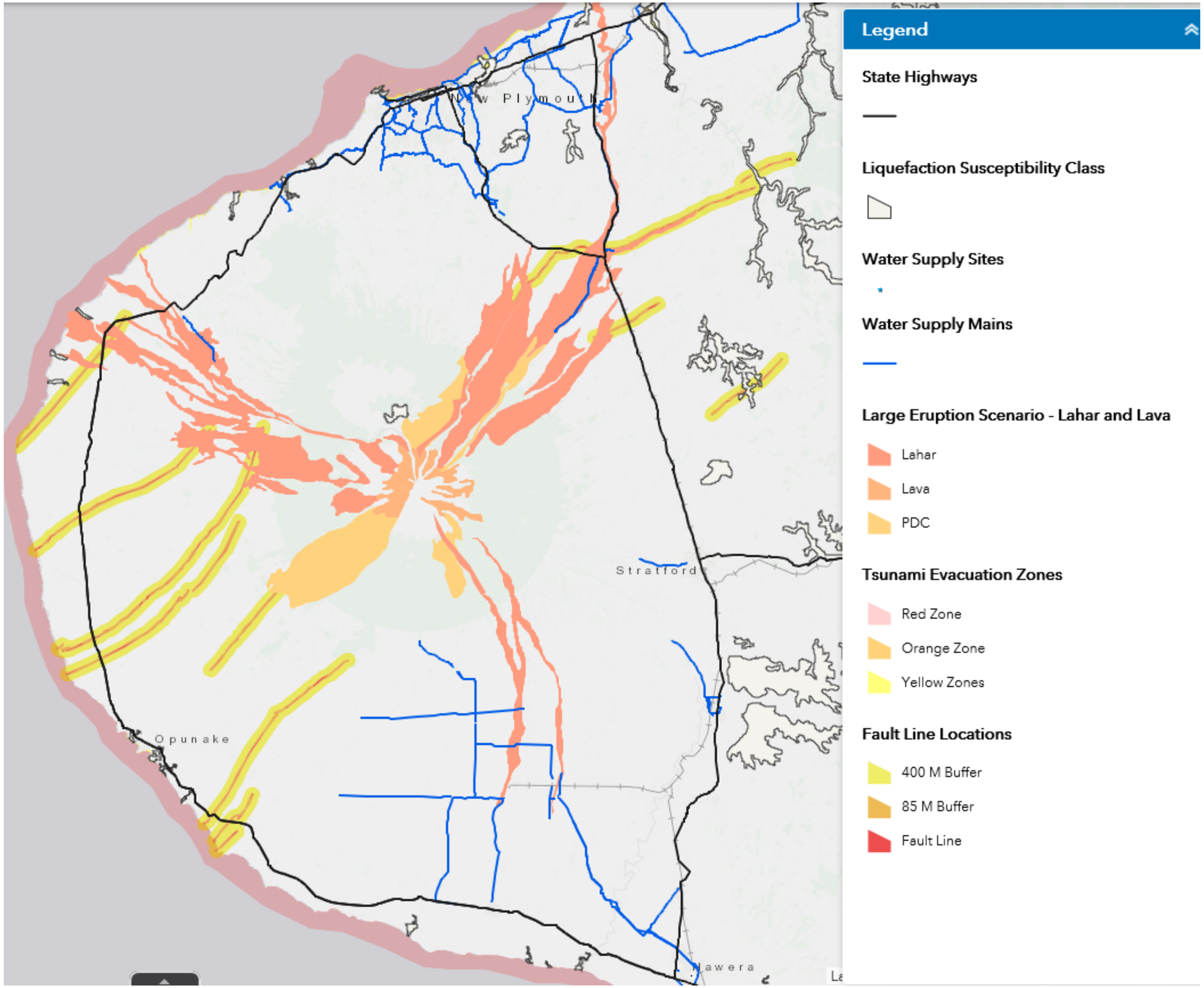


Figure 3-9: Critical Water Supply Assets and Hazards

4. Lifelines Interdependencies and Hotspots

4.1 Lifelines Sector Interdependence

Interdependency Matrix

All lifelines services rely to some extent on some or all the other lifelines services in order to operate and vice versa. Therefore, a hazard impacting on one lifelines network is likely to have a knock-on effect on others. To mitigate the risk that arises from this dependence, many lifelines have backup services should the service they rely on fail.

