Emergency Management Otago
Te Rākau Whakamarumaru Ōtākou

Otago Lifelines Group

Vulnerability and Interdependency Study

2024

October 2024 Version 2.0

Preface

Acknowledgements

This updated study has been undertaken by Toa Consulting on behalf of Emergency Management Otago. The project has been greatly supported by Mel Banks, Lifelines Program Lead, and the wider Emergency Management Otago team.

The document builds upon information collated within previous studies, conducted in 2014 and updated in 2017 by Lisa Roberts, Infrastructure Decisions Limited. This also includes information collated as part of the National Lifelines Vulnerability assessment 2023 and lifeline studies from neighbouring Civil Defence Emergency Management Groups.

Collating new information for this study has required the input, knowledge and time of numerous members of the Otago Lifelines Group, and Emergency Management Otago would like to thank the following for their contributions in supporting this important piece of work:

- Central Otago District Council
- Queenstown Lakes District Council
- Clutha District Council
- Otago Regional Council
- Network Waitaki
- Lakelands Network
- Kordia, Unifone, CountryNet and YRless
- Liquigas, Genesis, and Nova Energy
- Z Energy and NZOSL
- Dunedin City Council
- Waitaki District Council
- Aurora Energy
- PowerNet / OtagoNet
- Dunedin and Queenstown Airports
- Woolworths NZ and Foodstuffs
- KiwiRail
- New Zealand Transport Agency Waka Kotahi

Disclaimer

The information contained within this study has been provided by members of the Otago Lifelines Group and from publicly available material. While every effort has been made to ensure this information is correct at the time of issue, the information is maintained by a third party and may have changed since completion of the study.

The hazards information has been collated from available sources, including the Otago Regional Council Natural Hazards Database and scientific studies. Otago CDEM take no responsibility or liability for the use of the hazard information included in this study by lifeline agencies to support other projects or decisions on future infrastructure developments.

Document History

Versions	Issue date	Notes	Name / Org
1.1	June 2024	Draft provided for review	Jim Tetlow, Toa Consulting
1.2	August 2024	Final draft for consultation	Jim Tetlow, Toa Consulting
2.0	October 2024	Amendments from review included and Final version issued	Jim Tetlow, Toa Consulting

Contents

Foreword

Matt Alley, Group Manager, Emergency Management Otago

As the Otago region continues to evolve and face new challenges, it is of utmost importance to comprehensively understand and address its vulnerabilities. This vulnerability assessment serves as a crucial tool in guiding the region toward greater resilience and sustainability.

The assessment delves into the intricate web of social, economic, and environmental factors that shape the vulnerable landscape of Otago. By shining a light on these factors, we gain a deeper understanding of the potential risks and threats that the region faces. Furthermore, this assessment presents an opportunity to identify the strengths and capabilities that can be leveraged to mitigate vulnerabilities and build resilience.

Through the collaborative efforts of researchers, stakeholders, and community members, this assessment captures the diverse perspectives and insights that are essential in crafting effective strategies for a more resilient Otago. It is a testament to the collective resolve and commitment to safeguarding the well-being and prosperity of the region and its inhabitants.

I extend my sincere gratitude to all those who have contributed to this assessment, and I am confident that its findings and recommendations will serve as a catalyst for informed decision-making and proactive measures to enhance the resilience of the Otago region.

Introduction

Background

Lifeline service providers play a critical part in the delivery of response and recovery activities following an emergency. However, they are not immune to the impacts of hazards and their ability to deliver services to the community can be greatly affected during major events. This can have impacts on the provision of other key services and hamper the ability for communities to respond to, and recover from, adverse events.

Otago's lifelines providers have both national and regional significance. As a region, Otago is one of the largest producers of electricity into the National Grid. It also has international airports in both Dunedin and Queenstown, a major sea port in Dunedin and critical road and rail connections to neighbouring regions. Significant three waters infrastructure supports the main centres of Dunedin, Queenstown, Oamaru and Wanaka and many of the smaller settlements around the region, such as Cromwell, Alexandra and Balclutha.

The hydroelectric power stations throughout the southern part of the South Island provide for a large portion of the national electricity demand and any loss of these can have significant impacts well beyond the region. Many of these assets are located in the Southern Alps on the Clutha and Waitaki rivers. The Otago region produces approximately 40% of New Zealand's power requirements.

The re-establishment of critical lifeline services can have a huge impact on the response capability of organisations, the provision of welfare to those impacted by an event and the re-establishment of interdependent lifeline services. Understanding the vulnerabilities and potential impacts of different hazards can help preparation for emergency events and the prioritisation for re-establishing services to communities.

To ensure that the impacts of events upon lifeline infrastructure within the Otago region are understood, the **Otago Lifelines Group** has undertaken a review of the previous interdependency and vulnerability studies conducted in 2014 and 2018.

This report builds upon the information collected during those reviews to identify any new areas of vulnerability from the region's main hazards, key interdependencies between lifeline providers and risk reduction activities that have been conducted for critical infrastructure assets previously deemed vulnerable.

Purpose and Audience

This study is intended to support decision making by the CDEM Group and its partner agencies in reduction, readiness, response and recovery activities (the 4R's of emergency management). The document provides background information regarding all the regional lifeline utilities, their exposure to hazards and the impact of loss of service to the communities of the Otago region.

The document is intended to be utilised as a companion to other plans and procedures, rather than a stand-alone response document. As such, this document should be used for reference when consulting documents such as the Otago CDEM Group Lifelines Protocols, the Alpine Fault Catastrophic Response Plan and other hazard specific response plans developed by the Otago CDEM Group.

Conducting the Review

The review of Otago's Lifeline interdependencies and vulnerabilities has utilised the process outlined in the New Zealand Guide to Infrastructure Vulnerability and Resilience Assessments (*Lisa Roberts, New Zealand Lifelines Council 2024*). The review included the following activities:

- Regional workshop to review current risk from key hazards and interdependencies of lifeline utilities
- Review of available hazard information and GIS data sets with critical infrastructure locations
- Identification of critical service providers and interdependencies with lifeline services

The Otago Lifelines Group

Intent

Lifeline Groups are established to ensure that there is clear understanding of the interdependencies between critical services and clear coordination of restoration following an emergency. As such, the Otago Lifeline Group has been established to enable all key asset operators within the region to connect and share information that will support the response to any major emergencies within the region. Generally this includes:

- Carrying out lifelines projects such as hazard studies and specific restoration and management planning
- Encouraging and supporting lifeline utilities to identify hazard impacts, and the associated risks to assets
- Developing and promoting emergency preparedness throughout the partner organisations
- Carrying out risk reduction and readiness initiatives that involve more than one lifeline utility.

Supporting Work

Since the previous study a large number of supporting projects have been conducted that should be referenced in addition to this document. These include:

- Otago CDEM Alpine Fault Catastrophic Event Response Plan
- Otago CDEM Group Priority Routes study
- Otago CDEM Aviation Emergency Support Plan
- Otago CDEM Lifeline Response Protocols
- Otago CDEM Regional Fuel Management Plan

Definitions

The Civil Defence Emergency Management Group

The Otago Civil Defence Emergency Management Group undertakes work across the 4R's (Reduction, Readiness, Response, Recovery) to ensure the region is prepared and capable of responding to major hazards within the region. The CDEM Group consists of the following organisations and agencies:

- Emergency Management Otago
- Otago Regional Council
- Queenstown Lakes District Council
- Central Otago District Council
- Dunedin City Council
- Clutha District Council
- Waitaki District Council
- New Zealand Police
- Fire and Emergency New Zealand
- Hatu Hone St. John Ambulance
- Te Whatu Ora
- Ministry of Social Development
- **Lifeline Utility providers**

The CDEM Group workplan is coordinated by Emergency Management Otago, who are responsible for identifying the needs of the Group in reduction, readiness, response, and recovery activities, including liaison and coordination of the Otago Lifelines Group.

Lifeline Utilities

Lifeline utilities are entities that provide essential infrastructure services to the community, such as water, wastewater, transport, energy and telecommunications. Lifeline utilities are defined within the CDEM Act 2002 as any entity that:

- Operates the primary Airport in the area
- Operates the commercial port
- Generates or distributes electricity
- Supplies or distributes water
- Provides a waste water and sewage disposal network
- Provides telecommunications networks
- Provides a road network (including state highways)
- Produces, processes and distributes any bulk petroleum products
- Provides a rail network

Civil Defence Emergency Management Act, Schedule 1, Part A, Part B

In addition to the above, several other services are also considered to be Lifelines providers:

- Fast moving consumer goods (Supermarkets etc)
- Financial services
- Waste Management

The duties of Lifeline utility providers are outlined in section 60 of the Civil Defence Emergency Management (CDEM) Act 2002. Every Lifeline utility must:

> (a) 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:
>
> (b) make available to the Director in writing, on request, its plan for functioning during and after an emergency:
>
> (c) participate in the development of the national civil defence emergency management strategy and civil defence emergency management plans:
>
> (d) provide, free of charge, any technical advice to any Civil Defence Emergency Management Group or the Director that may be reasonably required by that Group or the Director:
>
> (e) ensure that any information that is disclosed to the lifeline utility is used by the lifeline utility, or disclosed to another person, only for the purposes of this Act.

The members of the Otago Lifeline Group are both contributors and consumers of the information contained within this study. This information has been collated to support decision making and planning across all partners in readiness, response and recovery.

Otago's Lifelines Infrastructure

Energy Sector

Electricity

Electricity is an important lifeline used in daily life and heavily supports people's well-being. From an interdependency perspective, it is needed to treat and distribute water, operate telecommunications networks, run railways and ports, refine and distribute fuel and gas, and allow other lifelines to function.

Maintaining a reliable electricity supply is core to the business of electricity generation, transmission and distribution. Key facets of resilience include:

- Ensuring a reliable supply of electricity
    - New Zealand is transitioning to using more renewable energy sources at the same time as experiencing higher peaks in winter demand; this means the base supply is becoming more variable, and so, at times over winter, energy security may be reduced more often in future.
- Designing and building networks to have redundancy.
    - The national grid connects to most generation sources, so if any single generation is isolated, supply will be maintained at normal demand levels. However, energy security will be reduced.
    - Most critical parts of the transmission and distribution network operate with at least n-1 security (have alternate supply paths). However, if alternate paths are also damaged, then outages are likely.
- Designing critical assets so that they minimise the impacts of natural hazards.
    - Assets can be designed to minimise the impacts of natural hazards. However, this will be up to the threshold, as set by the risk tolerance of the network owner.
- Locating critical assets in lower-risk areas where circumstances allow.
- Maintaining staffing capacity and capability to maintain and repair assets when required.
    - Maintenance and repair of networks require appropriately trained and skilled personnel.
- Developing response plans, and standard operating procedures that support the timely repair of the network and damaged assets when outages occur.
- Ensuring stocks of critical spares and equipment are held so that networks can be repaired promptly.
- Provisioning of backup electricity (generators and batteries) at key distribution sites to maintain communication and control of substations during outages.

Sector Overview

Electricity networks are broadly comprised of the following:

- Generation sources.
- Transpower's national transmission grid connects to electricity line distributors and some larger direct connect customers.
- Electricity lines distributors, which connect to the national grid and distribute to consumers.
- Electricity retailers that buy wholesale electricity and sell to consumers (not part of the scope of the programme as they do not operate network assets)
- Consumers.

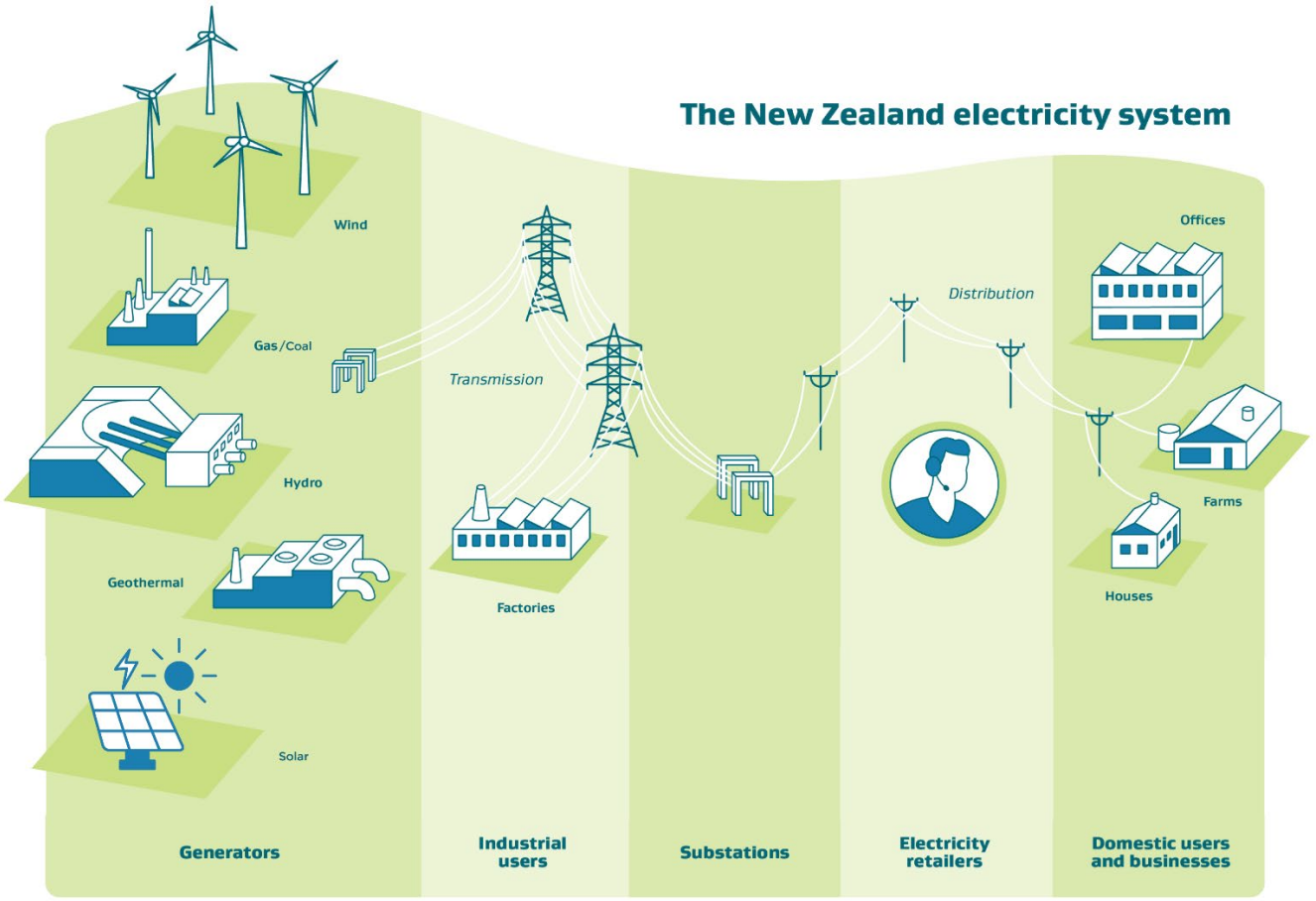


Figure 1 - The New Zealand electricity system

Generation

Electricity generation in the region leverages primarily natural resources (hydro, wind, solar); a significant amount of New Zealand's electricity is generated in Otago primarily through hydropower generation. The growth in renewable energy has seen a drive upward of energy production from Geothermal and Wind (hitting record highs in 2022).[1]

[1] https://www.mbie.govt.nz/assets/energy-in-new-zealand-2023.pdf

Otago's electricity generation sites currently include:

- **Contact Energy's** two hydropower stations, Clyde (432MW) and Roxburgh (320MW), on the Clutha River, produce nearly 10% of New Zealand's electricity. The Clyde Hydropower Station is a critical site as it also houses the Control Centre for the Roxburgh and Hawea Dams.
- **Meridian's** six hydropower stations, Ohau A/B and C, Benmore, Aviemore and Waitaki in the Waitaki Valley, generate a maximum of 1540MW and supply 20-30% of New Zealand's electricity.
- **Manawa Energy** supplies around 130MW from four schemes that are a combination of wind and hydropower. The largest is Waipori Falls, which generates 72MW.
- **Pioneer Generation's** fifteen generation sites, which are a combination of hydro, gas and wind, generate a total of 43MW. No single site produces over 10MW.

Figure 2 - Clyde Dam (Left) and Waipori Falls (Right)

Most electricity generated is injected directly into Transpower's national grid at switchyards, except for some of Manawa Energy's and all of Pioneer's generators, which are embedded in the local Aurora Energy distribution network.

Manawa Energy (formerly 'Trustpower') operates the following power schemes in Otago:

Paerau / Patearoa	Paerau	Hydro	12MW
Waipori	Deep Stream	Hydro	5MW
	Waipori	Hydro	84MW

Loss of any single power generation dam or station should not cause a loss of supply to customers unless it occurs concurrently with another generation failure or during peak demand periods in winter. Meridian's and Contact's stations are rated criticality 1 (except for Lake Hawea, rated a 2), and Manawa's stations are rated 3, based on the national vulnerability study.

Solar Generation

Large-scale solar is one of the lowest impact and lowest cost form of energy. Since 2021 a number of solar farms have been commissioned across the country (Wairau Valley, Marlborough; Kapuni, Taranaki; and Kaitaia, Northland), and there are ~25 in the planning stages (2023)[2].

As at June 2024, Helios Solar have plans to seek consent for a 660ha solar farm (producing 300 megawatts) near Naseby on the Maniatoto (Otago region), with the intent to connect into the existing Transpower substation on Fennessy Road. The farm could produce power for approximately 70,000 households (roughly 60% of the dwellings in the region[3]). If approved, construction will begin in 2026.

[2] https://www.mysolarquotes.co.nz/blog/solar-power-news-in-new-zealand/wave-of-grid-scale-solar-arriving-for-2023/

[3] Based on dwelling counts in the 2018 census

Transmission

Transpower's transmission lines are rated as criticality 1 (>200MW), criticality 2 (>50MW) and criticality 3 (all other lines). The highest capacity line is the 350kV HVDC line from Benmore to Haywards (Wellington), the loss of which would result in a loss of transmission capacity between the North and South Islands.

When all generators operate at installed capacity, each island can generate sufficient capacity to meet demand within the island when supply is at normal operating levels; however, peak winter load demand will reduce each island's security.

There are several highly critical switchyards and substations, most significantly:

- Benmore is a major hub that includes the southern end of the HVDC line.
- Halfway Bush substation supplies a large Dunedin area, including the CBD.
- South Dunedin substation, servicing that area of Dunedin.
- Three Mile Hill is a key switching station supplying the Halfway Bush and South Dunedin substations.
- Roxburgh and Clyde switchyards are key national grid transmission hubs.
- Cromwell substation supplies the wider Queenstown, Wanaka and Cromwell areas, noting that Frankton substation connects the Cromwell substation to Queenstown.

Most large switchyards have redundancy within the substation, so the failure of a single asset or circuit is likely to reduce security rather than a loss of supply. The transmission companies also have their own communications networks, which enable communications in remote areas where other services are unavailable and allow remote network control.

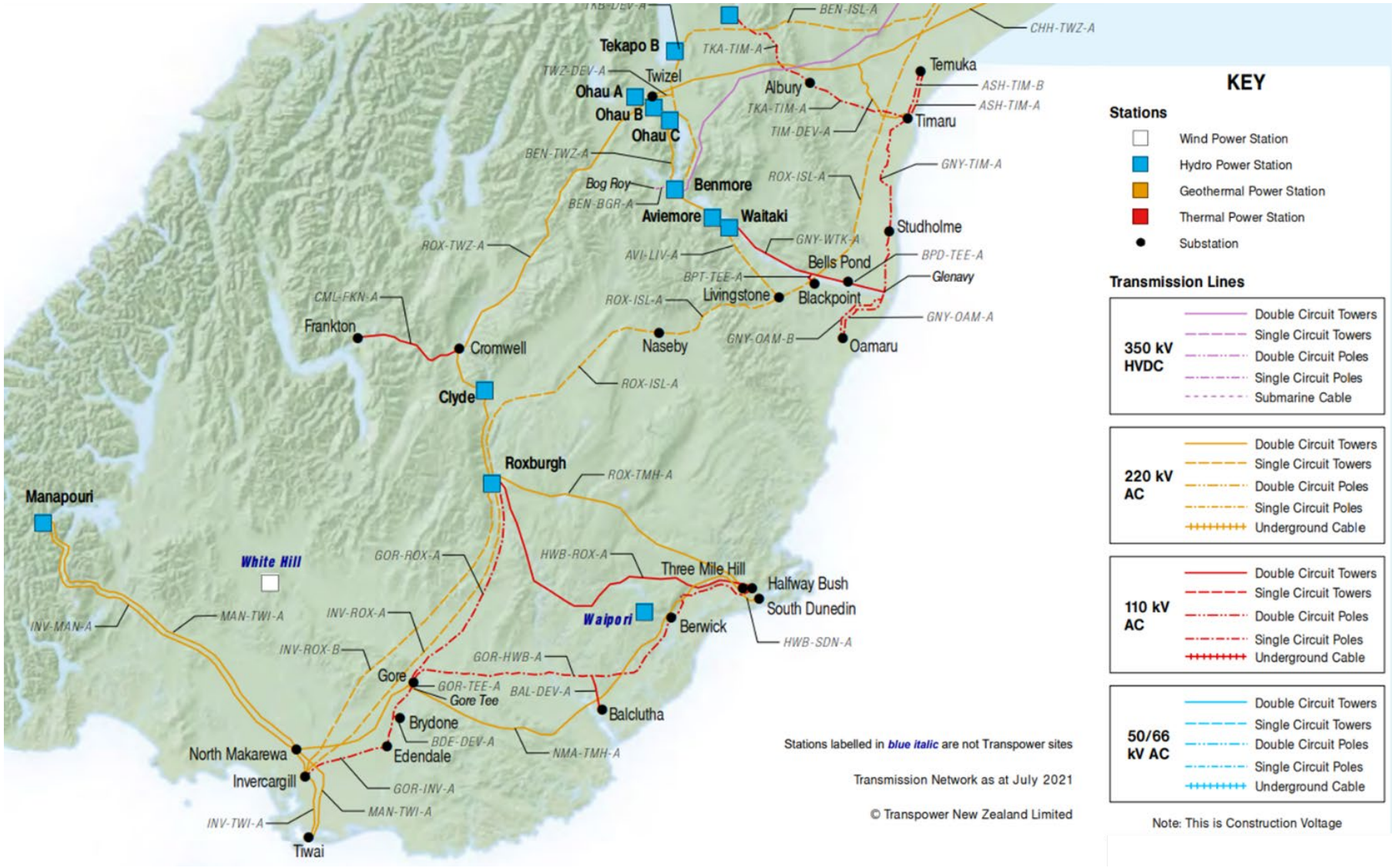


Figure 3 - The National Grid (cropped to Otago Region)

Distribution

Transpower manages and operates the national grid and supplies the four electricity line companies in Otago:

Aurora Energy

- Supplies electricity to around 97,000 customers in Dunedin and Central Otago
    - Dunedin: 57,000 customers
    - Queenstown: 15,000 customers
    - Central Otago & Wanaka: 24,000 customers
- Delivers around 1400GWh annually.
- Maintains a network of around 6,300km of lines and cables and 36 zone substations.
- Transpower supplies Aurora Energy at five GXPs;
- Dunedin: Halfway Bush GXP and South Dunedin GXP
- Queenstown: Frankton GXP
- Cromwell & Wanaka areas: Cromwell GXP
- Alexandra, Roxburgh and Omakau areas: Clyde GXP
- Aurora Energy has two Network Operating Centres, one based in Dunedin, the other in Cromwell.
- Aurora Energy partners with Delta Utilities Ltd, who is Aurora Energy's primary field-based fault response provider

PowerNet/OtagoNet

- Supplies electricity to around 15640 customers.
- Covers a large area with a network of around 4503km of lines, cables, and 32 zone substations.
- Delivers around 442GWh annually.
- Direct connects to Transpower at four GXPs: Balclutha, Naseby, Frankton and Halfway Bush.