Figure 4-1 summarises interdependencies within the Taranaki Lifelines Advisory Group during a major disaster event where disruption is expected to roads and electricity networks.

While the findings are generally quite common across all regions, a unique factor for Taranaki is the strong interdependency between gas and electricity (the majority of electricity generation in the region is gas fired and the gas production sites require mains electricity to operate).

For each sector, the dependence on other lifelines sectors is described in more detail in the 'Resilience Considerations' in Section 2.

Impacts of a Major Lifeline Utility Failure

A major lifeline utility failure is a hazard to the wider lifelines sector even if it happens outside a wider disaster. The impacts on the lifelines sectors from failure of individual networks in both business-as-usual and during a disaster are summarised below.

Electricity
During normal operations, electricity is required to operate most the other lifeline utilities to some degree and, because of this dependence, most utilities have backup generation at their most critical sites. However, a widespread regional power outage would, after varying periods of time, still cause service losses for customers of gas, telecommunications, water supply, wastewater, fuel supply and traffic management services.

Dependence on Telecommunications
A major telecommunications failure will impact the business sector and wider community and impede the efficiency of utility businesses; however, most utilities could continue core services at near full capacity without telecommunications in the short term. Some utilities would need to revert to manual operation and monitoring of facilities and response to service requests could be impaired.

The situation changes in an emergency because telecommunications become critical for coordinating response. There is a high reliance on the cellular network for voice communications and this network may become overloaded during or shortly after an event. Most utilities use a combination of cellular, landline and other technologies to monitor their own infrastructure and some have their own dedicated network of links and radio.

Highlights

- **There is a strong interdependency between gas and electricity networks in the region; most of the electricity generation in the region is gas fired and the gas production sites require mains electricity to operate.**
- **This is a key issue for the region given the national significance of the gas supply and gas-generated electricity generators.**
- **Electricity is the most important supply to other lifelines services during business-as-usual and, in a power outage, fuel to operate generators.**
- **In an emergency, roads and telecommunications become more important to coordinate response activities.**
- **Critical community services such as police, fire and health have backup power and water to maintain essential functions. However, there are limited stocks of water at the hospitals and limited fuel stock for generators.**
- **Major industrial sites are vulnerable to loss of electricity, water supply and gas and, in many cases, would have to shut down within 1-2 days of a key supply failure.**
- **The poultry and dairy sectors have multiple points along the supply chain requiring electricity, water and fuel to operate. Backup generation capability is improving (more farms are installing generators) though the actual extent is unknown.**

The degree to which the utilities listed to the right are dependent on the utilities listed below	STDC water	SDC water	NPDC water	Wastewater - all	Telecomms	Roads	Airport	Port	Powerco Gas	FirstGas	Trans power	Rail	Fuel	Contact	Trust pwer	Kupe (gas/ LPG)	Kordia	Nova Gas	Comments
Electricity	2	3	2	3	3	2	2	2	1	2	3	1	3	3	3	3	2	3	All utilities are dependant on electricity to function (except roads which only affects traffic lights). Where backup generation enables the majority of the service to function, the rating is a 2 instead of a 3.
Gas	1	1	3	2	1	1	1	1	3	3	1	1	1	3	1	3	1	3	Gas fired electricity generation sites are most dependant. There is also dependencies within the network - transmission/gas require production sites to be operational.
Fuel (if power out)	3	3	3	3	3	3	3	3	3	3	3	3		1	1	2	3	1	The '3's reflect sectors that rely on backup generators in a power failure.
Fuel (power on)	2	2	2	2	2	3	3	3	2	2	2	3		2	2	2	2	2	Most are rated as '2' reflecting the need for fuel to operate vehicles during response. Roads, airport, rail and the port are more critically reliant on fuel to operate.
Roads	3	3	3	3	3	3	3	3	3	3	2	2	3	3	2	2	2	2	The port and airport require vehicle access to operate. In a response, roads become critical for access to sites. Those rated a '2' consider helicopter access to be feasible (lower number of sites to access
Rail	1	1	1	1	1	1	1	2	1	1	1		1	1	1	2	1	1	Required to bring some products to the Port and to distribute LPG to the South Island.
Airport	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	Could become critical for bringing in emergency resources and evacuation, but not critical to the operation of other lifelines.
Port	1	1	1	1	1	1	1		1	1	1	1	3	1	1	3	1	1	Port operations are important for bringing in fuel for regional use and exporting petroleum and LPG.
Water Supply				3	2	1	2	2	1	1	1	1	1	2	1	1	1	1	Required for fire fighting (at Port and Airport) though there is storage on site amd cooling (eg: NP telephone exchange). Important for staff, but bottled water can be provided.
Wastewater	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Not essential for other utilities to function.
Telecommunications - landline	1	1	2	2		1	1	1	1	1	0	1	1	1	1	2	1	1	Important for some remote monitoring/control processes, but otherwise dependency is reduced (unless cellular networks are down).
Telecommunications - cellular	2	2	2	2		3	3	3	2	2	2	2	2	2	2	2	2	2	In a disaster, important for coordinating communications, however most rate as a '2' assuming that other comms methods are available.
Telecommunications – internet	1	1	2	2		2	2	2	2	1	1	1	1	1	1		1	2	Becoming increasingly important as part of monitoring and communication processes.
Telecomms - broadcasting	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1		1	Obviously important in a major disaster for public communications, for other lifelines, may be important for key public health messaging around water supply

Figure 4-1: Interdependency Matrix – During / Post Disaster Event

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

Dependence on Broadcasting

All utilities rate broadcasting as '1' (minimal requirement for service to function) during business as usual. This increases to a '2' during a response situation as a means of communicating public information such as road disruptions, public water supply warnings and advising of fuel shortages.

Dependence on Roads

The road network is important for all utilities to operate, particularly for sea/air/rail networks which are connected by road and for fuel as there is currently only diesel brought in by ship to Port Taranaki. Road failures during business-as-usual may affect response to service requests and asset failures would be affected. Also, staff need to be able to access facilities and diesel and plant needs to be transported to construction sites and this would become critical in longer-term road failures. In a major disaster, road access to other critical sites to enable restoration makes the road network much more critical.

Dependence on Sea and Air Transport

Port Taranaki is a key part of the gas supply chain and could potentially important for evacuations if the region is isolated by road (possible in earthquake, flood or volcanic scenarios assessed). Similarly, the airport, if it is operational, will become important for flights to assess damage, bring in equipment and spares and access sites when there is significant road disruption.

Dependence on Water Supply and Wastewater

While water supply and wastewater services are critical for the community (and for firefighting), the lifeline utilities only require these for building services (and alternative arrangements can be made such as re-location other locations, or using bottled water supplies and temporary wastewater facilities). The exceptions are telecommunications, which requires water for equipment cooling.

Dependence on Fuel

All utilities have some dependence on fuel for vehicles for service personnel. If electricity is affected, diesel supply to critical sites to operate backup generators becomes more important. Even those sites with on-site diesel storage typically only hold a few days' supply. Refuelling of generators deployed to other critical facilities is likely to become a significant logistical issue.

Dependence on Gas

There are two major gas-powered electricity generators are in the region – Contact's Stratford Plant and Nova McKee.

4.2 Dependence on Lifelines by Critical Community Sectors and Major Industry

Modern communities increasingly rely on lifeline utilities to function. Major failures of lifelines services will impact on the economy as well as having social and public health impacts. Some consequences are more obvious than others. For example, extended failure of water supplies to schools results in school closures which keeps parents' homes and can impact on resources available for operations and response.