Lakelands Network

- Supplies approximately 4800 customers – a completely underground network.
- A direct connection to Transpower at Frankton GXP supplies 1 zone substation at Frankton (approx. 3855 customers)
- Delivers around 55GWh annually.
- The remaining portion of this network is embedded (islanded) within Aurora Network:
    - 1 x embedded network in Queenstown (Te Pa Tahuna – approx. 30 customers)
    - 2 x embedded networks in Wanaka (Clearview/Northlake – approx. 785 customers)
    - 1 x embedded network in Cromwell (Wooing Tree – approx. 130 customers)

Network Waitaki

- Supplies approximately 13,400 consumer connections
- Network of 1,900km of power lines
- Delivers around 274GWh annually
- Directly connects to Transpower at four GXPs: Oamaru, Black Point, Waitaki, and Twizel.
- Oamaru is the largest, supplying around 10,500 people. The Weston Switching Station (Network Waitaki) is also critical to the supply of electricity to these people.

- Network Waitaki has identified some 33kV lines as critical because of a lack of alternate distribution routes.

Figure 4 - Distribution Companies in NZ (updated July 2023)

Petroleum/Fuel

Currently all refined fuel in New Zealand is shipped from overseas via fuel tankers which discharge at ports across the country.

New Zealand no longer runs its own coastal tanker service. Additional pipelines are used to move fuel overland to storage farms, and the rest is trucked/tankered from the fuel terminals.

Pipelines currently in use are Marsden Point to Wiri (operating at 50% capacity), and Lyttelton to Woolston (and the Wiri pipeline is identified as a nationally critical asset).

Z energy sources its fuel through Ampol (previously Caltex), trading through Singapore. The Z Energy brand supplies roughly 40% of all fuel volumes in New Zealand (2024).[4]

New Zealand Oil Services (trading as BP) brings its fuel in through Australia (sourced from other countries such as Korea or Malaysia).[5]

Bulk Storage

Fuel comes into the region via ~27-30 annual bulk fuel shipments to Port Otago's oil berth. It is piped from the berth to three terminals on Dunedin's waterfront:

- Z Terminal (10Ml petrol, 500kL diesel)
- Secondary Z Terminal (12Ml of diesel, 5Ml of light fuel for ship bunkering).
- BP Terminal, operated by NZ Oil Services Ltd (7Ml of petrol, 6Ml of diesel and 0.9Ml of jet) – the jet fuel supplies airports in the Otago and Southland regions. An additional 2ML of jet fuel storage capacity is in development for BP Dunedin.

Mobil's Bluff terminal supplies their Southland sites, while the Otago sites are supplied from the BP terminal in Dunedin. Their terminals have capacity to hold around 2 weeks jet fuel demand and 1 month petrol/diesel.

Demand during emergency events is generally for Diesel (emergency vehicles, lifelines contractors etc.). For any significant event, the national fuel emergency working group takes over fuel management (directives, rationing, deployment). Fuel is stored in other sites across New Zealand, with Bluff, Timaru and Lyttleton the nearest alternate major sources of fuel.

Key Sites/Assets

BP (NZOSL)	• Bulk terminal based **in-region**, at Dunedin City • Bulk terminal located to the north in Lyttleton • Aviation facilities at Christchurch Airport • Supplies Jet Fuel to Queenstown Airport by road
Z Energy	• Bulk terminal based **in-region**, at Dunedin City • Bulk terminals located to the north at Lyttleton and Timaru • Aviation facilities at Christchurch Airport
Mobil	• Bulk terminals located to the north and south of Otago region: Woolston, Lyttelton, and Bluff. • Two unused aviation fuel tanks at the Christchurch Fuel Farm (2020)
Gull	• Minimal presence in South Island – managed through RD Petroleum

[4] https://www.ampol.com.au/about-ampol/who-we-are

[5] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-publications-and-technical-papers/energy-in-new-zealand/energy-in-new-zealand-2023/oil

Timaru Oil Services (Tasman Fuels)	• Terminal storage at Port of Timaru

The majority of sites which are significant to the fuel and gas sector are located in Dunedin City, and adjacent to the Port. The one exception being the Nova Energy storage site which is in an industrial area in South Dunedin and is flanked by commercial real estate.

Figure 5 - Fuel and Gas Sites – Dunedin City (updated from previous study, 2015)

Supply Redundancies

All of Otago's fuel is normally supplied by the Dunedin City terminals, however if needed, Otago's fuel can be trucked in from Timaru, Lyttleton or Bluff. In the event of a major spill, both will be able to continue operation, however this may at a reduced capacity.

The primary fuel terminals in Dunedin City have indicated that should communications be lost or the sites need to go 'off grid' there are a number of different options for risk mitigation. Both terminals are able to default back to operating off SCADA, which is able to operate offline. There are no back-up communications methods to talk between terminals currently, and satellite phones/units are not owned/spread consistently across the network of terminals in New Zealand.

A key risk for Otago's fuel infrastructure is a total loss of electricity: while some gravity-feed is able to be used to secure fuel supply to a generator, in order to power the terminals themselves (and standard fuelling operations) the operators require heavy duty GenSets, of which there are very few in the South Island, and none of which are located in Otago.

Should back-up generation be required, the closest available GenSet would likely be Christchurch via NZOSL (ETA 4-5 hours on good roads). Z currently has 1x 300kVA generator in the North Island.[6]

In Dunedin the two terminals are supplied via a pipeline, running from the berth to each farm. Within this pipeline are two product lines – one for petrol, one for diesel. In the event of significant damage to one of these lines, there is the potential for the products to be swapped/run down the alternate line as required (e.g., petrol down the diesel line and vice versa): however, this has not been tested and would only be tried in the event of the appropriate product line being unusable.

Minimum Stock Obligations

The Fuel Industry (Improving Fuel Resilience) Amendment Bill, which will provide the statutory framework for the minimum fuel stockholding obligation (MSO), was introduced in June 2023 and will be a requirement from 1st January 2025.

The minimum stockholding obligation aims to ensure a sufficient supply of petrol, diesel and jet fuel to help mitigate the impact of any major disruptions to our national fuel. The MSO will be applicable to the five fuel importers with access to bulk storage facilities – BP, Gull, Mobil, Tasman Fuels and Z Energy. The minimum levels for fuel importers will be an average of:

~ 28 days' use of petrol	**~ 24 days' use of jet fuel**	**~ 21 days' use of diesel**

Outside of the MSO, each terminal also has its own 'operational minimum' which varies by tank.

Distribution

Fuel is distributed from Z terminals by two operators (Move Logistics and Allied Petroleum) and two operators from BP (RD Petroleum and Allied Petroleum) to fuel stations and customers around the Otago region. There is no consolidated view of service station numbers and capacity, nor the extent of backup generation for pumping at these sites. This is an area for future work.

Aviation Fuels

Dunedin and Queenstown airports are supplied by tanker to their onsite bulk stores. Wanaka and Taieri are unmanned sites. Other smaller stores may be held at airfields and aerodromes, however these are not considered large/bulk supplies.

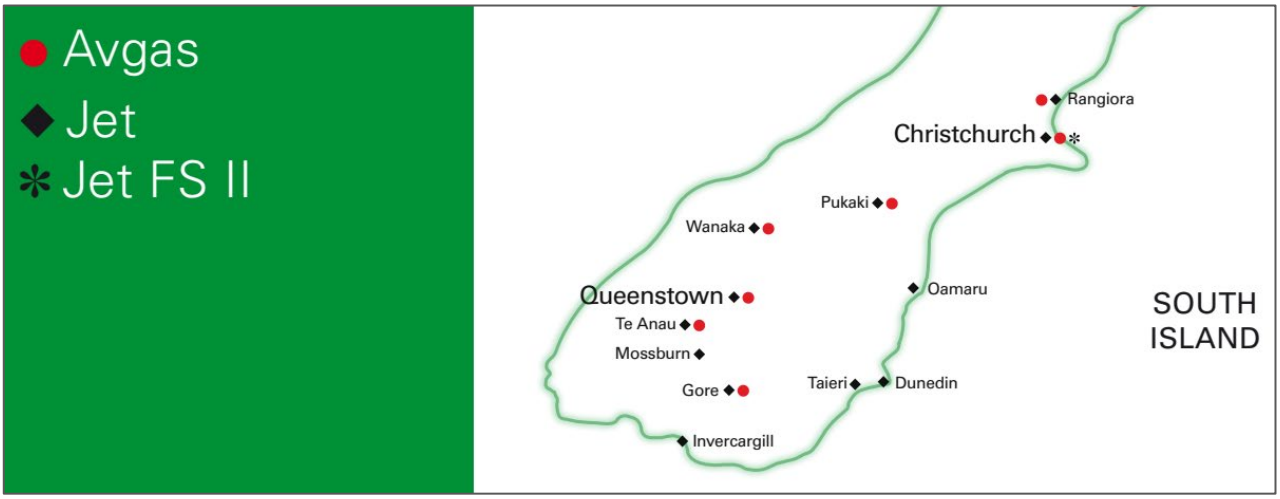


Figure 6 - Aviation fuel storage locations

[6] Project underway FY 2024/25 for procurement of GenSets for terminals across New Zealand (A Robinson, Z Hawke's Bay)

Road Transportation

Fuel distribution in New Zealand is highly road dependent, and large areas of Otago region are totally dependent on trucked fuel. Fuel is not moved by rail in New Zealand, nor is there capacity/capability to move fuel by air (even in underslung loads, though some exceptions may occur if using NZDF resources).

Lyttelton to Woolston Pipeline

As with the gas transmission network, this oil pipeline is designed to withstand seismic events but is at risk from major land movement/landslides, third party damage, explosion, or loss of electricity supply to pump stations along the line. Regular inspections, testing, spares and contingency planning are all undertaken to mitigate the risk of failure and facilitate a quick restoration if failure does occur.

Terminal Outages

The operators of fuel storage facilities take risk very seriously, however there are many potential hazards that are challenging to mitigate. The Dunedin fuel terminals are in a tsunami hazard-prone area and are dependent on the electricity supply which is in itself vulnerable to hazards. Fire is another risk for oil terminals.

Customer Supply Points

Fuel is stored for supply at retail outlets supplied by the four major oil companies (Mobil, BP, Gull, Z). Some of these are oil company owned and managed, some independently owned and 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.

Other operators also store and supply retail fuel to the wider population, including NPD (Nelson Petroleum Distributors Ltd), Allied Fuels Ltd and the Waitomo Group. These businesses operate both manned and unmanned facilities and are supplied from the main storage in Dunedin and Timaru.

The key vulnerability in the retail outlet network is the dependence on electricity to pump fuel. Only a few stations in New Zealand have on-site standby generation, though some new fuel stations are increasingly being built with 'plug in' generator capability. Regional and local fuel plans are being developed that both highlight and seek to address this key resilience issue.

Private Bulk Stores

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.

McKeown Petroleum are an independent retailer who supply a number of truck stops in the South Island. They have a bulk supply (exact amount unknown) located near Gore which holds diesel and petrol. RD Petroleum also have an inland depot near Invercargill (truck stop) with bulk tanks onsite. In addition, Fern Fuels also distribute bulk fuels from Christchurch to businesses within Otago. Identification (and verification) of private bulk stores (exceeding 1000L) should be considered as a future programme of work (or extension to the existing Regional Fuel Plan).

Findings from the Government Inquiry into the Response to the North Island Severe Weather Events (2024)[7] identified that loss of power to operate fuel stations and run Eftpos systems created difficulties in access/supply of fuel for responders and the public, and those regulations preventing the transport of fuel inside helicopters highlighted a shortage in the number of approved drums available to under-sling fuel.

[7] https://www.dia.govt.nz/diawebsite.nsf/Files/Government-Inquiry-into-Severe-Weather-Events/$file/Report-of-the-Government-Inquiry-into-the-Response-to-the-North-Island-Severe-Weather-Events.pdf

Gas supply

Gas is used in the Otago region for both industrial (e.g., Macrae's Gold Mine) and domestic purposes. Gas is sourced from the Taranaki region and brought to Otago by ship. If there is a failure in the supply chain or insufficient capacity to meet demand, typically in winter, gas can be imported from Australia within 1-3 weeks.

Figure 7 - Gas storage, Port Otago

Liquigas

Liquigas brings in all of the region's LPG supply by ship to Port Otago, with an annual throughput of 20,000 tonnes. This is stored at Liquigas's Dunedin depot which holds 1300 tonnes of bulk LPG before being distributed by road tankers to 4 LPG distributors in the region – Genesis, Rockgas, Vector Ongas, and Elgas.

Gas distribution at Liquigas relies on electricity and there are no emergency generator facilities onsite. Communications for the site (SCADA) is backed up for two hours on an uninterrupted power supply (UPS). The nearest bulk storage site is Liquigas in Woolston (Christchurch).

Rockgas

RockGas takes LPG shipments through the Dunedin port into Liquigas Dunedin, where product gets uplifted by bulk tankers (Alexanders). Rockgas has reticulated LPG systems in Wanaka and Queenstown. There are branches and franchises in the region that provide LPG bottle deliveries to business and houses as needed (from tanks filled by the same Alexanders tankers).

Genesis

Genesis supplies LPG to reticulated customers in Dunedin (via over 33km of underground pipe) as well as to their cylinder customers. The most critical sites for Genesis include the LPG Vapourisation Facility on Hillside Road and the 20 tonne tanks at Balclutha and South Dunedin, the latter supplying key industrial customers. ***See appendices for maps of the Genesis gas network.***

As well as Genesis, three other gas providers in the Otago region include:

- Rockgas, which provides a reticulated gas supply in Queenstown and cylinder distribution services.
- Vector Ongas, which provides bulk support to service station outlets in Dunedin, a reticulated gas supply in Wanaka, mainly around the business district and cylinder distribution across the wider region (based in Wanaka).
- Elgas which provides bottled gas only

Future Fuels - Hydrogen

Utilising its Allied Petroleum refuelling station network that operates throughout New Zealand, HW Richardson Group will produce, distribute and utilise green hydrogen within its heavy vehicle fleet by adding hydrogen refuelling capability to its existing and new sites. The first refuelling station (in Gore) is due to be operational in April of 2024 with an initial fleet of 10x duel-fuel hydrogen trucks in the South Island.

Meridian, with the support of Ngāi Tahu, and partners Woodside Energy and Mitsui Ltd are moving forward to the development stage of the Southern Green Hydrogen (SGH) project, which aims to develop a 500,000 tonne per year hydrogen and ammonia production facility in Southland utilising electrolysis and renewable electricity. This is anticipated to be a five-year project, commencing in 2023.

While the above projects may have relevance to the current lifelines environment in Otago, this is a space to be aware of for future reviews of this study.

Sector coordination in an emergency

The fuel sector operates a Sector Coordinating Entity (SCE) in readiness and response chaired by the Ministry of Business, Employment and Innovation (MBIE) and is made up made up of the key industry distributors/operators. This group plans and prepares for the requirements of response in a major event as part of the National Fuel Plan and supports/coordinates delivery of the plan in an event. The National Fuel Plan is facilitated by CDEM Group fuel plans created in collaboration with the key operators/distributors within the region.

In an event the response level will determine the appropriate level for sector coordination as shown in the response framework below.

Escalation Level	Description
Level 1: Minor Impact on Fuel Sector	• Potential for escalating fuel supply disruption to Levels 2-3 but minimal current impact on fuel distribution. • Fuel companies notify Fuel SCE Chair and start planning for potential disruption. • Fuel SCE convened to monitor situation and start planning for potential escalation. • NEMA notifies CDEM Groups (noting CDEM Emergency Operations Centres (EOC's) and Emergency Coordination Centres (ECC's) may already be activated if this is part of wider emergency).

Escalation Level	Description
Level 2: Moderate Impact on Fuel Sector	• Moderate fuel distribution impacts, most customers still serviced but causing risk of shortages to critical fuel customers. • Fuel SCE activated (Section 4.2.2) to monitor demand levels and re-supply options and coordinate Government support as required for the fuel sector (Section 5.4). • Critical Fuel Customer prioritisation is invoked (Section 5.7). Fuel companies to take steps to ensure critical customers are supplied. Government powers may be used to enforce this. • CDEM ECCs maintain list of critical customers and communicate changes to national LUC and local service stations. • State of emergency may be in place (see note).
Level 3: Major Impact on Fuel Sector	• Serious impact on fuel distribution with severe resource and capacity constraints and multi region and/or major impacts to critical customers. • Actions as above, plus additional demand management measures implemented (Section 5.6 and Section 5.7) and coordinated through the Fuel SCE. • State of emergency likely to be in place (see note).
Level 4: Severe Impact on Fuel Sector	• Severe impact on national fuel supplies and resource and capacity limits well exceeded. • Actions as above, plus fuel companies to supply only critical fuel customers and these customers to be serviced by any supplier. • State of emergency likely to be in place (see note).

Note: The level of activation of CDEM and declaration of emergencies will not necessarily follow the level of fuel disruption if a wider emergency is in place.

Figure 8 - Description of Escalation levels for Fuel Response[8]

[8] National Fuel Plan [04/24], Section 4.2 Escalation and activation of arrangements, Page 39.

Telecommunications

Telephone, internet, and broadcast services in the Otago Region are provided in a variety of ways due to the challenge of distance, topography, and network vulnerability. Although wired network reach is increasing, so too is the use of wireless or satellite solutions. The high demand for subscription services also poses challenges due to the constrained capacity of frequencies, and during emergencies when the load is high, those outside wired areas may struggle to gain connectivity or to transmit information.

Figure 9 - Wireless Communications in Everyday Use (Rural Connectivity Group)

Copper Network

Chorus is retiring its copper lines – which means phasing out the availability of broadband and phone services that use this network. This will only apply to areas where fibre is available.

As at the 2018 census, 65.1% of households still had access to a landline phone.

As well as the withdrawal of the copper line, Spark is also phasing out the Public Switched Telephone Network (PSTN), an analogue network that connects voice calls over copper lines, which is reaching the end of its lifespan. Once the PSTN is removed, those with an old home phone connected to the copper network will need to switch to an alternative phone service.

The impacts of losing this service are that power outages have a significant (and immediate) impact on VoIP services (i.e., Voice Over Internet Protocol, which requires electricity to operate) and fibre usage.

Mobile/Cellular

In 2017, the Rural Connectivity Group (RCG) was appointed by the government to be the infrastructure provider to bring 4G wireless broadband, 4G voice calling (VoLTE) and 3G mobile service to rural New Zealand under the Rural Broadband Initiative 2 (RBI2) and the Mobile Black Spot fund (MBSF).

In June 2024, the 500th 4G cell site went live. Each site gives remote coverage to all three mobile network operators (Spark (including Skinny), One NZ (previously Vodafone), and 2degrees).

Over the past few years, mobile providers have introduced 4G coverage for voice calls as well. This is otherwise known as VoLTE – which stands for Voice over Long Term Evolution (with LTE being the technical term for 4G).

One NZ

In early 2023, Vodafone was rebranded to One NZ, and launched its 'Starlink for Business' offering (**see section on 'Satellite'**). One NZ operates mobile network services in Otago providing 2G/3G/4G/5G across the region (with 5G mainly focused in urban centres).

One NZ operates a high-capacity fibre-optic transmission ring that passes through Dunedin in the east, south to Invercargill, and up through Queenstown in the west. Consumer fixed-line voice/data services are also provided through the region under wholesale from Chorus.

One NZ has around 60 cell sites[9] providing cellular services in the region and 200 fixed-line service sites (exchanges and roadside cabinets). They identified 3 sites as 'regionally critical', including:

- The Dunedin POP (Point of Presence): from where fixed line services into Dunedin are provided.
- The Balclutha POI (Point of Interface): provides a voice interconnect between One NZ fixed-line and other networks in the region.
- Northeast Dunedin Radio Access Network transmission hub.

Spark

Spark owns cellular and landline exchanges plus some fibre trunks and links. Spark exchanges have duplicated processors on each site and there is diversity in the 'daisy chain' networks which allow some exchanges to be fed from the other direction if a cable fails. **Skinny Mobile** leverages the Spark network and therefore has similar coverage.

Other Providers

- **2degrees,** which owns a number of cell sites in the region
- Kordia (50% telecommunication services)
- FX provides a fibre optic trunk network across New Zealand
- One NZ trunk fibre networks (parallel and in some cases, shared with Chorus and Spark

For cellular/4G coverage maps, see: Appendices.

The Rural Broadband Initiative

Since 2017, the government has been working in collaboration with Chorus and One NZ to roll out the Rural Broadband Initiative (RBI), which aims to get 99% of New Zealand's population online with fast broadband. The options currently available for rural broadband in New Zealand are:

- Copper line ADSL or VDSL – "regular" broadband (being phased out)
- 5G/4G/3G – wireless mobile network
- Wireless broadband – available in areas where towers are installed
- Satellite – for those outside of wireless range
- Fibre – in urban-adjacent areas where cabling is available

[9] This number is from the previous report, and may be outdated.