This section discusses the reliance on lifeline utilities by critical community facilities in Taranaki such as hospitals, CDEM operations centres and emergency services headquarters. It also looks at the dependence of major industry - noting of course that many of the lifeline utilities themselves are important industries for the region – and the extent of backup arrangements in each sector is also discussed.

Health

The region's hospitals require water and electricity to function. There are backup generators at the three hospitals, but fuel storage is limited. For the main hospital, at full capacity there is only around 1-2 days fuel on site but that could extend to 3-4 days if energy use was conserved. There is around 3 days of water stored at New Plymouth hospital but there are concerns about the quality of the stored water.

Gas (or alternatively diesel) is required for heating and hot water).

St John operations are based at the hospitals – fuel is critical for ambulance services and there are no backup stocks for this purpose at the St John bases.

Emergency Services

Most fire stations and police stations have backup generators. Water supply for firefighting and fuel for vehicles are the key dependencies. These agencies do not specifically hold stocks of water and fuel, other than what is in the vehicles and generators.

CDEM / Local Authorities

There are backup generators at all the local authority main buildings and CDEM Emergency Operations Centres. As with most other facilities described in this section, the generators would require refuelling within 1-2 days as there is only the fuel stock held in the generators themselves.

Dairy Sector

Electricity is required at many parts of the dairy supply chain – to milk cows, keep milk chilled, pumping water for stock, as well as the dairy processing factories.

Many farms do have generators and fuel stocks (typically refilled on a monthly basis) – at best estimate around half have this capability.

Some farms rely on public rural water supplies.

The Fonterra dairy processing plants at Eltham (the largest in the Southern Hemisphere) and Whareroa (opened in 2018) have backup generator on sites. However, they do rely on gas and mains water as well.

Meat Processors

Poultry is a major industry for the region – the Tegel processing plant in Bell Block supplies a third of NZ's poultry products.

Electricity requirements are very high, making a backup generator cost-prohibitive. The plant also requires water supply to operate and would be unable to operate if the water supply failed for longer than 2 days. Effluent discharges to the New Plymouth wastewater treatment plant and, if that wasn't functioning, they would likely be required to close down.

Aviagen supplies around two thirds of the breeding stock for NZ and also relies on electricity and water.