New tower sites are prioritised by the number of people they can service, the more people in an area, the more towers that can be built, and the greater the available bandwidth for those residents.

Rural Broadband Initiative (RBI) - **3G or 4G**	Utilises the radio spectrum (same as cell phones) to provide wireless broadband connectivity between two fixed points (i.e., a cell tower and a device).	• Relies on cell tower/network tower connectivity and power supply. • Subject to slowing with load. • Radio signal is shared with multiple users and degrades over distance.
Fixed Wireless Access (FWA) - **4G or 5G**		

Systems such as RBI or FWA rely on network towers (cell towers) to transmit the radio signals, in remote areas the signal will be passed along a series of towers that communicate like an invisible phone line.

A clear line of sight is required from tower to tower, and tower to customer, to create a connection.

Some hazards such as earthquakes, storms, cyber-impacts, power loss etc., may cause one or more towers to be damaged or taken offline, this has the potential to remove connectivity for the relay.

The Rural Connectivity Group links all 3x cell networks through a single tower: [10]

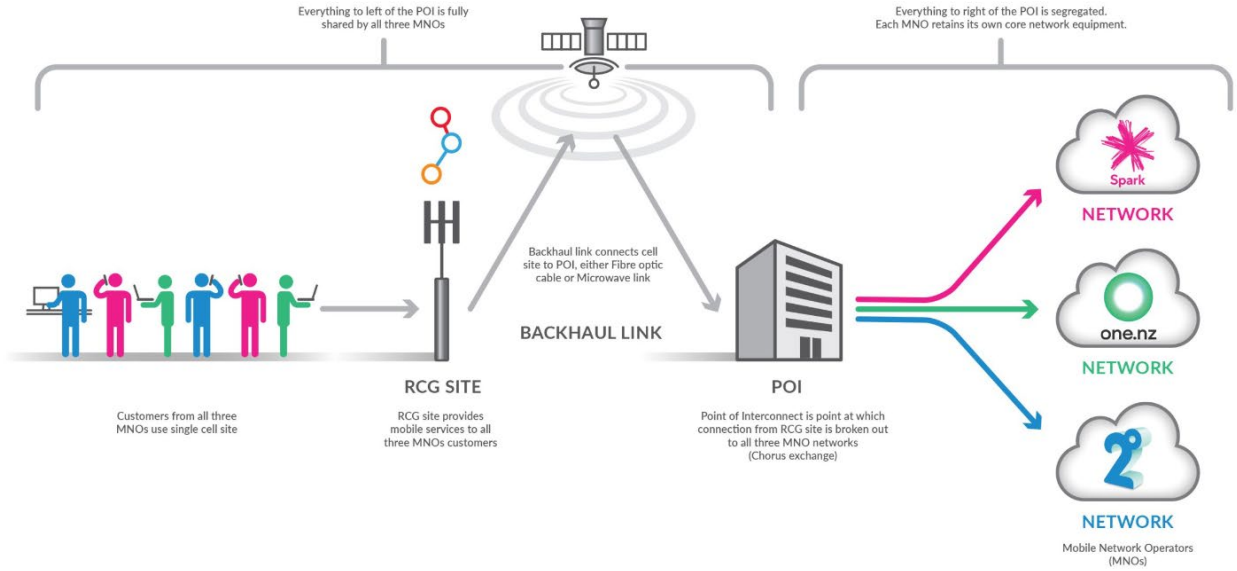


Figure 10 - Rural Connectivity Group

[10] https://www.thercg.co.nz/rcg-network/

Broadcasting

Two service providers – Kordia and Johnston Dick and Associates (JDA) are the main players in the traditional television and FM radio broadcasting transmission markets, while Radio New Zealand (RNZ) is the main provider of AM broadcasting transmission services. In terms of service coverage in Otago, JDA transmits from sites in Timaru and Invercargill, with a significantly smaller footprint overall.

A number of RNZ AM sites have already or are in the process of, being shut down, with full closure to occur by 2031 – coinciding with the year in which management rights for spectrum expire. Since the 2015 study, broadcast consumption behaviours and changed with the advent (and proliferation) of digital applications (Apps), radio can now be accessed via DTT or direct-to-home (DTH) satellite as well as on computers, handheld devices and traditional radios. [11]

Kordia

Kordia owns and operates the digital television platforms in New Zealand – digital terrestrial television (DTT) and direct-to-home (DTH-satellite). Kordia's Mt Cargill Transmission facility in Dunedin's North East Valley is the main broadcast transmission site for Dunedin, providing Freeview Digital Terrestrial Television and all FM radio services.

Kordia provides a managed environment (watertight, ventilated, and powered) with associated towers (antenna aperture) for others to locate their transmission equipment, such as Spark, One NZ etc.).

Loss of the Mt Cargill site would cause almost total loss of broadcast services in the wider Dunedin area (FM), rating it as a Criticality 1 site.

Mt Cargill has back-up power generation onsite and its own fuel supply. At full capacity the fuel storage will allow for up to 17 days of transmission.

In the event of a full failure of the site, Kordia would deploy services from alternate sites, however, with reduced height, the coverage of Dunedin (to some dependant translators) may be limited.

Queenstown / Wanaka: Kordia provides limited services in these towns across a number of sites (Mt. Maude, Queensberry, Big Hill and Queenstown) and doesn't have any back-up power generators on site. However, there is the ability to run these sites on batteries for 8 hours with a power inlet box for a generator to be plugged into. This site would require a 7.5KVA generator or larger to operate at full capacity.

Alexandra / Cromwell: The Kordia site is located at Obelisk and has back-up power generation onsite and its own fuel supply. At full capacity, the fuel storage will allow for up to 13 days of transmission.

Oamaru: The Kordia site is located in Oamaru. This site doesn't have any back-up power generation, however there is the ability to run this site on batteries for 8 hours with a power inlet box for a generator to be plugged into. This site would require a 7.5KVA generator or larger to operate at full capacity.

Balclutha: Kordia has no services in this area, but FM services from the Kordia site in Kuriwao covers this area.

11 https://comcom.govt.nz/__data/assets/pdf_file/0033/286179/Network-Strategies-Broadcasting-transmission-services-market-review-1-June-2022.pdf

Kordia operates a number of other sites including Mt Studholme, Razorback (Oamaru), Mount Stuart and Kuriwao. These sites would also require the sourcing of back-up power supplies in a major event of 7.5KVA or more to continue operation.

In all events Kordia would require road access to maintain the operation of their sites. In addition, they would require support from CDEM to source appropriate generators to provide backup power for several sites.

There are a significant number of radio stations which transmit from sites other than Mt Cargill, and could be used for back up broadcast/communications if required. To view the full list, see: https://en.wikipedia.org/wiki/List_of_radio_stations_in_Otago

Vital (previously TeamTalk)

Vital runs an eDMR network (ethernet Digital Microwave Radio) across the South Island. Digital Microwave Radio uses radio waves to deliver resilient internet (and is connected back into the fibre network).

Vital also runs a Digital Radio network as well as FleetLink (an analogue Land Mobile Radio network with nationwide coverage). In 2022 core sites in the FleetLink Network were upgraded to MPT-IP (including the commissioning of 325 new Tait MPT-IP repeaters).

Vital supply/maintain/support the radio network for St Johns Ambulance, making them a key lifeline utility provider.

Mobile Radio (HF / VHF / UHF)

Radio is still a key asset within the region for communication and is used by multiple agencies. Radio communications come in three main forms – Ultra-high frequency (UHF) and Very-high frequency (VHF) and High frequency (HF) and can be used in both analog and digital formats. Digital mobile radio (DMR) generally enables clearer and more consistent sound quality at distance, enables higher capacity on a frequency and encrypts communications.

HF Network

HF networks operate between the frequencies of 3 to 30megahertz and allow long distance broadcast in New Zealand. HF utilises both direct line of sight and the earth's atmosphere to bounce radio signals further, rather than relying on cables or satellite. It is still utilised for maritime (known as Single-side band SSB), aircraft communications and by amateur radio enthusiasts and some commercial operators.

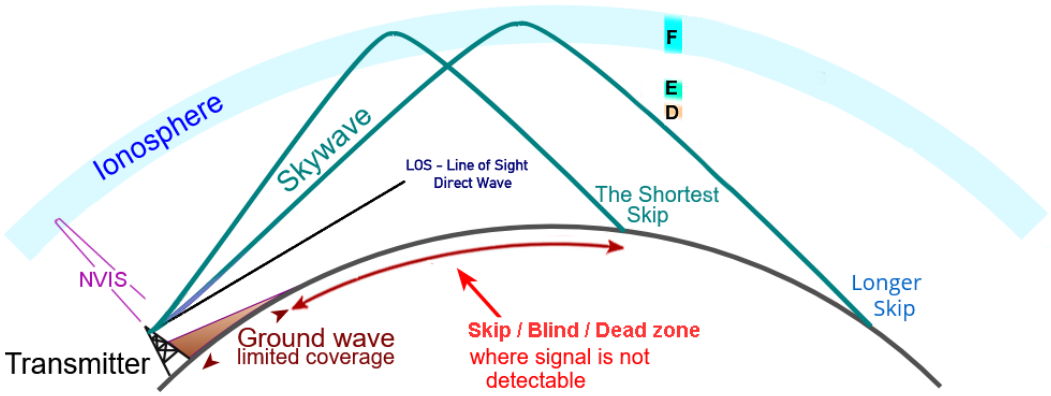


Figure 11 - Transmission using radio waves

VHF Network

The VHF network is probably the most extensive within New Zealand and operated between the frequency of 30 to 300megahertz. Unlike HF radio, VHF utilises line of sight (station to station) or repeaters (intermediary transmitters) to increase the distance a signal can be sent, as shown in the diagrams below.

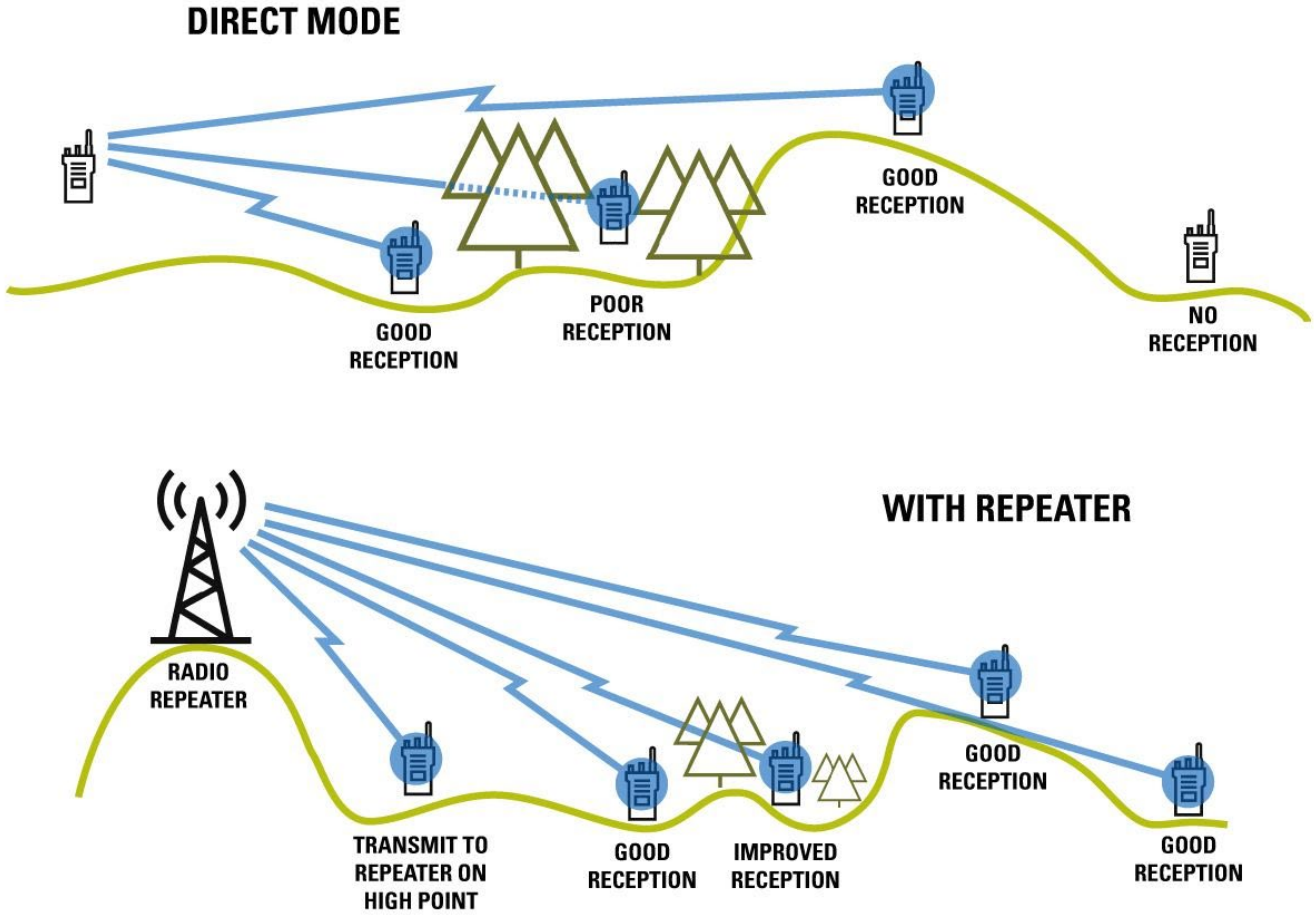


Figure 12 - VHF Broadcast with / without repeater

VHF can operate as either simplex or duplex channels. Simplex channels transmit and receive on a single frequency, meaning the channel is only used by a single person at one time, before another can speak.

Duplex channels transmit and receive on two frequencies, enabling people to speak and listen at the same time, similar to using a mobile phone.

Numerous organisations throughout the Otago region utilise VHF for communications, including the following:

- Emergency Services (Police, FENZ and St. John Ambulance)
- Civil Defence Emergency Management
- Local Authorities
- Department of Conservation
- Downers
- Coastguard (Maritime radio)
- Air operators / Airports
- Ashley Communications
- Unifone
- Vital (Land mobile radio)
- Amateur Radio Emergency Communications (AREC)

UHF Radio

UHF Radios operate on frequencies from 300megahertz to 3gigahertz, so offer a wide range of frequencies, meaning less chance of interference from other users. However, UHF is not as good for wide area coverage as VHF and is better suited to situations where there is a need to penetrate barriers, such as dense forestry or buildings, or in close settings. Due to the higher frequency that they operate on, UHF radios use up battery power more quickly than VHF, so they're not ideal if workers don't have easy access to a charging station.

Some agencies and organisations utilise UHF in addition to VHF. These include:

- New Zealand Police
- Kiwirail
- AREC
- Otago Corrections facility (Milton / Milburn)

Repeater sites

VHF and UHF base sets and handsets require limited resources to operate and can be run from solar and battery, meaning they are generally fairly resilient. However, for longer distance applications they are reliant upon repeater stations throughout the region to relay transmission.

While the majority of smaller repeater sites are run on battery with solar, several of the larger repeater sites that house a number of different service repeaters require a consistent power supply. This means that loss of power can have a significant impact on the network and backup generators are stationed at critical repeater sites. Generators require on-going fuel and maintenance to ensure no loss of signal at the site.

The use of key repeater sites in the region by multiple agencies/organisations is shown below:

- Cape Wanbrow (CDEM, FENZ, St. John Ambulance and rescue helicopters, Maritime radio, Kiwirail, AREC)
- Highcliff (CDEM, Marine radio, AREC)
- Mt. Cargill (FENZ, NZ Police, Maritime radio, AREC)
- Razorback (St. John Ambulance and rescue helicopters, Kiwirail, Vital)
- Remarkables (St. John Ambulance and rescue helicopters, DoC)
- Roys Peak (CDEM, Doc, Downers, Maritime radio)

*This is not a definitive list of users and other organisations may also use the sites above for radio communications.

The critical repeater for Fire and Emergency New Zealand for the Wakatipu basin is the repeater site at the top of deer park heights. This enables communications within the Queenstown area.

NZART operates a network of UHF and VHF repeater sites nationally to support emergency communications. The locations of these sites are shown in the appendices on pages 101 to 106.

Otago CDEM VHF Network

The Otago Civil Defence VHF radio network is operated by Ashley Communications Limited and is utilised to connect emergency coordination centres and provide alternative communications throughout the region in the event of a major network outage. This relies on a number of repeater stations, listed below. These have alternative/independent power supplies and backup generator capability to enable them to continue to operate.

Repeater stations utilised by Otago CDEM Group	Channels								
	All Call	Central	Coastal	Control	Clutha	Dunedin	Inland	Waitaki	QLDC
Blue Mountains	■	■			■				
Cape Wanbrow	■		■	■				■	
Dunstan	■			■			■		
Highcliff	■		■	■		■	■		
Hinahina	■				■				
Kaihiku	■		■	■	■				
Morven Hill	■			■			■		■
Mount Benger	■	■							
Mount Roy	■								■
Mt. Obi		■						■	
Narrowdales	■				■				
North Swampy	■					■			

■ Supports channel

Fibre Network

From 2012, New Zealand began the Ultra-Fast Broadband (UFB) rollout, a partnership between the Government and private companies to install fibre in homes and businesses across all cities and towns in the country. The first phase of the UFB rollout was completed in late 2019 and laid fibre down the streets where 79% of New Zealanders live. The second phase, covering smaller communities, has increased fibre availability to 87% by the end of 2022.

Chorus has been working to establish/install new fibre links across the country, with their most recently completed projects providing upgraded service between Timaru and Omarama/Lindis Pass, Mataura and Gore, Gore to Lumsden, and the addition of a new network tower into Milford. The most recent project launch (FY 2024/25) includes a fibre upgrade for Westwood (Dunedin City).

The rapid network growth in the last 10 years has resulted in a large number of independent fibre companies, it was not possible to canvas *all* retailers (or even large-scale providers) regarding vulnerabilities or interdependencies. **For a full list of retailers/companies, see appendix.**

Most of the region is connected via ADSL or VDSL lines, or rural broadband. The installation of fibre and hyperfibre has been steadily increasing in urban areas and in 'rural adjacent' locations where infrastructure allows.

Satellite

Since the last vulnerability study (2018) satellite technology has advanced at a rapid pace and has expanded to offer more consumer/emergency response options to New Zealand. Several providers are now making services available across the country which are being used by both lifeline utility providers and emergency management agencies/organisations.

One of the limitations of satellite services is that, not unlike fibre, they rely on an uninterrupted power supply to both the ground station and the dish/unit. This means that the user must have back-up power and the ground station needs to be powered either through the local network or a generator.

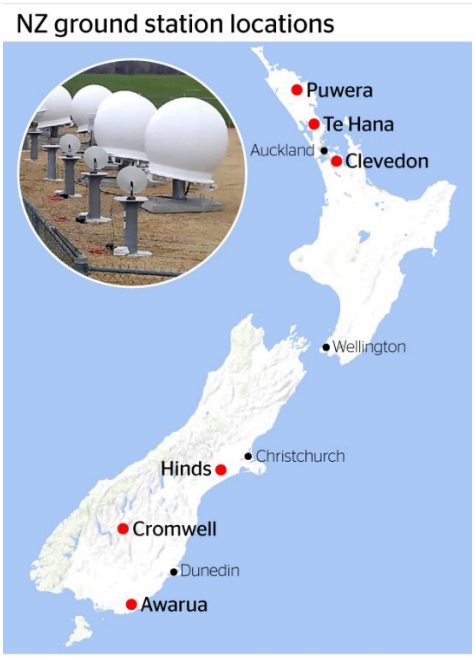
Starlink

The most prominent provider to feature in recent events is Starlink satellite internet (owned by SpaceX). Starlink is a low earth orbit (or LEO) internet satellite system, leveraging around 4,000 satellites in space and (as of 2023) six Starlink ground stations in New Zealand (see image on page 35).

Currently, the Starlink system claims about 14% of the rural internet market.[12]

SpaceX is due to launch an additional 2,000 'second generation' satellites to enable text (SMS) provision to the US and New Zealand. The Starlink service is provided through a partnership with One NZ, and alongside internet connectivity, will offer the text (SMS) service by the end of 2024, with voice and data to follow.

To deliver internet connectivity to its users, Starlink relies on a system of ground stations called gateways; these need to be in somewhat close distance (1,000 kilometres) to receive that signal.



Source: Radio Spectrum Management / Herald Network graphic

The Cromwell ground station is co-located next to the Cromwell substation (Richards Beach

[12] https://www.farmersweekly.co.nz/technology/rural-nz-first-for-satellite-liftoff/

Amazon

In May 2024, Amazon attended the Rural Connectivity Symposium in Rotorua and announced Project Kuiper, a US$10 billion project to get 3200 low earth orbit satellites spread across the globe's skies to increase access to the internet, with a focus on developing nations. The company intends to launch clusters of satellites from the outer edges of the map and work inwards, with NZ in the early launch window. It is anticipated that commercial service will begin in 2025.

Regional communications providers

There are a number of organisations providing broadband in Otago alongside the major providers, both through existing 4G and 5G networks, satellite and radio/microwave networks using transmitting/repeater stations. Below are some of the main providers within the region.

Farmside

Farmside provides rural broadband via the existing One NZ mobile network, and existing Chorus copper and fibre connections via satellite. As such, the provisions already on those networks for backup power also impact the capability of the Farmside network to operate.

Unifone

Unifone provides point-to-point data, broadband and VoIP phone services to customers within the coverage area of the Unifone radio broadband network and also by reselling mobile fixed wireless data and Chorus/Enable fibre. The Unifone radio broadband network has a high level of resiliency built into it, which gives some independence from upstream carriers. All Unifone sites are mains powered with battery backup and generator inlets.

Unifone covers 3000 residential and business end users within its coverage area. This total includes other telcos and critical infrastructure providers.

Yrless / Tussock Networks

Yrless/Tussock Networks provides rural broadband via existing 4G and 5G networks, DSL and fibre connections and in more remote areas via Fixed Wireless Access (FWA) using radio signals. The network relies on mobile phone towers and therefore some redundancy is built into the system, such as battery backup power and in some cases generators. Rural broadband services are currently provided to around 1500 customers across Otago and Southland.

CountryNet

CountryNet provides rural broadband and telephone services utilising long-range microwave wireless technology. The service requires a series of transmitters located throughout the Queenstown Lakes and Central Otago area and can provide service within a 50km line of sight. A map of current broadcast sites is shown in the appendices on page 106. The system operates near off-grid, with solar / battery power and a generator. The network is also multi-homed through Devoli and Spark, with backup using Starlink. CountryNet also provides some digital mobile radio VHF / UHF connectivity via a number of sites, including the Remarkables, Bare Hill, Hokanui Mountains, Mount Saint Bathans and some lower altitude sites. CountryNet also has a number of sites around Queenstown Lakes that can be activated to provide public wifi.

Netspeed

Netspeed operates rural broadband through One NZ 4G networks and a 5G wireless network through Dunedin, Oamaru and Wanaka. This is largely based upon the availability of 4G / 5G in the area, or location in relation to a transmitter. Many sites have solar / battery with generator backup, however,

there is a large reliance upon the existing One NZ network, so any issues with cell towers can directly impact the ability to provide services to existing customers.

Transport

Rail Network

The Main South rail line (MSL) enters the Otago region at the Waitaki River Bridge, 20km north of Oamaru, and runs 300km before crossing the Otago/Southland regional boundary at Landslip Rd in the Waikaka Valley. This stretch of the MSL includes 116 rail bridges with a total length of 4.66 km and seven tunnels with a total length of 4.67 km.

KiwiRail operates three trains per day on the MSL through Otago, plus shorter services between destinations e.g. Invercargill to Port Chalmers. Fonterra are a key customer and their Mosgiel distribution centre relies entirely on rail to transport milk powder and cheese to Port Chalmers for export. Other freight loads include coal, wood and non-perishable supermarket goods.

The Taieri Branch Line is managed by KiwiRail for the first three km to the Fonterra sidings at Taieri. The remaining 61 km to Middlemarch are managed by Dunedin Railways, which runs the Inlander tourist service.

Airports

There are several air transport facilities of note in the Otago region, providing both commercial and private air operations. Queenstown and Dunedin airports are the fourth and fifth busiest airports in New Zealand respectively (based on passenger numbers, rather than aircraft movements) and provide for both domestic and international travel. Oamaru, Wanaka and Alexandra Airports largely support private charter flights and some limited inter-region travel.

Queenstown Airport

Queenstown Airport is New Zealand's 4th busiest airport by passenger numbers after Auckland, Christchurch and Wellington. Due to the popularity of the region as a visitor destination, the airport is considered a strategic national asset and a key driver of the region's tourism industry and broader economy.

Located 10 minutes from downtown Queenstown, the airport is the direct domestic and international entry point to the lower South Island, servicing 2.4 million passengers in the 2023 year across four airlines (Air NZ, Jetstar, Qantas and Virgin Australia). The airlines operate daily direct scheduled services from New Zealand's main metropolitan ports of Auckland, Wellington and Christchurch which provide strong regional links throughout the country, as well as from the Australian cities of Brisbane, Coolangatta, Sydney and Melbourne.

Queenstown Airport is New Zealand's busiest helicopter port and is heavily used for tourist 'flightseeing'. Private jets are also a growing market, both short and long haul, with aircraft flying direct from north Asia and the west coast of the United States.

The airport has a 3-day supply of Jet A1 fuel and more can be trucked to the airport from the BP terminal in Dunedin or flown in as extra fuel on aircraft.

Queenstown Airport Corporation manages Queenstown Airport and is also contracted by Queenstown Lakes District Council to provide general airport and property management for Wanaka Airport and property maintenance for the Glenorchy Aerodrome. The nearest airports to Queenstown are Wanaka Airport (1 hour drive), Invercargill (2 hour drive), Dunedin (3.5 hour drive), and Alexandra Airport (1.5 hour drive).

Queenstown Airport runway overview

Airport operator	Runway types	Direction	Length / width	Elevation (AMSL)	Maximum aircraft size	Hazard vulnerability
Queenstown Airport Corporation Ltd.	**Runway 05/23** Grooved Bitumen	North-east to South-west	1889m / 45m	357m	narrow-body commercial jets (B737/A320/A321) and turboprop aircraft (ATR72 andQ300). No commercial wide-body aircraft can operate at the airport	Earthquake, Severe weather, Snow fall, Wildfire, Solar storm
	Runway 14/32 Bitumen	North to South	720m / 40m (10m sealed centre section)		Aircraft with a maximum certificated take-off weight (MCTOW) of 5700 kg	

Figure 13 - Aerial view of Queenstown Airport

Dunedin Airport

Dunedin Airport services Air NZ and Jetstar, which fly to other regional airports around New Zealand. Since COVID-19, regular international flights have ceased, although the airport can accept international charters. Dunedin is primarily a passenger airport with around 900,000 passengers annually.

The Airport is self-sufficient for 3-4 days with backup services. 'JetA1' (jet fuel) is trucked to the Airport from the BP terminal in Dunedin or from Christchurch (via Air BP). Refuelling is dependent on road access via State Highway 1 and State Highway 86 across the Allanton bridge from Dunedin City.

There are two substation power feeds to the site with automatic changeover along with generators that supply the terminal building and airport infrastructure, in addition to a second generator that supplies emergency power to the Airways facilities. The generator has approximately 7,500L diesel capacity, with around 72hrs worth of fuel held onsite.

Onsite is a water storage facility of 500,000L and distribution network, along with a wastewater treatment plant. There is a network of stormwater pumps that protect the airport during times of heavy rainfall, although these may not be sufficient to protect against flooding. The airport is also in a liquefaction awareness area.

Dunedin Airport runway overview

Airport operator	Runway types	Direction	Length / width	Elevation (AMSL)	Maximum aircraft size	Hazard vulnerability
Dunedin Airport Ltd	**Runway 03/21** Bitumen	North-east to South-west	1900m / 46m	5m	Narrow-body commercial jets (B737/A320/A321) and turboprop aircraft (ATR72 andQ300). Some commercial wide-body aircraft can operate at the airport, such as the B767	Earthquake, Severe weather, Flooding, Snow fall, , Solar storm

Figure 14 - Aerial view of Dunedin Airport

Wānaka Airport

Wānaka Airport is owned by Queenstown Lakes District Council (QLDC) and is managed by Queenstown Airport Corporation (QAC). Wānaka is deemed a non-certified General Aviation Airport with its current activity being about 40,000 aircraft movements per year, anticipated to achieve 50,000 movements over the next 12 months (2024). Accordingly, it was deemed a 'busy' airport and in the future CAA may require its status to be changed to a qualifying or certified airport.[13]

Wanaka Airport is primarily a base for flightseeing, flight training, private flights, aircraft maintenance operations, and some visitor attractions. There are scheduled services to Christchurch operated daily by Sounds Air.

There are a number of businesses operating at the airport with around 250 people working on day-to-day operations. There is a small terminal building which Sounds Air and Southern Alps Air operate from. There are a number of general aviation aircraft, hangars, aircraft maintenance operations and a supply of Jet A1 and AVgas available on-site.

[13] Wānaka Airport Liaison Committee Meeting Minutes 29 April 2024

Wanaka Airport runway overview

Airport operator	Runway types	Direction	Length / width	Elevation (AMSL)	Maximum aircraft size	Hazard vulnerability
Queenstown Airport Corporation Ltd.	**Runway 11/29** Asphalt	North-west to South-east	1200m / 30m	348m	Turboprop aircraft (up to 30 seats max due to non-CAA certification) Can accommodate Q300, Hercules C180 as non-passenger flights	Earthquake, Severe weather, Snow fall
	Runway 11/29 Grass (runs parallel to main runway)	North-west to South-east	840 /40m		Light aircraft (e.g. Cessna single-prop)	

Figure 15 - Aerial view of Wanaka Airport

Oamaru Airport

Oamaru Airport is operated by the New Zealand CAA and is situated on Waitaki District Council owned property in a rural setting between the two settlements of Oamaru and Glenavy. As the Oamaru Airport is considered a non-certified airport, there are no significant domestic travel operations. However, the main runway is operationally long enough to accept non-regular Q300 or ATR72-type aircraft operations.

There are three resident aviation operations established at the airport; Heliventures NZ Limited, North Otago Aero Club, New Zealand Airline Academy Limited (Aviation College)

Both Heliventures and the Aviation College are very active, operating light aircraft on either Commercial Transport and Agricultural activities or Flight Training. In addition to these resident businesses, there are also casual users and infrequent corporate jet activities. The following fuels are available on-site: Avgas, JET A1, 95 Octane and diesel. The airport maintains approximately 20,000lts of fuel storage.

Oamaru Airport runway overview

Airport operator	Runway types	Direction	Length / width	Elevation (AMSL)	Maximum aircraft size	Hazard vulnerability
New Zealand CAA	**Runway 18/36** Asphalt	North-north-east to South-south-west	1283m / 30m	30m	turboprop aircraft (ATR72 andQ300)	Earthquake, Severe weather, Snow fall, , Solar storm
	Runway 11/29 Grass	North-west to South-east	947m		Light aircraft (e.g. Cesna single-prop)	
	Runway 02/20 Grass	North-east to South-west	846m		Light aircraft (e.g. Cesna single-prop)	

Figure 16 - Aerial view of Oamaru Airport

Alexandra Airport

Alexandra Airport is a small general aviation airport located approximately 4km NW of Alexandra township. The airport has a resident population of approximately 40 light aircraft hangered on-site together with a number of standalone aircraft hangars, several hanger-home units and motel type overnight accommodation. The airport has Avgas and Jet A1 fueling facilities for light aircraft.

The airport, which is owned by the Central Otago District Council (CODC) and operated on its behalf by the Central Otago Flying Club, does not have any scheduled air services.

The main runway is capable of taking aircraft up to 5700kg maximum take-off weight, but due to its non-certified status does not have any large aircraft utilising the airport on a regular basis. However, it is able to support ATR72, Q300 and Hercules C130 aircraft. The airport lacks the required runway lighting to enable night operations, however, this has previously been achieved using a temporary runway lighting system.

Alexandra Airport Runway overview

Airport operator	Runway types	Direction	Length / width	Elevation (AMSL)	Maximum aircraft size	Hazard vulnerability
Central Otago District Council	**Runway 14R/32L** Asphalt	North-north-west to South-south-east	1200m / 30m	229m	Turboprop aircraft (up to 30 seats max due to non-CAA certification) Can accommodate Q300, Hercules C180 as non-passenger flights	Earthquake, Severe weather, Snow fall
	Runway 14L/32R Grass (runs parallel to main runway)	North-north-west to South-south-east	1200m / 60m		Light aircraft (e.g. Cesna single-prop)	
	Runway 01/19 Grass	North-east to South-west	652m / 60m		Light aircraft (e.g. Cesna single-prop)	

Figure 17 - Aerial view of Alexandra Airport

Glenorchy Aerodrome

The Glenorchy Aerodrome Reserve is situated just south of the township of Glenorchy on the banks of Lake Wakatipu. Glenorchy Aerodrome is owned by QLDC. QAC provides grounds maintenance services and airstrip management. The airstrip is utilised by small private and commercial fixed-wing aircraft and helicopter operations, with ~850 air movements in 2023.[14] A newly formed vehicular access road from Glenorchy-Queenstown Road was opened in 2019 to provide a safe access route to the airstrip.

[14] Glenorchy Airstrip Governance Committee Meeting Minutes 4th June 2024

Glenorchy Aerodrome runway overview

Airport operator	Runway types	Direction	Length / width	Elevation (AMSL)	Maximum aircraft size	Hazard vulnerability
Queenstown Lakes District Council	Grass	North to South	700m / 40m	357m	Light aircraft (e.g. Cesna single-prop)	Earthquake, Severe weather, Snow fall

Figure 18 - Aerial view of Glenorchy Aerodrome

Port Otago

Port Otago is primarily an export port with 80% of freight exported, all logging from Southland and Otago is exported via ship. Exported products are brought to the Port by road and rail and most of the imported product is fuel.

Port Chalmers is the primary South Island port for cruise ships and generally the port of call immediately before or after visiting Fiordland.

Port Chalmers

This is one of New Zealand's two deepest container ports and services the largest container ships visiting New Zealand. It can store more than 7000 containers and has one of the highest numbers of refrigerated shipping container points in New Zealand (1650).

- Container Terminal: 17.7ha
  - Log area – 4.6ha
  - Warehousing – 63,400m²
- Total wharf length: 1143m
- Lower Harbour Channel depth: 14m (consented to 15m)

Dunedin Bulk Port

In Dunedin, Port Otago has two wharf-side cold storage facilities, able to hold up to 10,500 tonnes of chilled product. This is used primarily to service fishing customers. There is also significant log activity, including storage, scaling and export.

- Log area: 4.5ha
- Cool storage: 21,000m²
- Warehousing: 8500m²
- T/U wharf: 766m Upper Harbour Channel depth – 8.5m

The fuel wharf is a *Regionally Significant Critical Asset* for the Otago Region, as this is where the primary import of fuel occurs. Loss of this capability would compromise recovery activities. The fuel wharf has undergone strengthening to increase its resilience to adverse events

If the port were inoperable for any reason, some products could be transferred to Bluff or Timaru. The impact would be more significant in the food industry, as products from dairy factories and meat works are exported through Port Otago and are more difficult to reduce production.

A recent digital upgrade (2024) has replaced the Port's analogue set-up and substantially increased the coverage for radio communications across Port Otago sites. This has improved operational communications by removing comms black spots and allowing communications outside of the public

marine VHF network. Several other significant resilience projects have been completed since the last study and some other major upgrades are planned, or underway. These include the Port Chalmers Ring Main Power Supply upgrade (due for completion end of 2024) and the upgrade of the rail pad in 2024/5. This is a significant piece of infrastructure for the port and provides for the transportation of many of the goods that are exported through the port. However, depending on the scale of the event, the tunnels in Sawyers Bay and Port Chalmers could be impeded, reducing the use of the rail lines.

Roading

There are around 10,500 km of public roads in the Otago region. These are owned and managed by various road authorities. New Zealand Transport Agency (NZTA) Waka Kotahi operates the state highways, and local authorities operate the public local roads.

Road Authority Networks (km)	Sealed	Unsealed	Total
CDC	828	2070	2898 km
CODC	509	1376	1885 km
DCC	1070	694	1764 km
QLDC	490	348	838 km
WDC	777	1035	1812 km
NZTA Waka Kotahi	1306	0	1306 km

Figure 19 - Roading Authority Network lengths within the Otago Region

The topography is predominantly flat to rolling; however, some mountainous areas throughout the region make for challenging road alignments and increased exposure to severe weather events such as strong winds, ice, snowfall, and heavy rain. Many of the limited routes in and out of the region are highly susceptible to periodic closure due to natural hazards such as snow, flooding, and landslides.

One Network Framework (ONF)

Roads are classified using the One Network Framework (ONF) hosted by NZTA Waka Kotahi. This tool helps to establish transport network function, performance measures, operating gaps and potential interventions for each road and street type. The process of defining these classifications takes into consideration the following:

- **Place:** Defines the land-use vision and user experience that transport needs to support.
- **Movement:** Considers the mix of transport modes and defines priority for moving people and goods safely

It clearly classifies each road so that decision-makers can prioritise maintenance and repair of roads based on their place and movement.

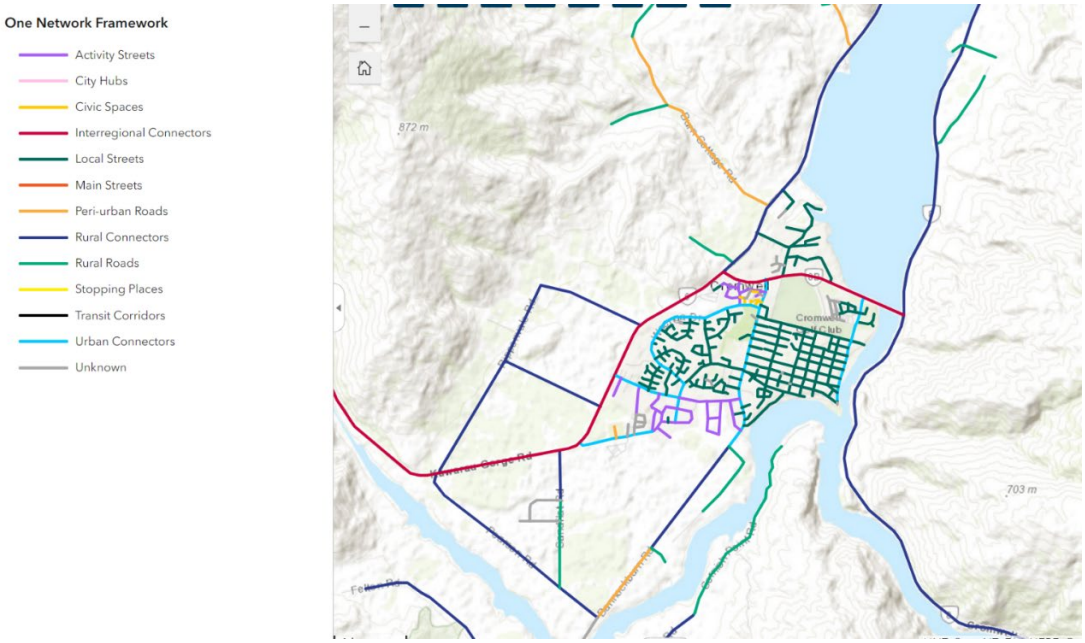


Figure 20 - One Network Framework map of Alexandra

Arataki 30yr Plan

The Arataki 30yr plan is being developed as a shared sector view of how to plan, develop, and invest in the land transport system during the next 30 years. This provides detail of the future of the land transport network in the region and identifies key areas for development. A key area for this project is the addressing of resilience within the network to meet the potential impacts and consequences of a major emergency event. Recent weather events in 2023 have greatly informed the need for resilience in the network.

Key actions over the next 10 years to make progress on this outcome are:

- Continuing design and planning work to identify and prioritise responses to natural hazards in high-risk areas – this includes working with communities to identify plans for when to defend, accommodate, or retreat
- Better understanding routes that provide critical connections, the conditions of these, the pressures, and the level of investment needed to address impacts – this includes identifying priorities for network resilience
- Engaging in local planning processes to avoid infrastructure and development in areas at risk of natural hazards and climate change
- Seeking continuous improvement in network resilience through maintenance, renewals, and 'low cost/low risk' investments
- Improving operational responses to events to support quick recovery following disruption to the land transport system
- Shifting to more adaptable 'scenarios-based' planning
- Improving personal security for people using the region's transport system.

https://www.nzta.govt.nz/planning-and-investment/planning/arataki/national-and-regional-directions/regional-directions/otago/

NZTA Waka Kotahi current resilience programme

Road networks within the region have been shown to be vulnerable to both high-frequency (floods) and low-frequency (earthquakes) events, with long recovery times following some events. NZTA Waka Kotahi is continuing to invest in road network resilience, and projects are planned and underway to improve

resilience to flooding, underslip, and rockfall on major highways across the region. This includes flood mitigation work at SH1 Kakanui River, underslip at Ash McGregors and Scrubby Corner on SH8, and rockfall on SH6 Nevis and SH8 Cromwell Gorge. Work is also being undertaken for rockfall on sections of the Otago Coastal sections of SH1.

South Island Priority Routes Project

This project encompasses work across CDEM Groups, key response agencies, and lifeline utilities to identify and categorise routes critical for restoration and life safety activities following an AF8 earthquake scenario. These images are a release from this project.

Figure 21 - Alpine Fault earthquake priority routes Otago Region June 2024

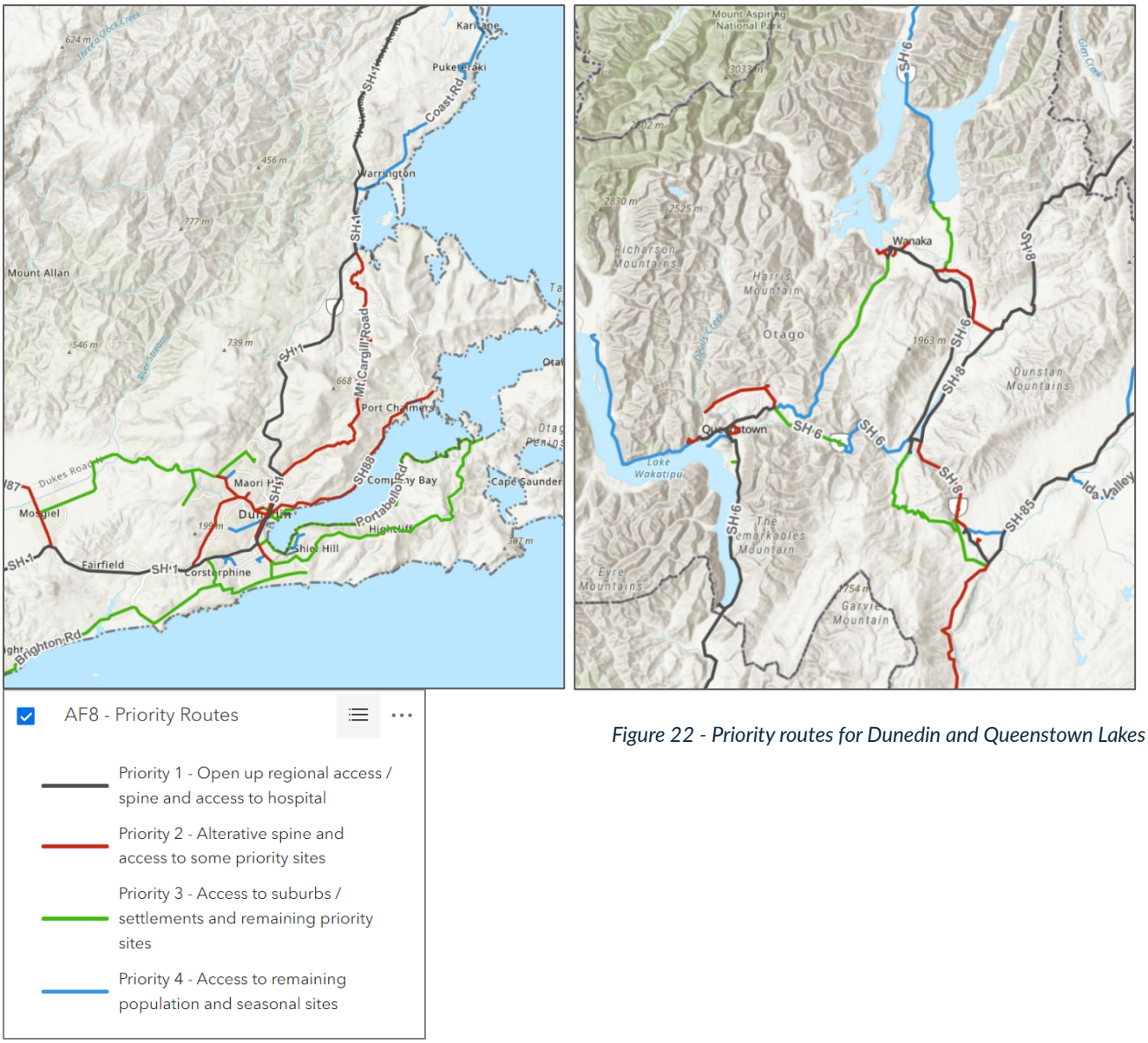


Figure 22 - Priority routes for Dunedin and Queenstown Lakes

Priority routes note:

During non-seismic events (e.g. flooding), SH6 Kawarau Gorge and SH8 Cromwell Gorge have different priorities/criticalities.