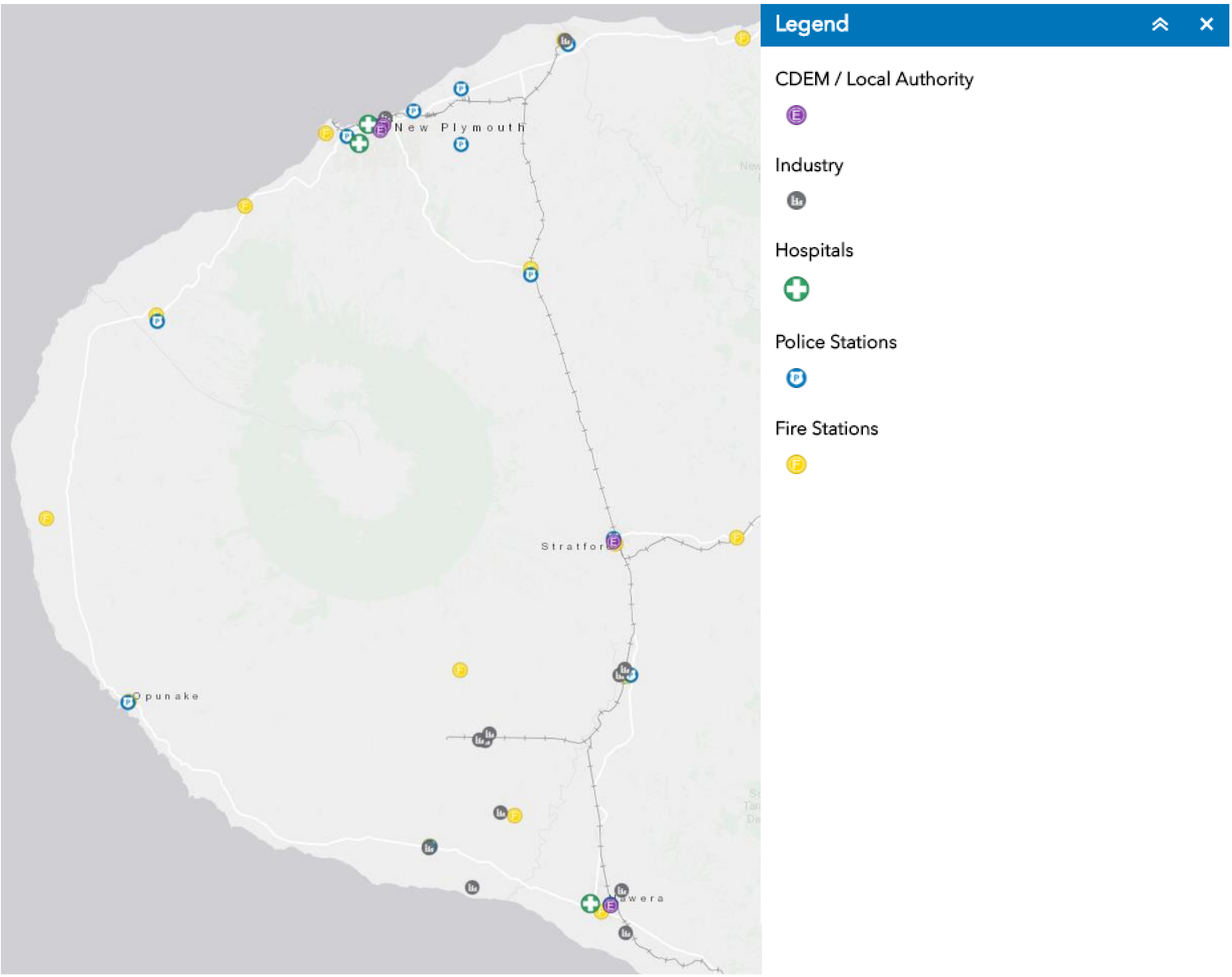


Figure 4-2: Critical Community Sites and Major Industry

4.3 Infrastructure Hotspots

Defining an Infrastructure Hotspot

Infrastructure interdependence increases the overall risk and consequence of a potential failure of a single infrastructure type. Co-location of critical infrastructure assets also increases the risks of a damaging event at a single site, both in terms of the direct impact of a number of critical assets simultaneously failing (e.g. a major landslide) and in terms of the potential hazards that some assets pose to others (a major water main failure could wash away other assets in the area). These areas are termed 'hotspots - where a number of critical infrastructure assets from different sectors converge in a single area.

Regionally Identified Hotspots

Major hotspots identified during project workshops include the following State Highway bridges that carry other critical infrastructure:

- Waiongana Bridge - telco cable.
- Waitara town bridge – water mains, sewers including Methanex effluent discharge lines.
- SH3 Waiwhakaiho Bridge- Chorus western cable, water mains (the intermediate gas pressure pipeline supplying New Plymouth crosses under the river downstream of the Waiwhakaiho River bridge..

Further analysis to identify hotspots areas is recommended in the future work programme.

5. Building Resilience

5.1 Improving Asset and Hazard Knowledge

This project was undertaken using the most recent hazard information available for the four main hazards investigated. There were a number of known limitations around the hazard information, such as:

- There was no spatial information on likely ground shaking arising from either local or distant earthquakes to support the seismic analysis.
- Flood modelling was only available for a few areas.
- The tsunami inundation areas are based on conservative 'evacuation zones' which likely overstate the extent of probable inundation.
- There was no spatial representation of storm related wind damage available which is of particular relevance to the electricity and telecommunications sectors.

The Taranaki Emergency Management Office is undertaking a hazard improvement programme of work over the next few years which will address a number of the gaps identified above.

Also, in terms of understanding the impact of hazards on floods, some key areas of further work were identified as follows:

1. Further work needs to be done to understand the hazard impacts on the region's flood protection assets.
2. Specific site risk assessments for key infrastructure (low lying bridges, key transmission line pipe crossings) is needed to verify the extent of risks from lahars, tsunami, earthquake and flooding.
3. The likely impact of a seismic event needs to be reviewed once better hazard information is available.