Impacted routes for other hazards

A range of major routes are impacted by other hazards, which key connections between the major settlements in the region. The table below provides impacted routes for other hazards, including flooding, coastal erosion and snowfall. For many of these routes there are no alternatives, meaning isolation of some areas until they are re-opened.

Hazard	Potentially susceptible routes/areas
Flooding	• SH1 – Oamaru • SH1 – Waianakarua • SH1 – Hampden • SH1 – Palmerston • SH1 - Goodwood • SH1 - Waikouaiti - Waitati

Hazard	Potentially susceptible routes/areas
	• SH1 – Dunedin CBD • SH1 - Balclutha - Clinton • SH8 – Lindis Valley • SH8 – Waitahuna • SH8 - Lawrence • SH8 – Beaumont • SH8 - Alexandra • SH85 – Alexandra • SH85 – Becks • SH85 – Waihemo • SH86 – Mosgiel – Momona • Twelve Mile Creek on the Queenstown - Glenorchy Road through Glenorchy and over the Dart River to Routeburn
Snow fall	• SH1 – Leith Saddle • SH6 – West Coast • SH6 - Kawarau Gorge / Devils Staircase • SH8 – Lindis Pass – Alexandra • SH8 – Alexandra – Beaumont • SH8A - Luggate • SH85 – Alexandra – Kyeburn • SH87 – Kyeburn – Mosgiel • SH93 – Clinton - Otaraia • Crown Range Road • Queenstown Glenorchy Road
Coastal erosion	• SH1 – Waikouaiti • SH1 – Coastal Rd – Karitane • SH1 – Evansdale • SH1 - Kaitaki • Brighton Rd @ Waldronville • Coast Rd @ Toko Mouth • Kaka Point Rd @ Port Molyneux • Owaka Highway @ Owaka - Houipapa

Three Waters

This section provides an overview of the provision of potable water, wastewater and land/stormwater networks to communities within Otago.

Potable water supplies are the most vulnerable of the three networks and can have the most severe impacts to community health and wellbeing. Past water supply incidents, such as the 2016 Havelock North and 2017 Dunedin, Lower Hutt, and Auckland Hunua incidents, were all related to quality rather than quantity issues, leading to serious health challenges and impacts to the local economy.

The treatment of wastewater varies greatly across the region, from large scale treatment plants through to household septic tank systems. Loss of the wastewater network can have implications for both communities and industry following an event.

Stormwater standards for the whole network are not generally mandated. However, primary systems are usually designed to pass a 1:10 year rainfall event and secondary systems (overland flow paths, detention areas) a 1:100 year event. The Building Act requires new houses and habitable buildings to be designed with the floor level above the 50-year ARI event. It also requires the 10-year ARI event not to cause a nuisance to other properties. Urban stormwater systems need to be designed and managed to meet this requirement. These design standards are often at odds with planning for other hazard types, which specify standards for much lower frequency events. Decisions on funding and levels of resilience are made by local authorities or their governing boards.

Central Otago District Council

Water production and supply

Central Otago District Council operates nine schemes, the two largest being Alexandra and Cromwell. Each serve around 5,000 customers (approximately 6,150 connections). These schemes' treatment plant, bore fields, and main pump station have been rated Criticality 2 (‘regionally significant’).

Other schemes at Clyde, Roxburgh, Naseby, Omakau/Ophir, Ranfurly, Pisa Village and Patearoa supply 2,950 dwellings.

The water reservoirs in Cromwell, Alexandra, Ranfurly, Roxburgh, and Little Roxburgh Village have been rated Criticality 3 (locally significant), as have the water source and treatment facilities in the remaining schemes.

Wastewater

Central Otago District Council provides a reticulated wastewater network to around 7,700 properties in eight schemes – Alexandra, Cromwell, Bannockburn, Roxburgh, Naseby, Omakau, Lake Roxburgh Village and Ranfurly. From a wastewater perspective, the district’s critical sites are the treatment plants in Alexandra and Cromwell and large and terminal pump stations in those towns. In addition, wastewater pump stations in Roxburgh, Bannockburn and Pisa have been rated Criticality 3.

Land/Stormwater

The Central Otago District Council operates two major stormwater schemes in Alexandra and Cromwell, with properties serviced by a piped network and pumps. Smaller networks exist in Bannockburn, Roxburgh, Naseby, Omakau, Lake Roxburgh Village and Ranfurly.

Clutha District Council

Water production and supply

The Clutha District Council operates 15 water schemes within the district. These supply seven urban areas and eight rural (although some rural schemes supply urban towns i.e. Puerua WTP supplies Kaka Point, Clydevale/Pomahaka WTP supplies Clinton).

The two largest schemes are Balclutha and Milton:

- Balclutha is sourced from the Balclutha River and has two offsite reservoirs and two smaller onsite reservoirs servicing around 2,000 properties.
- Milton is sourced from the Tokomariro River and has two reservoirs servicing around 1,000 properties, including the Otago Corrections Facility.

The Clutha District Council also operates 48 reservoirs across the district. These are largely made up of water tanks and are supplied from bores and river takes. All sites utilize SCADA to provide network information, and this is highly dependent upon both electricity supply and telecommunications. There are no backup generators at any of the water supply sites.

Wastewater

The Clutha District Council provides reticulated wastewater to around 5,500 properties across nine wastewater schemes, the two largest being Balclutha and Milton, servicing the same population as the water supply. As with the water supply, these are monitored using SCADA and are reliant on power and communications network availability. They also have no backup generators; the loss of power would result in the inability to process wastewater.

Land/Stormwater

The Clutha District Council operates two main stormwater networks in Balclutha and Milton. Schemes are present in eight smaller towns across the district.

Dunedin

Water production and supply

Raw water for Mount Grand is sourced from Deep Creek (around 20% of the supply) and Deep Stream (around 80% of the supply) and piped to the Mount Grand Water Treatment Plant (WTP). These pipes are highly critical for the security of supply. A notable point of vulnerability is where both pipes cross the 80-year-old Taieri River Pipe Bridge.

Monitoring of the bridge, rock face and adjacent landslide includes:

- Inspection of bridge and slopes (annually)
- Monitoring survey of landslide (true right) and rockface (true left) (every three years)
- Ropes access inspection of the rock face (every three years)

Mount Grand WTP supplies approximately 53% of Dunedin's water and is another significant critical asset. The treated water demand MLD (3-day peak) is 30.7 MLD. Mount Grand WTP supplies Southern WTP with raw water via the raw water reservoir most of the time and can also supply treated water when necessary.

Southern WTP supplies approximately 47% of Dunedin's water, which fluctuates at different times of the year. Southern WTP also pumps treated water to Mount Grand treated water reservoirs when necessary. The plant is currently treating up to 24MLD. It is supplied by Deep Creek/Deep Stream (via a raw water

pipeline) and Silverstream and supplemented by Taieri River via the raw water pumping main on the Taieri plains.

Port Chalmers WTP currently operates from spring to autumn, depending on demand, as a supplement to the water provided by the Mount Grand water supply for the Port Chalmers area. The plant is started up before the demand outstrips the Roseneath pump capacity. The increased demand can be caused by the cruise ship season, dry seasonal conditions, and/or network maintenance.

Water is mostly gravity-fed from WTPs, with some small areas supplied by booster pumps. Water is fed via the northern pipeline to Waitati, Warrington and Seacliff communities.

Dunedin City Council also provides smaller water supply schemes in Outram, West Taieri, and Waikouaiti (it also supplies Karitane communities, Merton, and Hawksbury Village)

Currently, the city is highly reliant on the pipelines that bring water from the Deep Creek/Deep Stream sources. The pipelines are vulnerable to several hazards, passing through landslide–and liquefaction–prone soils. Long-term network upgrades are being planned to provide increased redundancy and mitigate the risk of failure of those pipelines.

Wastewater

The Tahuna Wastewater Treatment Plant (WWTP) treats around 78% of Dunedin's wastewater, with a smaller plant at Brighton Road. The Tahuna WWTP is a highly critical facility, along with the Main Interceptor Sewer and the Musselburgh pump station, which respectively collects and pumps most of the City's wastewater to the Tahuna WWTP.

Primary treatment occurs at the Mosgiel WWTP and services approximately 10% of Dunedin wastewater. The treated effluent is then pumped to Green Island for secondary treatment before being discharged.

The Green Island WWTP treats wastewater from Brighton through to Burnside, parts of Kaikorai Valley and Wingatui. It services approximately 25% of Dunedin wastewater, including the 10% transferred from Mosgiel WWTP.

Middlemarch, Seacliff, Waikouaiti, Karitane and Warrington provide smaller self-contained wastewater schemes.

Back-up power contingency

Dunedin City Council has invested in the following backup power supply systems to ensure the continuous operation of critical systems in three waters.

Mount Grand WTP has a UPS/generator backup for critical services and instrumentation only. Outram, Port Chalmers, Southern, Waikouaiti, and West Taieri Water Treatment Plants also have UPS backups for critical services and instrumentation only.

Tahuna WWTP has UPS for SCADA and plant automation and a backup diesel generator with a 5000l fuel tank with approx. 24hrs run time. The backup generator can only run half of the process. UV disinfection is sacrificed in the event of a power outage.

Green Island WWTP has UPS for SCADA and plant automation and a backup diesel generator with a 1300l fuel tank with approx. 8-12hrs run time.

Mosgiel WWTP has a UPS for SCADA and plant automation and a backup diesel generator with a 5000-litre fuel tank and an approximate 24-hour run time.

Middlemarch has no power requirements on site.

Warrington, Waikouaiti and Seacliff WWTP have no backup power supply.

Musselburgh pumping station has a diesel backup generator on site. It can be used for emergency storage in dry conditions for 2-8 hours.

Land/Stormwater

Dunedin City Council operates 11 catchment management plans for the management and control of stormwater across the city. These include the management of the piped stormwater network throughout the city and overland flow paths.

Queenstown Lakes District Council

Water production and supply

Queenstown Lakes District Council operates twelve water supply schemes across the district (Queenstown, Wanaka, Arrowtown, Lake Hawea, Glenorchy, Lake Hayes, Luggate and Arthurs Point, Shotover Country, Cardrona, Corbridge, Wanaka Airport). These schemes supply the majority of the district's dwellings.

Raw water is sourced directly from Lakes Wakatipu and Wānaka for the largest water supplies into Queenstown and Wanaka. The balance of the water schemes source water from relatively shallow bores (the majority circa 30m deep). All schemes' intakes and treatment plants are rated as Criticality 3.

Across the district, treatment typically consists of Ultraviolet Disinfection (UV) and Chlorination. Several sites include additional treatment steps such as filtration or pH correction. The exception is the new Cardrona WTP, which utilises membrane filtration without UV. The nature of the treatment employed is highly reliant on the raw water being of good quality for the treatment processes to be effective. Post-natural hazard, it is possible that raw water quality will be adversely affected, meaning boil water notices are likely.

The district's schemes include limited degrees of treated water storage, with most locations having storage that achieves between 12 and 24 hours of average day demand.

All larger intakes and treatment plants are equipped with permanent standby diesel generators. Smaller sites have provision for a temporary generator, and the Council has a fleet of trailer-mounted generators for this purpose.

QLDC is currently designing its treatment infrastructure and key facilities for Importance Level (IL) 3 and key reservoirs for IL4.

Key vulnerabilities in our network are listed below:

- The Beacon Point intake supplies the majority of water into Wānaka. The existing raw water rising main has no redundancy and is seismically vulnerable.
- Several critical trunk water mains cross bridges, including the Shotover Bridge (SH6), Kawarau Bridge (SH6) and Edith Cavell Arthur's Point).
- The Asbestos Cement trunk main in Frankton Rd will be vulnerable to seismic events and challenging to access post-event.
- Access to assets post natural hazards is also a key vulnerability, with dependencies on

key transport routes such as the Crown Range and Kawarau Gorge, along with the bridges mentioned above. In addition, the district's topography and geology make it very susceptible to slips, which are likely to impact access to individual sites.

Wastewater

Queenstown Lakes District Council provides wastewater reticulation to around 70% of the district's dwellings, discharging to four treatment plants in Wanaka, Hawea, Cardrona, and Queenstown. The serviced areas include Queenstown, Franklin, Kelvin Heights, Arthurs Point, Lakes Hayes, Arrowtown, Wanaka, Hawea, Luggate, and Glenorchy.

The treatment plants at Queenstown, Hawea, and Wanaka, along with several of the largest pump stations, are rated Criticality 3. Treatment plants and larger pump stations are equipped with permanent standby diesel generators. Smaller sites have provision for a temporary generator to be brought to the site, and the Council has a fleet of trailer-mounted generators for this purpose.

Emergency storage is available at some pump stations, and QLDC's ongoing resilience priority is to strategically add storage at more sites.

Key network vulnerabilities are listed below:

- The critical wastewater pipeline located in the Frankton track adjacent to Lake Wakatipu is vulnerable to landslide and, if severed, will cut off the conveyance of all wastewater from Arthurs Point, Queenstown (incl. Fernhill and Sunshine Bay) and Frankton Rd from the treatment plant.
- The existing concrete main is being relined, and an additional rising main in this corridor planned for construction over the next three years will add resiliency.
- In Wanaka, all flows are currently conveyed to the wastewater treatment plant (WWTP) via a single pump station and rising main located near the intersection of SH84 and SH6 in Albert Town. This pump station has no emergency storage and only a single rising main. In the event of catastrophic failure, it is possible to temporarily divert flows of raw sewage to the old Albert Town oxidation ponds.
- Several critical trunk water mains cross bridges, including the Shotover Bridge (SH6) and Kawarau Bridge (SH6)
- The Shotover WWTP is located close to the Shotover River, and although it is designed above the 1 in 100-year flood level, there is risk to continuity in the event of more extreme weather events.

Land /Stormwater

QLDC maintains seven public reticulated stormwater systems throughout the district – Queenstown, Wānaka, Arrowtown, Hāwea, Glenorchy, Albert Town and Arthur's Point, made up of 368km of pipes.

Other small settlements in the district, such as Kingston, Luggate and Makarora, have limited stormwater systems and generally rely on ground soakage and natural watercourses, swales and gullies for their disposal of stormwater.

Waitaki District Council

Water production and supply

Waitaki District Council operates 23 urban and rural water supply schemes, which supply 20,000 people (95% of the district's population).

Two sites are considered critical from a local perspective:

- Oamaru's Redcastle Road Raw Water Pump Station, which supplies around 15,000 people (there are ten days of raw water storage) and

- The King George Park pump station supplies around 14,000 people (one day's treated water storage).

Wastewater

Waitaki District Council provides ten reticulated wastewater schemes servicing around 16,000 people.

Of the 28 pump stations in the networks, three in Orwell Street, Beach Road, and Regina Lane are rated as Criticality 3. Each serves between 3,000 and 9,000 people.

Land/Stormwater

The Waitaki District Council operates two main piped stormwater schemes in Oamaru and Palmerston. The majority of stormwater within the region is managed using drainage ditches.

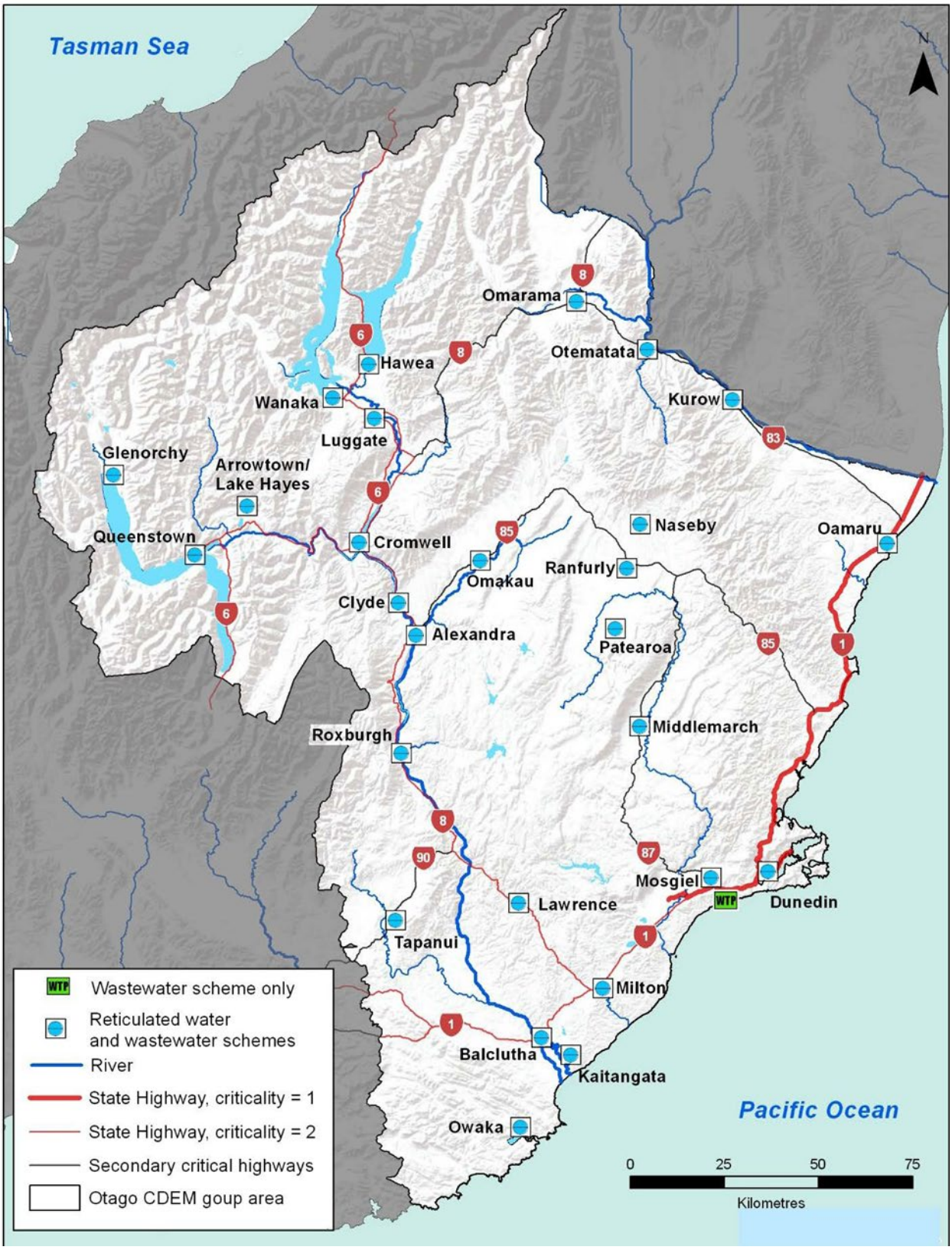
Otago Regional Council

Flood Schemes

Otago Regional Council (ORC) provides flood protection and land drainage to approximately 43,000ha of rural and urban land in Otago. Flood protection assets include over 200km of stop banks, 12 pumping stations, 55 bridges, culverts and various other related assets. ORC also own and manages a total of seven flood protection and drainage schemes.

ORC manages flood protection and drainage infrastructure in the following areas:

- Lower Clutha
- Lower, East and West Taieri
- Water of Leith
- Alexandra
- Shotover Delta
- Tokomairiro
- Lower Waitaki


Tasman Sea
N
Omarama
Otematata
Hawea
Wanaka
Luggate
Kurow
Glenorchy
Arrowtown/
Lake Hayes
Queenstown
Cromwell
Naseby
Oamaru
Omakau
Ranfurly
Clyde
Alexandra
Patearoa
Middlemarch
Roxburgh
Mosgiel
Dunedin
Lawrence
Tapanui
Milton
Balclutha
Kaitangata
Owaka
Pacific Ocean
WTP
Wastewater scheme only
Reticulated water
and wastewater schemes
River
State Highway, criticality = 1
State Highway, criticality = 2
Secondary critical highways
Otago CDEM goup area
0
25
50
75
Kilometres

Waste Management

Clutha District

Clutha District Council operates the only sanitary landfill in the district at Mount Cooee on the outskirts of Balclutha, on the Kaitangata Highway. Open almost every day of the year, the Mount Cooee landfill accepts most types of waste as well as recyclables and e-waste. This landfill would only be used if the others were inaccessible, or expediency was demanded.

Dunedin City Council

Green Island Landfill Site on Brighton Road, Green Island is the only active landfill site in Dunedin and the main Landfill for the region accepting hazardous waste. Moving putrescible waste (spoil) to a landfill would be the first priority in an emergency event. Green Island can take Asbestos and sludges, contaminated soil plus some hazardous biological waste (i.e. dead animals).

Queenstown Lakes District

The Victoria Flats Landfill is located 17km from Frankton on the East Side of State Highway 6 between the Victoria Bridge and the Nevis Bluff. Scope Resources Limited is contracted to run the landfill on behalf of the Queenstown Lakes and Central Otago Districts. This landfill would only be used if the others we inaccessible or expediency was demanded.

The landfill which is not open to the public accepts the following from licensed contractors:

- Household Collection Waste
- Transfer Station Waste
- Commercial Waste
- Special Waste and Hazardous Waste.

Other commercial clean fill sites which may be able to be used in an event are:

- Hall Transport – Kaikourai Valley
- Nash and Ross
- Transfer Stations: Timaru, Oamaru, Queenstown and smaller sites across the region.
- Fulton Hogan Cleanfill

Fast Moving Consumer Goods

FMCG is a recent addition to the 'lifelines' environment and this sector is dominated by the two major retailers (Foodstuffs and Woolworths). Although these two retailers hold a commercial duopoly, the primary producers and growers are highly critical to the operation of the grocery sector in New Zealand:

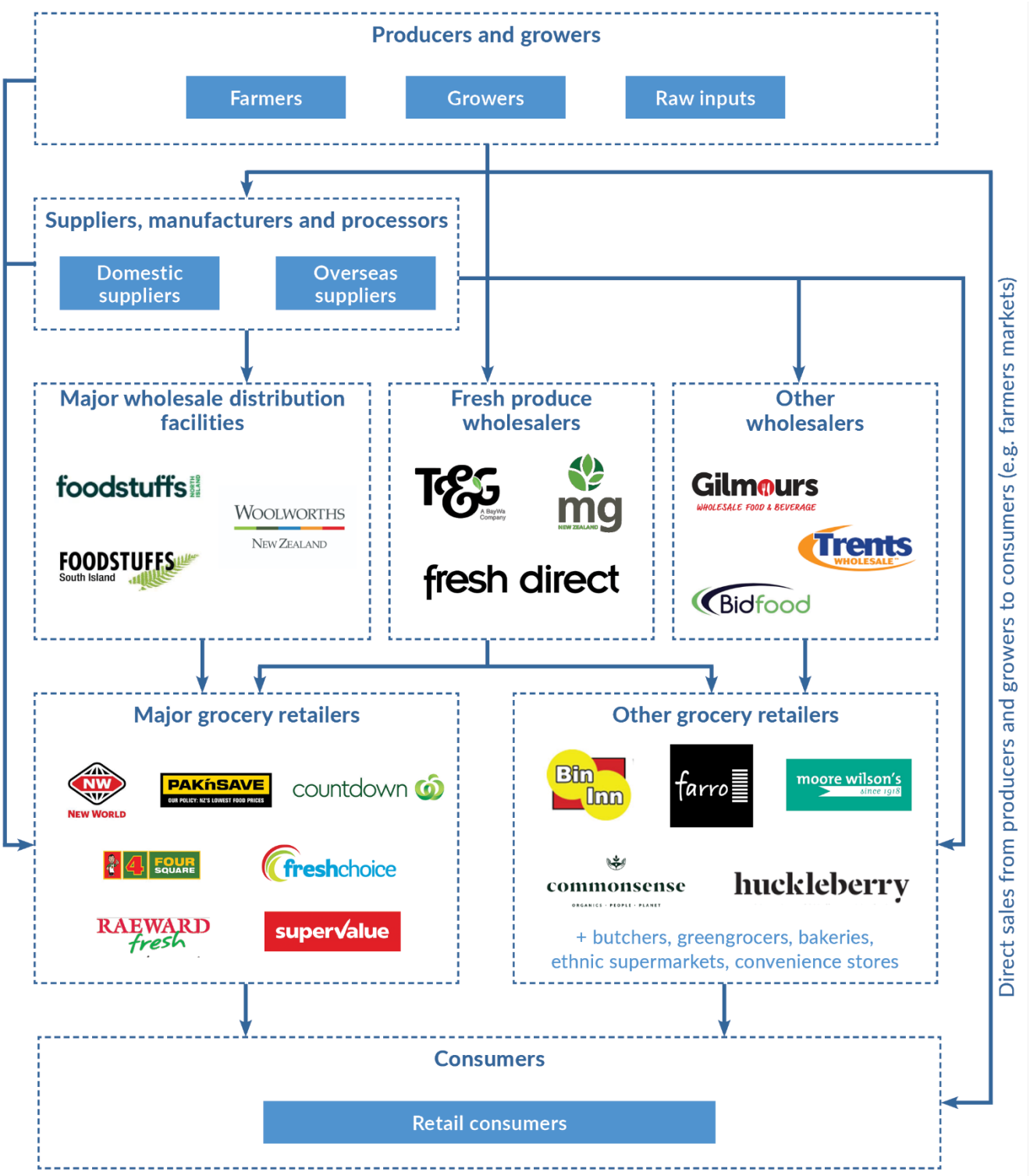


Figure 23 - NZ FMCG Flow diagram

"Retailers/suppliers require the whole supply chain to function, from primary production through to retail. Although FMCG providers maintain business continuity arrangements for backup services based on their own risk assessments, they will still require assistance in the form of priority restoration of service and access.

Examples of this include priority access to fuel under the National Fuel Plan, and access through cordons and restricted routes to maintain critical sites. Infrastructure providers should also consider the resilience of the supply to critical customer sites (in some cases these are direct commercial arrangements between the lifeline utility and the critical customer). "

Edited from: National Lifelines Vulnerability Assessment Report 2023, Part B, Section 3.3

From recent experiences across the country, it has been observed that FMCG in the emergency management context also includes non-food/hygiene items such as pharmaceuticals, personal protective equipment (PPE), and practical supplies (tarpaulins, ropes, nails, shovels, torches, batteries etc.) which are important to social and built recovery.

In terms of recovery operations, shipping/ports are used for the movement of bulk supplies, and air operations are unlikely to be used unless no other alternative exists (highly expensive and impractical) and would primarily be used to move personnel around.

Of primary concern to supermarkets are the FMCG suppliers from whom they source primary produce, where the supply chain is impacted (road closures, fuel shortages) then the ability to move product from places such as Fonterra, bread factories, meat producers (e.g., Tegal/Inghams), egg farms etc. is reduced, leading to shortages on shelves.

All supermarkets will face the challenges of getting personnel to site in order to facilitate the reopening of stores, particularly where population impacts are widespread or road/telecommunication links are severed.

Regarding social environmental issues, it is accepted knowledge in the supermarket sector that the New Zealand population drinks and smokes a lot, and the demand for cigarettes and alcohol will be difficult to meet during extended supply chain shortages (which will then create knock-on psychosocial impacts).

At the last census (2018)[15], 12.3% of the Otago population indicated they are regular tobacco smokers (roughly 27,700 people), and in the health indicators for the 2022/23 year, roughly 76.3% of the New Zealand adult population consumed alcohol in the past year (~130,600 adults)[16].

[15] https://www.stats.govt.nz/tools/2018-census-place-summaries/otago-region#population-and-dwellings
[16] https://www.health.govt.nz/nz-health-statistics/health-statistics-and-data-sets/alcohol-use-data-and-stats

Panic Buying

Most supermarkets run with a 2-3 day supply of goods ('just in time' supply), however buying behaviours may cut this down to 24hrs very rapidly.

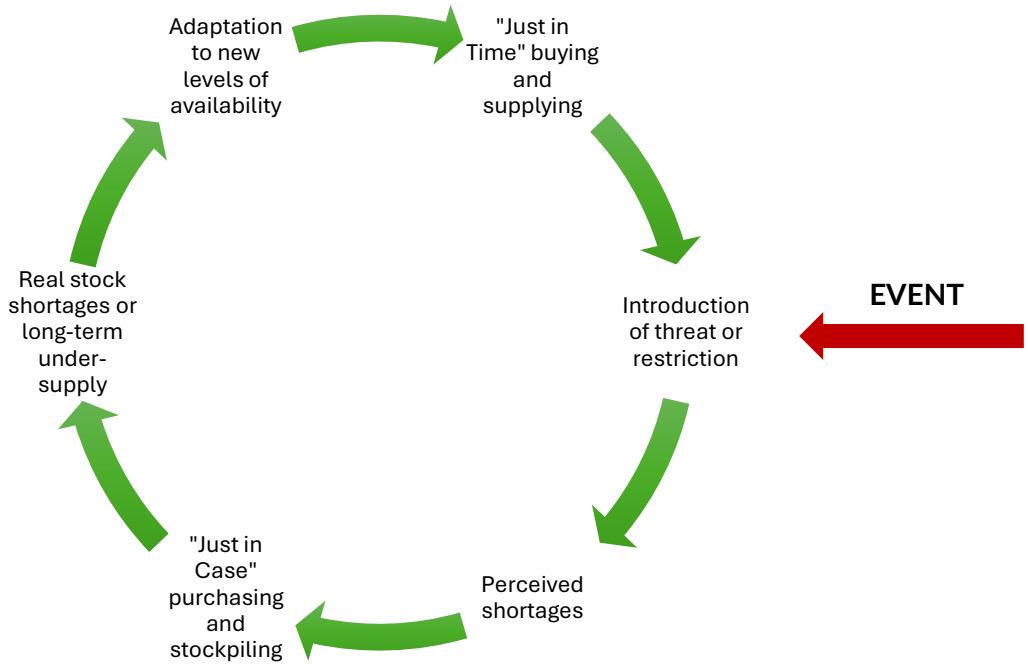


Figure 24 - Impact to supermarket supply and demand in an event

The event of COVID-19/ and the 2020, 21, & 22 lockdowns gave supermarkets a clear indication of high-consumption/turnover items, allowing them to better understand consumer behaviours:[17]

- Meat
- Poultry
- Toilet Paper
- Hygiene (soap, sanitiser)
- Deodorants
- Pet Food
- Sanity Pads
- Nappies
- Baby Formula

Photo: Rob Stock / Stuff.co.nz (23rd Jan, 2022)

Caption: "Panic-buying of toilet paper was evident at the Greenlane Countdown in Auckland, where staff said there had been a 'mad' three hours starting just before Prime Minister Jacinda Ardern made the announcement that the country would move to red setting in the traffic light system."

[17] Source: online interview with Woolworths resilience lead (April 2024).

Woolworths

(Previously Progressive Enterprises, retailers are Woolworths, FreshChoice, SuperValue)

The distribution centres in the South Island for Woolworths are all located in Christchurch. **Primary Connect** is the distribution/supply chain manager and holds the contract for the whole country, including international supply (Australia). All three distribution centres have back-up power generation and the GenSets onsite have supplies of fuel.

Presently there are some contingency plans in place around telecommunications: a project is due for completion in June 2024 which will furnish Woolworths with a satellite-based redundancy across their critical sites.

2x Woolworths stores in Otago also have pharmacies on site, these are operated under agreements with Te Whatu Ora and are supplied by a national warehouse in Auckland. Although the stock is slow moving, these items can be air freighted (flown) if necessary.

Following any kind of major event where the failure of reticulated water supply was a concern, the distribution centres (fresh) would urgently require tanked water for food preparation and hygiene.

Contingency planning is in development (not anticipated for completion in FY 2024/25) to formalise a process to establish an emergency satellite warehouse (distribution centre) within 10 days of a major emergency event (if an appropriate space/facility can be secured).

Woolworths has an additional project underway to identify critical stores (hubs) that are remote from any other supermarket (greater than 25km from the nearest store or competitor). Where a store is identified as a hub, there is the option to close other nearby (Woolworths owned) stores to push resources into supporting/running the hub. These locations would be also prioritised in terms of restoration and targeted for resilience projects.

Foodstuffs

(New World, Pak n Save, Four Square, Raeward Fresh, On the Spot, Trents, Liquorland)

Foodstuffs have distribution centres in both Christchurch and Dunedin. Both sites have their own water well (bore), however, Dunedin is an ambient distribution centre only. Power generation at the Hornby DC has enough fuel onsite to run the facility for a couple of days.

Unlike Woolworths (nationally managed supply chain), Foodstuffs has a large number of franchisees who leverage a 'supplier direct' model in some areas or for specific goods. This provides some redundancy in relation to securing products from local sources.

Diesel supply for Foodstuffs has redundancy in the form of their Pak n Save fuel sites. New World Queenstown is currently investigating the installation of a permanent generator to support the store when there is a loss of electricity.

Distribution Centres

Foodstuffs South Island operates central distribution centres (DCs) located at Hornby in Christchurch, as well as in Dunedin. These DCs are replenished by the central buying team located at the Foodstuffs Corporate office in Papanui.

Foodstuffs South Island Limited operates three distribution centres within the South Island:

Centre	Address	Region	Range
Dunedin DC	Midland Street Dunedin	South Island South of Timaru	Proprietary Brand Stock Keeping Unit's (SKU's)
Hornby DC (Ambient)	Quadrant Drive, Hornby	Total South Island	Proprietary Brand SKUs, Centralised slow-moving SKUs, general merchandise, imported SKUs
Hornby DC (Chilled/Frozen)	Quadrant Drive, Hornby	Total South Island	Centralised distribution of all chilled and frozen SKUs

For a list of Foodstuffs main/large supermarket sites, see appendix.
(this has been edited for brevity, and does not include convenience stores, supermarkets in malls, or outlets in partnership with service stations).

Woolworths New Zealand Limited (former Progressive Enterprises) has several distribution centres throughout the country, however only three located in the South Island, all in Canterbury Region.

Centre	Address	Region	Range
Christchurch ARDC	Shands Road, Hornby	Total South Island	Ambient
Christchurch Fresh	Hynds Drive, Rolleston	Total South Island	Fresh
Americold Christchurch	Halwyn Drive, Hornby	Total South Island	Chilled

For a list of Woolworths main/large supermarket sites, see appendix
(this has been edited for brevity, and does not include convenience stores, supermarkets in malls, or outlets in partnership with service stations).

Financial Providers

The financial sector has become a key part of enabling people to get through emergencies. The loss of key lifeline utilities, such as power and communications can result in difficulty in accessing cash, processing payments and supporting retailers.

The financial sector is coordinated by the Reserve Bank of New Zealand (RBNZ) in an emergency. RBNZ is required through the Reserve Bank of New Zealand Act 2021 to maintain the financial system within New Zealand and enable the availability of cash. In an emergency, the RBNZ will coordinate with the financial providers to ensure that the financial systems within New Zealand are able to operate as soon as possible.

Given the security requirements for the provision of cash into society, many of the arrangements for emergencies are of a high degree of sensitivity and are unable to be made public. However, in the main the RBNZ will work with the banking and financial sector to:

- Secure assets and cash reserves
- Provide alternate cash points for the public.
- Provide alternate communications to enable cashless transactions.
- Provide access to smaller denominations of currency for retailers (e.g. change)
- Provide for the transit of cash.
- Provide advice to the banking sector.

Many pre-existing contracts exist between the RBNZ and providers to enable the above to occur quickly in BAU and in an emergency.

Banking branches within Otago

The Otago region has numerous banks across the region, with many operating different levels of service. Many of the banks are impacted by loss of power, communications, or damage to the facility and access from events. While some have a lesser risk from earthquakes, all would likely be impacted by the disruptions to power production. Some may be directly impacted by building damage.

The RBNZ is currently working with the banking sector to improve access to alternate communications, with most now having access to Starlink. The number that can connect, or have access to alternate power supplies is currently unknown.

Bank branches located in the Otago region are shown in the appendices on pg. 110.

Automatic Teller Machines (ATMs)

Automatic Teller Machines (ATMs) are the most common way for people to access cash. There are many ATMs located across the region, both associated with the main banks and with other financial providers. These are reliant upon several other lifelines to ensure their operation, a consistent power supply, telecommunications, and road access for the replenishment of cash within the machine.

Temporary ATMs can be installed in an emergency where there is access to power, telecommunications and an ability to maintain the cash within them. It is likely that there are ATMs being privately operated within various locations throughout the region, as shown in the appendices, pg. 111-112.

EFTPOS System

Many businesses now operate on a predominantly cashless system, utilising the EFTPOS system for the majority of transactions. While this operates well in normal circumstances and reduces the need for retailers to keep large cash reserves on site, it is greatly affected by the loss of power and telecommunications.

Many mobile EFTPOS devices are now available, and these present an opportunity to continue services if there is access to telecommunication services and a power source to recharge the EFTPOS machine.

Regional Hazards and Impacts

Much of the region's key infrastructure is exposed to hazards, with some assets more exposed than others. This section outlines the hazards and the potential impacts on the region's infrastructure.

Earthquake

Most earthquakes occur on faults, which are weaknesses in the Earth's crust. A large number of active faults lie within Otago and many further afield are capable of affecting the region (in New Zealand a fault is generally considered active if it has ruptured in the last 120,000 years (MfE, 2003).

Faults build up pressure and then release energy in the form of seismic waves. When this energy is released, it can cause surface rupture, uplift or subsidence, ground shaking, liquefaction, and lateral spreading.

Surface rupture involves land movement on either side of a fault, generally confined to a relatively narrow corridor along the fault trace. This can range in length from a few metres to hundreds of kilometres with ground displacements of several meters possible. Any assets on top of this area may be affected.

Ground shaking is caused by the release of energy as it travels through the ground. The intensity of ground shaking is determined by the ground conditions, the land deep beneath our feet, earthquake location and magnitude and the direction the earthquake fault ruptures. One earthquake will be felt differently across a region, and therefore, it is common to see a range of hazard results, even within one region.

Liquefaction and lateral spread occur when saturated fine-grained sediments (such as sand and silt) are subjected to high intensity shaking and lose their ability to stay cohesive, causing deformation, settlement, and sometimes lateral spread towards rivers or lakes. Areas with fine-grained and unconsolidated sediments, soils, and high groundwater tables are susceptible to liquefaction and settlement. The Canterbury earthquakes showed liquefaction 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.

The region's exposure to earthquake hazards, particularly the Alpine fault, places many services in the Queenstown Lakes District and Central Otago at a high degree of risk, in particular electricity production, roading and three waters services.

AF8 Safer Framework

The Otago CDEM Group has been a partner in the Alpine Fault SAFER project since its inception in 2016. This project has sought to develop credible scenarios for a rupture of the Alpine fault, based on historical and geological evidence. The current science points to a significant rupture occurring on this fault approximately every 300 years, however, geological studies have shown that we are currently in a heightened period of risk, with the likelihood of a major rupture of the fault occurring within the next 50 years at 75%.

The potential impacts from an event of this scale and the likely response to an event are detailed within the AF8 SAFER Framework.[18] A number of workshops have been held within the region to determine the specific impacts of an AF8 event and the potential lifeline implications.

[18] https://af8.org.nz/media/tmkaaiwe/af8-safer-framework-2018-lr.pdf

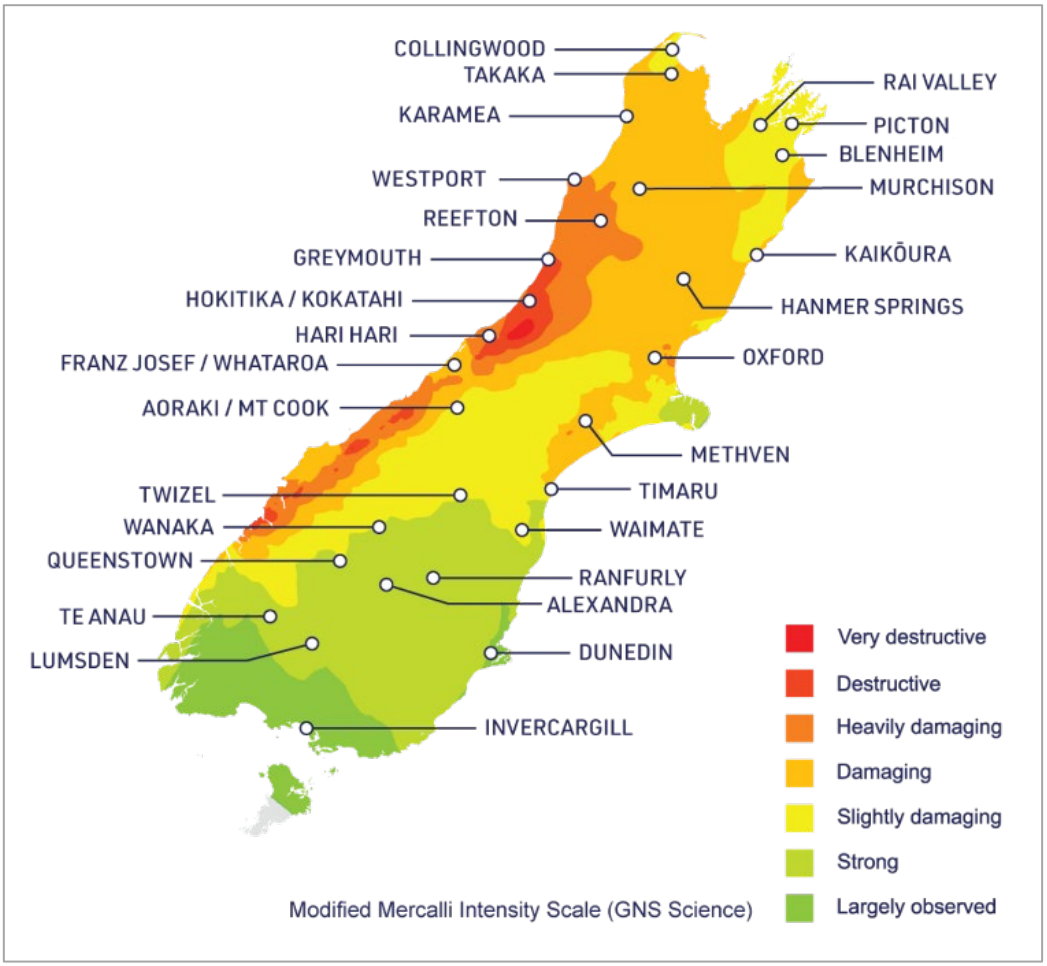


Figure 25- Modified Mercalli shaking intensity for an Alpine Fault rupture from South to North (Fiordland to Kelly)

Impacts on Lifelines sector from Earthquake events

Lifeline sector	Potential implications of earthquake hazard
Water production and supply	In a major earthquake, widespread damage can be expected to local reticulation networks, particularly in liquefaction-prone areas. Service restoration times will likely be weeks to months, and full recovery will take years. Modern, major assets providing bulk supply services, such as treatment plants, storage reservoirs and larger pump stations, have generally been designed to withstand seismic events and have controls to shut off supply following an earthquake. However, there are still several older critical assets that are at risk in liquefaction-prone soils and subject to seismic damage, including: • Somerville Street water pump station (servicing the peninsula, Dunedin). • Tainui and Portobello Stormwater pump stations (servicing South Dunedin). Dunedin City Council has identified the need for a seismic strengthening programme on major water storage tanks, and this plan is pending approval. • Māori Hill treated water reservoir. • North End treated water reservoir. • Greenhills treated water reservoir. • Wingatui treated water reservoir. • Quarry Hills treated water reservoir.