5.2 Potential Mitigation Projects – Lifelines Organisations

The following projects were identified in sector workshops in August 2018. These are a combination of risk mitigation projects (e.g. storage upgrades) and improvements to response processes.

Sector	Potential Projects
Electricity	▪ Provision of black start capacity in the region (to enable electricity generation within the region if transmission links fail) and exploration of accompanying reverse livened island (NG and Dist) network configurations. ▪ Improved alternate road access routes for emergency response and repairs. ▪ Improved contingency planning (all sectors). ▪ Alternative communication methods. ▪ Additional provision of critical spares and strategic placement in areas that may be isolated. ▪ Planning for extra resources (including people) required for a long duration hazard event, e.g. >1month. ▪ Building awareness / self-resilience within the community. ▪ Better compliance and monitoring of vegetation control near lines by landowners.
Gas	▪ Provide redundancy in the electricity transmission supply to nationally significant sites. ▪ Maui pipeline isolation east of the Waitara River to provide security of supply north from Pohokura and McKee Gas Plants (in the event that the pipeline is compromised). ▪ Earth moving equipment assurance supply contracts for critical infrastructure to remediate damage from ash, lahars and earthquake slips. ▪ More storage tanks at the Tank Farm and temporary ship loading equipment.
Fuel	▪ Develop a regional fuel contingency plan (in progress).

Sector	Potential Projects
	▪ Additional fuel tank storage at the Port.
Water / Wastewater stormwater	▪ Backup generators at all water / wastewater sites (or at least extend the coverage). ▪ Consider future water supplies outside the volcanic hazard zones and/or less vulnerable to volcanic ash. ▪ Review generator capability to operate in ash environment. ▪ Provide fuel storage at sites with generators. ▪ Alternative water supply distribution routes for Stratford, Inglewood, Oakura, Okato and Hawera trunk mains. ▪ Building awareness / self-resilience within the community. ▪ Ensure adequate resources to test water for human consumption (e.g. during volcanic ashfall). ▪ Increase treated water storage where there are vulnerabilities in the source / raw water supply chain.
Transport	▪ General upgrades to the road network including road widening, bridge strengthening / raising. ▪ Building alternate routes where there are currently no viable options – including for State Highways between Waitotara and Patea, Mount Messenger and at Awakino. ▪ Increase availability of resources in the region – skilled labour, critical stock, spare Bailey Bridge. ▪ Increase resilience of SH43 for heavy vehicles. ▪ Moving pipeline to other wharves. ▪ Floating discharge or import process. ▪ Condensate storage and production rates.
Telecomms	▪ Increase local spares holdings – filters, gensets, electronics, cable. ▪ Improve communications with power companies to manage generator deployment. ▪ In-house UPS for critical customers (e.g. medical register). ▪ Increase local resources – both people and equipment. ▪ Increase standby battery capacity.

Table 5-1: Potential Resilience Projects

5.3 Next Steps for Taranaki Lifelines

This is the first multi-hazard infrastructure vulnerability assessment completed for the Taranaki region. It has highlighted several areas for further consideration, including:

- Improved / expanded hazard information (for example, potential impacts from a Wellington or Alpine Fault rupture).
- Upgrades to lifeline utility networks (e.g. increasing backup generation on key facilities, increased fuel / LPG storage at the Port).
- The need for to review local resourcing (e.g. location and type of spares).
- Specific contingency planning (for example, targeted response plans by hazards).

It is recommended that the Taranaki Emergency Management Office and Taranaki Lifelines Group:

1. Prioritise the potential actions identified in this Section (those that can potentially be undertaken as a Lifelines Group) and use this as a basis for development of a 3-5-year work programme for the group.
2. Identify and carry out further assessment of risks associated with infrastructure hotspots areas.
3. Maintain and further develop the Lifelines GIS viewer as a tool both for lifeline utilities and CDEM to use for strategic hazard assessment and potentially an operational tool to support response.
4. Review the vulnerability assessments as and when new hazard information is produced.
5. Annually review lifeline utility mitigation actions – including those listed in the table above.