Lifeline sector	Potential implications of earthquake hazard
Wastewater services	The following wastewater assets are located in liquefaction-prone areas and may be impacted by an earthquake: • Musselburgh wastewater pump station (servicing most of central Dunedin) • Tahuna Wastewater Treatment Plant
Stormwater services	Stormwater services are likely to be impacted in liquefiable soils due to cracking and movement of pipes. In addition, pumps will be affected by damage to other lifeline services, such as electricity and telecommunications.
Flood schemes	Flood schemes are likely to be significantly impacted by earthquake events, particularly where these are located close to the epicentre of the quake. Earthquakes are likely to cause damage to stop bank and flood protection structures and potentially change the course or height of the riverbed, increasing the risk of flooding and decreasing the effectiveness of the protection structures.
Electricity Production	The majority of electricity production in the region is from hydropower stations, many of which are located in the high country of the region. Any major rupture of a fault causing widespread severe shaking in Otago will result in the immediate shutdown of the hydro dams until a full inspection of their structural integrity can be completed.
Electricity distribution	Both overhead and underground distribution infrastructure can be affected by an earthquake. This may be as a result of liquefaction, subsidence, lateral spread or loss of a transporting asset, such as a bridge.
Telecommunications	Telecommunications assets, such as aerials and repeaters can be impacted by earthquake. The majority of impacts relate to the requirement for a power supply and may assets are impacted through loss of alternate power supply, rather than total destruction or damage to the asset itself.
Roading infrastructure	Numerous roads within the Otago region are potentially prone to impacts from earthquakes, such as surface cracking, slips, washouts, liquefaction and subsidence. All significant state highway bridges meet seismic strengthening standards. The following are those listed within 'Critical State Highways' risk tables for earthquakes: • SH1: Waitaki Bridge (to be strengthened in 2017), Waiareka Creek Bridge, Kakanui Bridge, Waianakarua North River Bridge, Waianakarua South River Bridge, Pleasant Valley Bridges (two) & Balclutha Bridge. • SH6: Victoria Bridge (Kawarau Gorge) & Albert Town bridge • SH90: Pomahaka bridge. • SH8: Alexandra bridge & Luggate bridge (SH8A) Dunedin City Council is currently assessing all bridges and significant retaining structures.
Rail network	Rail infrastructure may be affected due to land movement, slips, liquefaction, and damage to supporting infrastructure. Severe shaking may result in the movement of lines and the loss of bridges and tunnels.

Lifeline sector	Potential implications of earthquake hazard
	Landslips and rock falls are a key risk for the inland stretches of the rail network. Key areas of risk include the tunnel portals and the rail corridor in Seacliff, between Waikouaiti and Waitati, where the slope has been moving over the years. Post-event engineering checks is required for the full rail line. It is likely to take more than 3 days to complete all checks on the network, but this will be dependent upon the scale of damage across the region.
Airports	Airports within the region may see some impacts to runways, terminals, and other supporting services. Airfields and airports located near faults may be more vulnerable. This includes Queenstown, Wanaka and the Dunedin Airport, which is located near the Titri Fault. The lack of supporting infrastructure is the biggest risk to the continued operation of the major airports in the region, rather than the total loss of runways.
Port Otago	Port Otago may see issues such as changes to the seafloor and channels, disruption of cargo services (e.g. loss of cranes, falling container stacks etc) and potential damage to wharves.
Fuel storage and distribution	Where ports are affected, this will disrupt tanker deliveries, risking fuel shortages/rationing. Road networks will hamper overland deliveries to many rural areas. The terminals will need to be structurally assessed/inspected before being able to operate, a minimum of 2-3 days.
Waste management facilities	A large earthquake is likely to create significant amounts of debris and may require specific sites to be established for the management of waste streams. The operation of waste facilities may also be impacted by the loss of connecting roads, electricity and other services.
Fast moving consumer goods	Disruption of road, rail, and port will likely sever supply chains from the north (primary distribution centres for supermarkets) causing shortages at supermarkets and pharmacies. Distribution centres without potable water access will not be able to prepare food for sale (washing or packing), and some areas will not be able to provide fresh food (meat, dairy etc.) due to lack of power/GenSets/refrigeration.
Finance	A large earthquake is likely to have a major impact on the ability for financial services to operate. This may be due to damage to key assets, such as banking facilities and ATMs, or as a result of impacts to other services, such as telecommunications, electricity and roads within the region.

Tsunami

A tsunami is a series of fast-moving waves caused by a large disturbance in the sea, on the ocean floor, or even in a lake (Power, 2013). Tsunami can be generated from earthquakes, volcanic eruptions or underwater landslides. These events may occur close to the New Zealand coastline or across the other side of the Pacific Ocean.

A tsunami could impact the districts of Waitaki, Dunedin and Clutha across 480 kilometres of coastline. Low-lying land near the coast and lakeside communities are most vulnerable to the effects of tsunami, although harbours, offshore islands and headlands do afford a degree of protection

Local Source

This is any tsunami that originates within an hour's travel time to the nearest coast. Examples of possible local source tsunami for Otago are:

- a Puysegur Trench earthquake creates a tsunami of up to 6 metres high in some locations.
- a local offshore fault earthquake, such as the Castle Hill, Akatore, Takapu, and Waihemo fault systems, creates a tsunami up to two metres high in some locations.
- a landslide into oceans

Regional source

This is any tsunami that originates between one and three hours of travel time to New Zealand. This may include events that occur off the east coast of the North Island (Hikurangi subduction zone / Tongan – Kermadec Trench) or from sub-sea volcanoes.

Distant source

This is any tsunami that originates from sources with a travel time of more than three hours to New Zealand, such as South America and, to a lesser extent, North America and the Aleutian Islands. Several faults capable of producing tsunami are located in subduction zones at the edges of the Pacific Ocean (Powell, 2013).

Lake Tsunami and Seiche

This is a tsunami caused by significant movement of the lake bed or substantial rockfall into the lake. Several major lakes are located near to the Alpine Fault, Including Lakes Wakatipu, Lake Wanaka and Lake Hawea. A tsunami occurred in Charles Sound after the Fiordland earthquake in 2003. Due to the remoteness, nobody was affected; however, a rockslide caused a 4-5 meter tsunami 800 metres away (Mackey and Goldsmith, 2015). In addition, many historical events have occurred on lakes within the region between 1864 and present as detailed in the report Tsunamis, seismic seiches, and undetermined wave events on New Zealand lakes, 1846–2022: a review J. L. Benn[19]

[19] https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc338entire.pdf

Storm Surge / Coastal Erosion

The term storm surge describes a state of elevated sea level due to a combination of tides, wind-stress, atmospheric pressure and waves and storms (NIWA, 2007).

Detailed modelling of selected communities along the Otago coastline by NIWA (2008) considered a range of storm surge return periods between 20 and 500 years. This modelling suggests that for storm surge events with return periods as low as 20 years the sea may reach a level of up to 2.37m above msl on the Otago coastline (NIWA, 2008). Storm surge can inundate land, often for prolonged periods resulting in damage to buildings, roads and submerged infrastructure. Storm surge waters may also entrain debris which can cause additional damage.

Combined impacts: Tsunami and Storm Surge / Coastal Hazard

Lifeline sector	Potential implications of tsunami / coastal hazard
Water production and supply	Wastewater and potable water networks are particularly vulnerable to tsunamis at their facility buildings and pipe intake and outflow sites. Even small amounts of seawater intrusion from a tsunami can contaminate drinking water supplies or sewerage containment ponds. This is particularly significant in relation to the Tahuna Wastewater Treatment Facility in South Dunedin due to the population served. Warrington, Seacliff, and Waikouaiti WWTP are also located on the coast at sea level and may be prone to tsunamis.
Wastewater services	
Stormwater services	Stormwater services in coastal communities may be affected by inundation, damage to pumping assets and blockage of existing networks with debris and sediment. These may also suffer from seismic damage prior to any inundation, which can make restoration difficult.
Flood schemes	Tsunami may result in some damage to flood schemes where overtopping occurs, but in general, these are likely to provide a degree of protection from inundation
Electricity Production	Most of the electricity production is inland and unlikely to be impacted by tsunami
Electricity distribution	Electricity distribution infrastructure in coastal areas, such as lines and cabinets may potentially be impacted by inundation and debris
Telecommunications	Telecommunications assets, such as fibre links, cables and cabinets located in coastal areas, or crossing bridges near to coastal inlets, may potentially be damaged by inundation and debris
Roading infrastructure	State Highway 1 passes through low-lying coastal areas in a number of places, notably around Waitati and north of Palmerston (Katiki Straight and the Karitane Straight). Brighton Road, a key arterial road in Dunedin, also runs along the coast.
Rail network	Significant stretches of Otago's rail network run alongside the coastline including through Oamaru, between Hampden and

	Palmerston and from Dunedin to Port Chalmers. Here the line is susceptible to coastal erosion and storm surge, as well as damage through tsunami inundation and debris. In a major tsunami it is likely that the Rail line will be significantly impacted in many places, perhaps permanently.
Airports	No major airports within the region are at risk from tsunami.
Port Otago	The port may be impacted by surges from tsunami. Impacts may include damage to wharves and infrastructure, damage to vessels and changes to channels within the port entrance
Fuel storage and distribution	Fuel storage is located on the wharf at Port Otago. It is located outside of potential tsunami inundation but may be affected by damage to other lifeline sectors. If shipping lanes are affected, this will disrupt tanker deliveries, risking fuel shortages/rationing. Damage to bridges may hamper overland deliveries to many rural areas.
Waste management facilities	There are no waste management facilities located in inundation areas. However, any tsunami is likely to create significant amounts of debris and may require specific sites to be established for the management of waste streams. The operation of waste facilities may also be impacted by the loss of connecting roads, electricity and other services.
Fast Moving Consumer Goods	The FMCG sector is reliant upon key routes being accessible to resupply stores across the region. Disruption of road, rail, and port in the coastal areas will likely delay supply chains from the north (primary distribution centres for supermarkets) causing shortages at supermarkets and pharmacies. However, many alternate inland routes will still be available, so any impacts are likely to be short-term.
Finance	No financial providers have assets located within tsunami inundation hazard-prone areas. However, these may be affected by damage to other lifeline service providers,

Severe weather events / Flooding

Severe weather is one of the region's major hazards and can create a wide range of impacts.

The majority of severe weather events within the region are as the result of low-pressure systems forming in the Southern Tasman Sea, or from ex-tropical cyclone events moving down from the North. These systems often result in heavy rainfall, high winds and large seas. In winter months they may also result in significant snow fall. In addition, these events can create secondary hazards, such as flooding, landslides and coastal inundation.

The Otago region has many large bodies of water and a number of large rivers, fed from the high country and glaciers of the Southern Alps. The rivers and lakes have the potential to cause widespread flooding throughout the region and several significant floods have occurred over the past 50 years, both from rivers, such as the Taieri and Clutha, and from the overtopping of the lakes in Queenstown (Lake Wakatipu) and Wanaka (Lake Wanaka).

During the winter months, the Otago region can be exposed to southerly storms that can bring low temperatures and high levels of precipitation. In high country areas of Central and Western Otago, this precipitation falls as snow, generally above 500m elevation. However, in some circumstances the temperatures can be low enough for the entire region to be exposed to significant snowfall and past events have seen several centimetres of snow down to sea level.

Lifeline sector	Potential implications of Severe weather hazard
Water production and supply	Water supplies sourced from rivers are likely to have water intakes disrupted during floods on those rivers. However, the local authorities that own these supplies note that supply can be quickly restored once flood water recedes and major damage to assets is unlikely. Some water treatment plants are also in flood-prone areas, including Balclutha, Mosgiel, and Taieri bores (Dunedin). These are typically bunded to protect against an estimated 1:100-year event. Larger flood events have the potential to inundate the treatment plant areas and may cause service disruption and damage to plant. Some raw water intakes, including the Waikouaiti River, West Taieri, and Outram bores (Dunedin), may be vulnerable to flooding. Resilience is built into the system; for example, if the Waikouati River floods and water quality is affected, abstraction is automatically stopped.
Stormwater services	Stormwater services may be impacted by the deposition of silt throughout the network, reducing or blocking flows, or damage to pipework and infrastructure, such as pump stations.
Wastewater services	Wastewater pump stations are often in low-lying or coastal areas as they typically receive gravity-fed wastewater and pump this to treatment plants. The impact of flooding of pump stations is that flood waters will be contaminated with wastewater; however, whether asset damage occurs depends on the pump station design. All areas have some pump stations in flood-prone areas; the larger pump stations likely to be impacted include:

Lifeline sector	Potential implications of Severe weather hazard
	• Musselburgh pump station (Dunedin) • Mosgiel Wastewater treatment plant transfer station (to Green Island) (Dunedin) There are also several treatment plants in flood-prone areas—again, by their nature, these sites are often close to waterways. However, other than temporary disruption to treatment capacity and contamination of flood waters, major damage from flood waters is not expected. If there is some minor damage, service can be expected to be restored within a few days.
Flood schemes	Severe weather can result in significant rainfall and increased flows within the region's rivers, This may cause damage to flood protection structures and pumping assets.
Electricity Production	Severe weather is unlikely to impact electricity production. Many of the hydro dams have significant capacity and can manage large influxes of water into the system.
Electricity distribution	Severe weather can result in the loss of distribution infrastructure, from line breaks and damage to substations and distribution cabinets
Telecommunications	Telecommunications infrastructure can be affected through damage/loss of lines, damage to assets such as aerials and towers and loss of key services such as electricity.
Roading infrastructure	Almost all State Highways have sections of road within flood-risk areas. Historic events have shown that the most vulnerable roads include: • 4 sections of SH1: Hilderthorpe area, north of Hampden, south of Waikouaiti & south of Milton. • 4 sections of SH8: Lawrence to Raes Junction, Alexandra and Omarama Stream Flooding would typically result in localised impacts only, with minimal damage expected after flood waters have receded. Worst impacted areas are typically where the road crosses a waterway, so bridges tend to be more vulnerable.
Roading (continued)	Many of the key local roads within the region are prone to flooding, either from rivers, or from surface flooding. Some key areas include: - Taieri Plains - Balclutha and surrounds - Area surrounding the Kakanui River - Paradise Flat and surrounds of the Pomahaka River and its tributaries Snowfall generally impacts the roads in the high country, including state highways connecting the region to the West Coast, Canterbury and Southland. Some key routes that can become impassible in heavy snowfall events include: - SH1: Leith Saddle - SH6: West Coast

Lifeline sector	Potential implications of Severe weather hazard
	- SH6: Kawarau Gorge / Devils Staircase - SH8: Lindis Pass – Alexandra - SH8: Alexandra – Beaumont - SH8A: Luggate - SH85: Alexandra – Kyeburn - SH87: Kyeburn – Mosgiel - SH93: Clinton - Otaraia - Crown Range Road - Glenorchy Queenstown Road
Rail network	Otago is one of KiwiRail's most exposed regions nationally. The MSL provides the only connectivity and runs alongside the coastline including through Oamaru, Hampden to Palmerston and Dunedin to Port Chalmers. Flooding of the line is of particular concern for the stretch of line between Dunedin and Lake Waihola. This section of the MSL can be underwater when the Taieri River floods. Severe weather can also result in landslides, rock falls and wash outs. These are a key risk for the inland stretches of the rail network. Key areas of risk include the tunnel portals and the rail corridor in Seacliff, between Waikouaiti and Waitati, where the slope has been moving over the years.
Airports	The Dunedin airport is located in the Taieri Plains and is susceptible to flooding of the runway and supporting infrastructure in major events.
Port Otago	Severe weather may result in high winds that can affect port operations, including docking of vessels and container operations
Fuel storage and distribution	Fuel storage is unlikely to be affected, however, the distribution of fuel is reliant upon key routes, which may be impacted by flooding and slips.
Waste management facilities	Mt Cooee waste disposal site in Balclutha is partially in the flood hazard-prone areas and may be impacted during large events. The waste transfer station in Queenstown is outside of the flood hazard-prone areas, however the hardfill site is located on the banks of the Shotover River and may be impacted by floods.
Fast moving consumer goods	The FMCG sector is reliant upon key routes being accessible to resupply stores across the region. Disruption of transport networks will likely delay supply chains from the north (primary distribution centres for supermarkets) causing shortages at supermarkets and pharmacies. However, many alternate inland routes will still be available, so any impacts are likely to be short term. In addition, the distribution and storage of goods is reliant on many other services, including power, telecommunications and financial services. Any loss of these will also impact the ability to supply FMCG within the region.

Lifeline sector	Potential implications of Severe weather hazard
	The Dunedin distribution centre (Foodstuffs) is in a flood hazard-prone area.
Finance	Several banking assets are located within potential flood hazard-prone areas. These include: - ANZ Balclutha - Westpac Balclutha - BNZ Wanaka - Westpac Wanaka - ANZ Wanaka ATM - Westpac ATM Wanaka

Human Pandemic

A pandemic is an epidemic of infectious disease that spreads through populations across a large region.

The most recent pandemic to impact New Zealand is COVID-19. Several other events have impacted New Zealand in the past, including the 1918 Spanish Flu epidemic.

The major impact of human pandemics on lifeline utilities is the ability to continue operations due to workforce availability. A severe pandemic could result in large numbers of staff becoming unavailable, meaning services are unable to operate to full capacity, or in extreme cases unable to operate at all.

Cyber Attack / Global service outage

A cyber-attack is an assault launched by cybercriminals using one or more computers against a single or multiple computers or networks. A cyber-attack can maliciously disable computers, steal data, or use a breached computer as a launch point for other attacks. Cybercriminals use a variety of methods to launch a cyber-attack, including malware, phishing, ransomware, and denial of service.

A global service outage can be triggered by a virus, or loss of a key component from a system, disabling its ability to operate. Global outages are fairly common, but for short periods of time and generally in specific systems, such as Microsoft 365. However, as seen recently, the loss or corruption of a core system component (such as security software) can lead to significant impacts across many services, including lifelines.

Global estimates suggest there is a cyber-attack every 44 seconds throughout the day. Cyber-attacks that successfully attack large organisations or businesses happen less frequently. In mid-May 2021, Waikato DHB hospital computer systems and phone lines were affected by a ransomware attack causing significant disruption to the DHBs services. A sustained attack against infrastructure providers, specifically electrical distribution and telecommunications, could have a significant impact upon the Otago region. For the majority of lifeline sectors, the significant impact would be to existing operating systems, which could impact the ability to provide a full service to the Otago communities.

Drought

Drought occurs due to significant periods without rainfall and sustained warm temperatures. This results in reduced river and groundwater levels and impacts to plant growth and services that utilise water. It can also greatly increase the risk of wildfires.

The driest places in New Zealand are southern inland areas: in Central Otago, potential evaporation always exceeds precipitation (rainfall or snow), except in winter. This means that drought conditions are almost continuous.

The Otago region is prone to drought and has experienced severe drought over the past two decades. This is likely to increase with climate change, with the region seeing increased frequency and severity of droughts.

Wildfire

Wildfires can occur in forestry, agricultural production land and areas of scrub. Fires can be started naturally, by lightning strikes, or by arcing from electricity supply lines and acts of arson. Fire is most common when ground moisture levels are low and relative humidity in the air is also low, providing perfect conditions for ignition.

High winds can also result in larger fires, providing mobilisation for hot embers and fanning flames.

The risk of wildfire is at its highest in the summer months in New Zealand when ground conditions are at their driest. The Otago region has large areas of pine forestry that are susceptible to fire in dry conditions. In addition, numerous grass fires can occur in very dry summers.

Among the many consequences of climate change, wildfires are growing in intensity and spreading in range across Earth's ecosystems. Fire and Emergency NZ have already seen a greater occurrence of wildfires happening earlier during the warmer months.

Areas in Otago exposed to wildfire risk include rural areas, native or plantation forests, shrub lands and grasslands. In addition, wildfires can also travel across the rural-urban divide, exposing buildings and infrastructure to this risk. Key services, such as telecommunications and electricity distribution assets often cross areas prone to wildfire and services can be disrupted due to damage caused by fire. The roading network may be impacted, but physical damage to key routes is unlikely and quickly recoverable. The rail network may be impacted, as trains are not able to operate near fire. Over a quarter of rail sleepers on the MSL through Otago are wooden, and there are also wooden components of many bridges. In addition, there is a risk of metal track buckling due to heat from wildfires or in extreme hot conditions.

Coastal erosion/inundation (Storm surge)

Coastal erosion is caused by waves, tidal currents, drainage or high winds. Parts of the Otago coastline have significant levels of erosion and several infrastructure assets are at risk from this, including sections of State Highway 1. High marine sea states from storms can exacerbate the rate of erosion and can also cause inundation of low-lying coastal areas.

Climate Change is expected to increase the frequency and magnitude of storm events at our coasts. This may affect the severity of erosion impacts along our coastlines and exacerbate coastal erosion hazards in our coastal communities.

Space Weather / Solar Storms

Driven by the Sun, space weather occurs in the areas between the Sun and other planets in the solar system and tends to impact Earth much higher in the atmosphere than meteorological events. Solar activity follows an approximately 11-year cycle, with sunspot activity peaking at 'solar maximum.' The next 'solar maximum' is predicted to occur in 2025.

During times of high activity, coronal mass ejections (CME's) come from the Sun: these are large expulsions of plasma and magnetic field from the Sun's corona. When a CME reaches Earth, it affects our magnetic field causing auroras. The fastest Earth-directed CMEs can reach our planet in as little as 15-18 hours; slower CME's can take up to three days to reach Earth.

Solar flares are large eruptions of electromagnetic radiation from the Sun. Unlike CME's which can be 'forecast,' the sudden outburst of electromagnetic energy travels at the speed of light: any effect upon the sunlit side of Earth's exposed outer atmosphere occurs around the same time that the event is observed.

Flares can last minutes to hours, and they contain tremendous amounts of energy. Travelling at the speed of light, it takes eight minutes for the light from a solar flare to reach Earth. Some of the energy released in the flare also accelerates very high-energy particles that can reach Earth in tens of minutes.

Although uncommon, large space weather events have occurred in New Zealand in the past, causing electricity blackouts and damage to infrastructure. [20]

Solar Storm 12-14th May 2024

In 2024 New Zealand experienced a significant solar storm that caused auroras around the world. The weekend storm displayed magnetic field changes larger than the biggest space weather event of 2001 (in the GNS Science digital records).