Attachment 1: Glossary

Term	Definition
Asset	The physical hardware (e.g. pipes, wires), software and systems to own, operate and manage lifelines utilities (energy, transport, telecommunications, water). In the broadest sense this includes utility business owners, operators and contractors.
Consequence	The impact of a supply outage on direct customers, usually extending to include the downstream impacts of the outage on society as a whole.
Critical Assets (Sites / Facilities / Routes)	Assets that are especially significant to societal wellbeing and that therefore merit priority attention by utilities in emergency response and recovery. *Note:* Both Infrastructure and community sites / facilities will generally feature in regional lifelines group critical sites / facilities lists.[2] A broad criticality rating of *Nationally Significant, Regionally Significant and Locally Significant* has been used.
Critical Customer	An organisation that provides services deemed critical to the functioning of communities and that rely on lifelines services to function. For this report, these include organisations emergency services, health, banking, Fast Moving Consumer Goods and Corrections services, as well as the lifeline utilities themselves.
Emergency *This definition has been paraphrased from the Civil Defence Emergency Management Act 2002.*	A situation that • is the result of any happening, whether natural or otherwise, including natural hazard, technological failure, failure of or disruption to an emergency service or a lifeline utility; and • causes or may cause loss of life, injury, illness or distress, or endangers the safety of the public or property; and • cannot be dealt with by emergency services, or otherwise requires a significant and co-ordinated response under the Civil Defence Emergency Management Act 2002.
Event	An occurrence that results in, or may contribute substantially to, a utility supply outage (i.e. an inability to continue service delivery). *Notes:* This informal term is often used in by Lifeline Utilities to refer to the onset of a hazard or an emergency. Events can be 'external', i.e. something that happens to the utility, or 'internal', i.e. a breakdown within the utility.
Four R's *Paraphrased from the National CDEM Plan*	Categories that form a framework for emergency planning and post-event actions. New Zealand's civil defence emergency management framework breaks down into four such categories: *Reduction, Readiness, Response and Recovery*. • *Reduction* means identifying and analysing risks to life and property from hazards, taking steps to eliminate risks if practicable, and, if not, reducing the magnitude of their impact and/or the likelihood of occurrence • *Readiness* means developing systems and capabilities before an *event* happens to deal with *risks* remaining after *reduction* possibilities have been put in place, including self-help and response programmes for the general public and specific programmes for *lifeline utilities,* emergency services and other agencies. The term *preparation* is sometimes used • *Response* means actions taken immediately before, during, or directly after an *event* to save life and property and to help communities begin to recover • *Recovery* means efforts and processes to bring about the immediate, medium-term, and long-term holistic regeneration and enhancement of a community after an *event.*

[2] A list in *The Guide to the National CDEM Plan* identifies these and other sectors and areas that should be prioritised in *response* and *recovery*.

Term	Definition
Hazard *Adapted from the CDEM Act 2002.*	Something that may cause, or contribute substantially to the cause of, a utility performance failure.
Hotspot	Place where critical assets of different infrastructure utilities or sectors are co-located. *Notes: It is envisaged that the 'location' will be 'tight' – the underlying principle is 'if a hazard strikes here, several asset-types will be affected'. Bridges often offer good examples. There doesn't need to be a 'supply' relationship between the assets for a hotspot to exist. Simple co-location is the test.*
Interdependence	Relationship between infrastructure types characterised by one's need for supply from another in order for their service to function. *Notes: The supply relationship need be in one direction only: if A needs B, that is an interdependency; B doesn't have to need A as well.* *In Vulnerability Studies, interdependence is usually identified at sector level, but interdependence can also be relevant at site level.*
Lifeline Utility	Lifeline utilities own and operate the assets and systems that provide foundational services enabling commercial and household functioning. *Notes:* Lifeline utilities are defined formally in the CDEM Act to include those operating in the following sectors: electricity, gas, petroleum, telecommunications, broadcast media organisations, ports, airports, roads, rail, water, and wastewater.
Lifelines Groups	Regional collaborations, typically bringing together representatives of utilities, the science community, emergency managers, emergency services and other relevant professionals, with the objectives of improving the resilience of the region's lifeline utilities. Lifelines groups focus on the first two of CDEM's *Four R's*: *Reduction* and *Readiness*.
Likelihood	The probability that an event will occur. *Note:* Depending on the context, 'likelihood' can be applied either to natural hazard return periods (e.g. 1:100 year flood) irrespective of whether a supply outage results, and to *events* (essentially, outage-causing occurrences whatever the cause).
Locally Significant	An asset or facility that, if it failed, would cause a loss of service of local impact (broadly, loss of service to more than 2,000-5,000 customers, or partial loss of service across the country). *Note:* The threshold for 'locally significant' used in regional lifelines projects has varied.
Mitigation	The pre-event, asset-related, steps of a utility to reduce or eliminate supply outages. *Notes: Use of the term mitigation is generally confined to asset- related risk reduction steps. Other steps to reduce or eliminate performance outages (e.g. ensuring access to spare parts, staff training for roles in outage events) are better described as readiness activities.*
Nationally Significant	An asset or facility that, if it failed, would cause a loss of service of national impact (broadly, loss of service to more than 100,000 customers, or partial loss of service across the country).
Pinchpoint	Utility asset or site where a satisfactory alternative is not available, and which is therefore essential to service delivery to *critical sites or facilities*. *Note: Pinchpoint* is equivalent to a 'single point of failure' (a term sometimes used in telecommunications) or 'bottleneck' (a term often used in road transport).
Resilience	The state of being able to avoid utility supply outages, or maintain or quickly restore service delivery, when *events* occur. *Notes: It is sometimes helpful to distinguish:*

Term	Definition
	• *'technical' or 'asset-related' resilience: i.e. the ability of physical system(s) to perform to an acceptable/desired level (and beyond the design event to prevent catastrophic failure) when subject to a hazard event* • *'organisational' resilience: i.e. the capacity of an organisation to make decisions and take actions to plan, manage and respond to a hazard event in order to achieve the desired resilient outcomes. Adaptation by the utility following an outage-threatening event can be an important aspect of resilience.* *Similarly, the broad 'service delivery' resilience focus adopted in this glossary draws attention to three components adopted by the New Zealand Lifelines Committee):* • *Robust assets (bringing in the engineering perspective)* • *Effective coordination pre-event and during response and recovery (participation in lifelines groups and sector coordination entities assist here)* • *Realistic end-user expectations (utilities have roles in fostering an appreciation that occasional outages will occur)* *The National Infrastructure Unit's (NIU's) description of resilience (one of its six 'guiding principles') is 'national infrastructure networks are able to deal with significant disruption and changing circumstances'. The extension to 'changing circumstances' broadens NIU's focus to pressures other than outage events.*
Regionally Significant	An asset or facility that, if it failed, would cause a loss of service of regional impact (broadly, loss of service to more than 10,000-20,000 customers, or partial loss of service across the region). *Note:* The threshold for 'regionally significant' used in regional lifelines projects has varied.
Risk	The effect of uncertainty in meeting objectives. Usually described as the combination of *likelihood* and *consequence*.
Risk Management	A systematic process to identify, analyse, evaluate, treat, monitor, and review *risks* that cannot be reduced. *Notes: Risk management is 'event-specific', i.e. addresses identified risks – likely to be those where the likelihood and consequence are greatest.*
Vulnerability	The utility state of being susceptible to loss of utility service delivery / outages when events occur and being unable to recover quickly. *Notes: The serviceability loss could arise from a failure of the utility's assets or systems, or from any external event. Vulnerability and resilience can be regarded as opposite ends of a continuum.*
Vulnerability Study	A review of and report on utility *vulnerability*, generally done at regional level. *Notes: Vulnerability studies generally include description of interdependencies and may also identify hotspots and pinchpoints.*