During this time electrical and radio broadcast assets were protectively isolated (such as transmission lines in Central Otago), and a grid emergency was pre-emptively declared.

Queenstown (Supplied / Emmilee Fendall Leech)

Solar storms are a significant issue for the production and distribution of electricity. Geomagnetically induced currents cause the 'exciting current' in power transformers to operate out of their designed range, resulting in saturation of the magnetic core material inside the transformer. Once the core saturates, the transformer no longer provides any back 'electromotive force' (a kind of electrical inertia) and the currents and voltages in the windings become abnormally large. Depending on the transformer design, this can lead to heating of the surrounding structures due to induced 'Eddy Currents' which have the potential to damage parts of the transformer.

Equipment trips can take needed equipment offline and cause voltage stability problems. A system that is near peak levels of demand prior to the geomagnetic storm event may not be able to meet the total power demand when the geomagnetic storm occurs, leading to partial or system-wide blackouts.

[20] https://www.geonet.org.nz/news/7CXlGbEfwGAiCITzbEkFYc

Otago's Infrastructure Hazard Vulnerability

Risk Assessment Process

The risk of hazards on each lifeline has been determined utilising the National Emergency Management Agency's (NEMA) Risk Assessment tool, as outlined in the DGL23/22 Risk Assessment: Guidance for CDEM Group planning.

While this risk assessment provides an overview of the potential impact of a hazard across the region, it does not determine risk and impacts at a local level, or to individual organisations, which may vary from the regional results. The risk to specific sectors has been determined through workshops, surveys and available hazard information. The overall risk is defined based on the likelihood of the hazard occurring and the scale of impact it may have upon a specific lifeline sector.

The risk assessment utilises Maximum Credible Event (MCE) scenarios to ensure that all the possible impacts of a specific hazard are captured. The scenarios utilised to determine the risk levels from each hazard are shown in the appendices. While these scenarios represent the worst-case scenario, they represent only one possible scenario amongst many that could occur. The use of MCE scenarios also means the likelihood of occurrence is different to smaller scenarios, which may occur more frequently.

The likelihood for a hazard is determined using the Annual Return Interval (ARI) or Annual Exceedance Probability (AEP). These are set based on historical records of event and scientific research. There are five levels of likelihood of occurrence, as below:

Likelihood Classification	Likelihood Description	AEP (%)	ARI (Annual Return Interval) (rounded)
Rare	Almost certainly not to occur but cannot be ruled out	<0.1	>1000
Unlikely	Considered not likely to occur	0.1 - <1	>100 - 1000
Possible	Could occur, but is not expected to	1 - <10	>10 - 100
Likely	A good chance that it may occur	10 - <63	>1 – 9.5
Almost Certain	Expected to occur if all conditions met	≥63	≤1

The level of consequence utilises descriptors for each specific sector. **These are shown in the appendices.** The general categories and descriptions are shown below:

Level of Consequence / Impact	Descriptor
Insignificant	No impact or negligible impact on the services/functions they provide
Minor	May have some impact, but likely to be restored within days
Moderate	Impacts may affect parts or all of the network for a number of days to a few weeks
Major	Impacts may affect parts or all of the network for weeks to months
Extreme	Impacts are likely to have a permanent affect to assets and services, with potential to restore limited, or not possible

Lifeline Utility Interdependencies

Many of our lifeline utilities cannot run independently from one another. Each sector relies on services from another to maintain normal business as usual (BAU) operations, with the most common requirements being power, communications, roading and fuel. In an emergency, there may be a reliance on other lifelines in addition to those identified in BAU to support restoration. The following two tables are taken from Part B of *'Aotearoa New Zealand's Critical Infrastructure: A National Vulnerability Assessment'* (2023)[21].

Sector / Service	Dependence on that service by other lifeline utilities
Water Supply	▪ Water supply and wastewater services are critical for the community, both for public health and firefighting purposes, as well as some dependence on these services by other lifelines. For example: ▪ Fuel terminals require a high-capacity water supply (or alternative firefighting capability). ▪ Building services require water and wastewater for health reasons, though alternative arrangements can be made - such as re-location or using bottled water supplies and temporary wastewater facilities. ▪ Water required for air-conditioning and plant cooling operations in some sectors. ▪ Air transport requires water supply at the airport (for passenger services for commercial flights), and telecommunications requires water for equipment cooling. ▪ Natural gas electricity generators require high quality water for cooling and compression.
Wastewater	▪ Wastewater pump stations and treatment plants rely on electricity and there is limited availability of backup generation apart from the most critical sites. ▪ Limited dependence on wastewater by other utilities, apart from airport operations.
Fuel	▪ All lifelines require fuel for plant and vehicles for service personnel. If electricity is affected, diesel supply to critical sites to operate back-up 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.
Gas	▪ Lifelines networks are not generally reliant on gas for network operation, with the exception of gas-powered electricity generators.
Solid Waste	▪ Roads have a higher BAU dependence on solid waste than other lifelines, due to the larger amount of construction activity and waste. In a damaging event, waste disposal become critical for clearing debris of roads and properties.
Stormwater / Flood Protection	▪ Drainage is most important for roads and at airports. There are also many individual assets reliant on stormwater and flood protection systems, however these represent a small % of the overall networks and have only been assigned a '1' dependency rating.
Financial Payments	▪ Financial payments systems are widely used across all sectors, most frequently for fuel, food and materials payments. In a response, there are likely to be a much larger number of transactions in some sectors, such as solid waste and air transport. Cash provides an alternative if electronic payments are down.

[21] pp. 22-23: https://www.nzlifelines.org.nz/site/assets/files/1019/nva_part_b_main_report_v1_0_sept_2023.pdf

Sector / Service	Dependence on that service by other lifeline utilities
Electricity	▪ During normal operations, electricity is required to operate most of the other lifeline utilities to some degree and, because of this dependence, typically utilities have backup power (batteries, generators) at their most critical sites. ▪ A widespread regional electricity outage would, after varying periods of time, still impact on telecommunications, water supply, wastewater, gas, fuel supply and traffic management services.
Telecommunications	▪ A major telecommunications failure will impact the business sector and wider community and impede the efficiency of utility businesses. ▪ Almost all businesses rely on telecommunications to operate and to receive payments. However, most utilities could continue core services without telecommunications in the short term. Impacts on control systems would mean that some utilities would need to revert to manual operation and monitoring of facilities and response to service requests could be impaired. As technology enables more complex operations arrangements, the service impacts of reverting to manual operation may be significant. ▪ The situation changes in an emergency because telecommunications become critical for coordinating response and recovery efforts. The cellular network may become overloaded during or shortly after an event. However, the copper, fibre, and wireless infrastructure (including cellular) and satellite services provides diversity. Most utilities use a combination of the above technologies and some have their own dedicated network of links and radio.
Broadcasting	▪ Broadcasting is not generally considered a critical supply to other utilities during business as usual. However, in a response situation, particularly where other telecommunications are impacted, broadcasting is a means of communicating public information such as to issue warnings, road disruptions, public water supply warnings and advising of fuel shortages. Some broadcasters are designated lifeline utilities, so have an obligation to relay this information.
Roads	▪ The road network is important for all utilities to operate, particularly for sea/air/rail networks which are connected by road and used for fuel distribution. FMCG, Financial payments and Cash System Networks need roads for food and cash movements. ▪ Road failures during business-as-usual may affect response to service requests and asset failures. In an emergency, staff need to be able to access facilities and diesel, and plant needs to be transported to sites.
Air Transport	▪ Air services also become important to other lifelines in a major disaster; to assess damage, bring in responders, equipment and spares and access sites when there is significant road disruption. It may be the only source for critical supplies in the early days of an event where roads are heavily disrupted and can be critical for evacuations.
Sea Transport	▪ The fuel sector is reliant on shipping for distribution of fuel, though most other sectors do not have a major dependency on sea transport during BAU operations. ▪ In a major disaster, some regions may be heavily dependent on sea transport for provision of emergency supplies (for example, Wellington and West Coast of the South Island) or evacuation of people.

Figure 26 - Lifeline interdependencies.

The next pages contain the results of the Otago Lifelines Risk Assessment, and an understanding of lifeline utility interdependencies (as determined during workshops and correspondence, February-June 2024)

Otago Region Lifelines Risk Assessment (2024)

The overall risk to each lifeline from key hazards is shown in the table below.

	Severe Earthquake		Severe weather - Flooding		Drought - Wildfire		Snow storm		Tsunami		Coastal erosion / inundation (Storm surge)		Cyber attack		Solar storm event	
	Likelihood of MCE scenario occurrence															
	Possible*		Possible		Possible		Possible		Rare		Possible		Unlikely		Unlikely	
	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level
Water production and supply	Extreme	Very High	Moderate	High	Moderate	High	Moderate	High	Minor	Low	Minor	Medium	Moderate	Medium	Moderate	Medium
Wastewater services	Extreme	Very High	Major	Very High	Moderate	High	Moderate	High	Moderate	Low	Minor	Medium	Major	High	Moderate	Medium
Stormwater services	Extreme	Very High	Major	Very High	Minor	Medium	Minor	Medium	Moderate	Low	Moderate	High	Insignificant	Low	Insignificant	Low
Flood schemes	Extreme	Very High	Extreme	Very High	Insignificant	Low	Minor	Medium	Moderate	Low	Moderate	High	Insignificant	Low	Minor	Low
Electricity production	Extreme	Very High	Major	Very High	Insignificant	Low	Minor	Medium	Insignificant	Low	Insignificant	Low	Major	High	Major	High
Electricity distribution	Major	Very High	Moderate	High	Major	Very High	Moderate	High	Moderate	Low	Insignificant	Low	Extreme	Very High	Major	High
Telecommunications	Extreme	Very High	Major	Very High	Major	Very High	Moderate	High	Moderate	Low	Minor	Medium	Major	High	Major	High
Roading networks – State Highways	Extreme	Very High	Major	Very High	Moderate	High	Moderate	High	Moderate	Low	Moderate	High	Insignificant	Low	Insignificant	Low
Roading networks - Local Authority	Extreme	Very High	Major	Very High	Major	Very High	Moderate	High	Moderate	Low	Moderate	High	Minor	Low	Minor	Low
Rail network	Major	Very High	Major	Very High	Moderate	High	Moderate	High	Moderate	Low	Major	Very High	Moderate	Medium	Moderate	Medium
Airports	Extreme	Very High	Major	Very High	Moderate	High	Minor	Medium	Minor	Low	Insignificant	Low	Minor	Low	Minor	Low
Port Otago	Moderate	High	Moderate	High	Minor	Medium	Minor	Medium	Moderate	Low	Minor	Medium	Moderate	Medium	Major	High
Fuel storage and distribution	Major	Very High	Moderate	High	Minor	Medium	Minor	Medium	Moderate	Low	Minor	Medium	Minor	Low	Moderate	Medium
Waste management facilities	Extreme	Very High	Major	Very High	Minor	Medium	Minor	Medium	Insignificant	Low	Minor	Medium	Minor	Low	Minor	Low
Fast moving consumer goods	Extreme	Very High	Extreme	Very High	Moderate	High	Minor	Medium	Insignificant	Low	Insignificant	Low	Insignificant	Low	Insignificant	Low
Finance	Major	Very High	Major	Very High	Minor	Medium	Minor	Medium	Insignificant	Low	Insignificant	Low	Major	High	Major	High
Overall Risk of hazard to regional lifelines	Very High		Very High		High		Medium		Low		Medium		High		Medium	

*While the ARI for an AF8 scale event is 1 in 300 (Unlikely), the likelihood is “Possible” for the purposes of this risk assessment due to research signalling there is 75% chance of a major Alpine fault rupture in the next 50 years

** For the purposes of the risk assessment at a regional level the risk to each sector from a hazard has been collated into an overall risk level. Individual organisations risk may vary according to the location and exposure of each organisation’s assets to individual hazards.

Otago Region Sector Interdependencies (2024):

Scores in the below assessment were determined through a Lifelines workshop. Where scores were not provided at the regional level, these have been updated with the relevant score from the 'Critical Customers' section of the National Lifelines Vulnerability Assessment (p. 21). The results are generalised for the region and will vary locally depending on the asset location and hazard exposure. Some lifelines not deemed critical for BAU service provision may be required for restoration/recovery activities (e.g. airports/ports for personnel and equipment movements).

Please note that the scoring is in reverse order to the national study – see key at bottom of the page. The table should be read from left to right.

Lifeline Service provided	Utility dependency: Potable water services	Stormwater services	Wastewater services	Electricity Generation	Electricity Transmission (Grid)	Electricity Distribution (Local)	Telecommunications	Roading Networks: State Highways	Roading Network: Local Authority	Rail network	Airports	Ports	FMCG / Finance	Waste Management	Fuel	Commentary / Additional Notes
Potable water services				1	1	1	1	2	1						1	Back-up generators in place, though not in all districts or pump stations, and is reliant on access to fuel supply. Road/rail/air access required for movement of critical/strategic spares. Telecommunications is critical for SCADA systems etc. Some waste management requirements regarding debris clearance. No alternative discharge options without ORC consenting.
Stormwater services				1	1	1	1	2	1						1	
Wastewater services	1			1	1	1	1	2	1						1	
Electricity Generation	1		2	*	1	1	1	1	1		2	1	2		1	Black start can be achieved using water through turbines (i.e., generation is required in order to create generation). Will not work in drought conditions if water reserves are low. 'Islands' method. Transmission requires inter-regional transmission to be functional in order to create stability/balance of supply/frequency. All distribution sites have restricted operational capability without telecommunications. Road access critical for pylons. Poles can be moved by rail but still require road movements.
Electricity Transmission (Grid)			2	1	*	1	1	1	1		2	1	2		1	
Electricity Distribution (Local)		2	2	1	1		1	1	1		1	1	2		1	
Telecommunications			2			2	*	2	2	2	2		1		1	Access to pits and manholes required (wastewater). Generators and batteries in place, but making it to 3 days is tight. (relates to Chorus network). If fibre link lost, multiple systems are inoperable.
Roading Networks – State Highways		1		2	2	2	2	*						2	1	Potable water required for welfare of contractors – not something stored in bulk across region by operators. Some roles able to be performed without electricity. Access to local roads assumes that state highway network is intact. Waste Management need reference's ability to move debris. Note: all transport modes are reliant in some manner on inter-regional counterparts to be functional. Port included for wharf side services and North South Island connection
Roading Networks – Local Authority		1		2	2	2	2		*					2	1	
Rail Network				2	2	2	2	1	1	*		2			1	
Airports	2	2	2	2	2	1	1	2	2		*		2		1	
Ports				2	2	2	2	1	2	1		*			2	
FMCG / Finance & Cash	1	2	1			2	2	1	1	2	2	2	*	1	1	Most supermarkets able to operate for 24-48hrs where back-up generation in place, however fresh goods reliant on suppliers being able to move inter-regionally.
Waste Management								1	1						1	Taken from national vulnerability study, adjusted during workshop.
Fuel	1			2	2	1	1	1	1			1			*	Many terminals have no access to 300kVa generators, telecomms relies on power at site, potable water needed for safety showers, reticulated water for firefighting (although bulk store onsite).
Health	2		1			2	1		1		1		1	2	1	Heating supplied from steam: critical for keeping hospital running, FMCG for movement of pharmaceuticals, waste management for bio/chem waste.
Fire and Emergency	1					2	1	2	1		1		1		1	Generator back up at many sites, limited potable water, airports needed for long term resourcing, nationally coordinated deployments and gear/PPE
New Zealand Police	1					2	1	2	2		1				1	Limited potable water, airport required for personnel movements/nationally coordinated deployments.

Scoring / Key:

1	**Critical for service provision**	2	**Critical, but some back-up capability in place**		**Not required for service to function in BAU**	*	**Reliant on inter-regional links or reliant on itself**

Key Assets for Otago Region

Critical Assets

Lifeline infrastructure criticality has historically been defined in three levels; Nationally significant, regionally significant and locally significant.

Nationally Significant

Nationally significant infrastructure is defined as:

> "Failure of the asset/supply would have national significance and cause loss of utility supply to most of the region or loss of supply to another nationally significant site that depends upon its service"

Within the region, there are several nationally significant assets and sites. These include:

- Benmore, Roxburgh, and Clyde power stations and switchyards
- Kordia Mt Cargill Transmission Site (Criticality 1)
- Chorus Eastern Core Fibre Route
- Queenstown Airport (international tourism hub)

Regionally Significant

Regionally significant infrastructure is defined as:

> Failure of the asset/supply would cause loss/disruption to more than **20,000** customers or reduction in service across the region or loss of supply to a regionally significant site.

Within the region, there are several regionally significant assets and sites. These include:

- Halfway Bush Substation (supplies large parts of Dunedin, including the CBD)
- Three Mile Hill, and South Dunedin Substations
- Oamaru, Livingstone, and Balclutha Substations
- Frankton, and Cromwell Substations
- Naseby Substation (future critical infrastructure for planned solar farm)
- Port Otago (primary import for fuel in the region)
- Kordia Obelisk Transmission Site
- Z and NZOSL Fuel Terminals (backed up by overland transport from north/south)
- Starlink Base Station: Cromwell
- One NZ: Dunedin POP / Balclutha POI (Point of Interface) /
- Northeast Dunedin Radio Access Network transmission hub.
- Regional VHF / UHF repeater sites: Cape Wanbrow, Mt. Cargill, Razorback, Remarkables, Roys Peak

Locally Significant

Locally significant infrastructure is defined as:

> Failure of the asset/supply would cause loss of supply to more than **2000** customers or reduction in service across part of the region or loss of supply to a locally significant customer.

Within the region, there are many locally significant assets and sites. These include:

- Water and sewage pipelines
- Key arterial routes, such as main highways and council roads
- Individual electricity supply assets, such as roadside cabinets and supply lines (overhead and buried lines)
- Telecommunications cabinets (for Copper and fibre connectivity)
- Local repeater sites

Hot Spots and Pinch Points

- A **hotspot** is an area with a high concentration of different lifeline assets, for example, a road or rail bridge that has fibre, electricity, and water infrastructure running through/beneath it.
- **Pinch points** are significant areas for one lifeline sector. There is usually no satisfactory alternative available, and it is therefore essential to service delivery.

The map below illustrates the location of known hotspots or pinch points in the Otago Region where critical lifelines infrastructure assets converge and/or are in a hazardous area (i.e. where they overlap with hazard-prone areas mapped by Otago Regional Council).

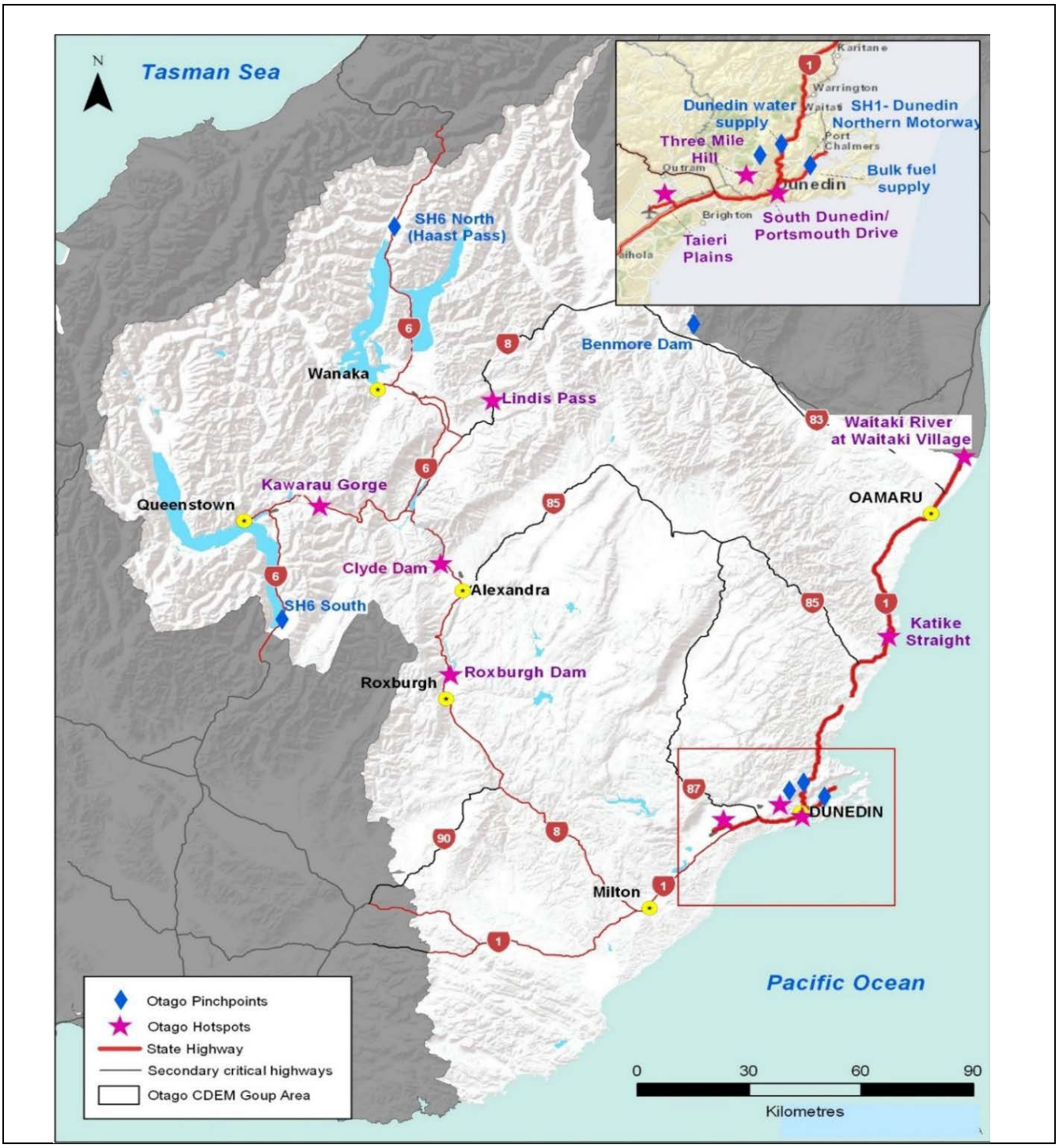


Figure 27 - Map of Otago Hotspots and Pinch points

Hotspots which are prone to liquefaction (from 2015 study)

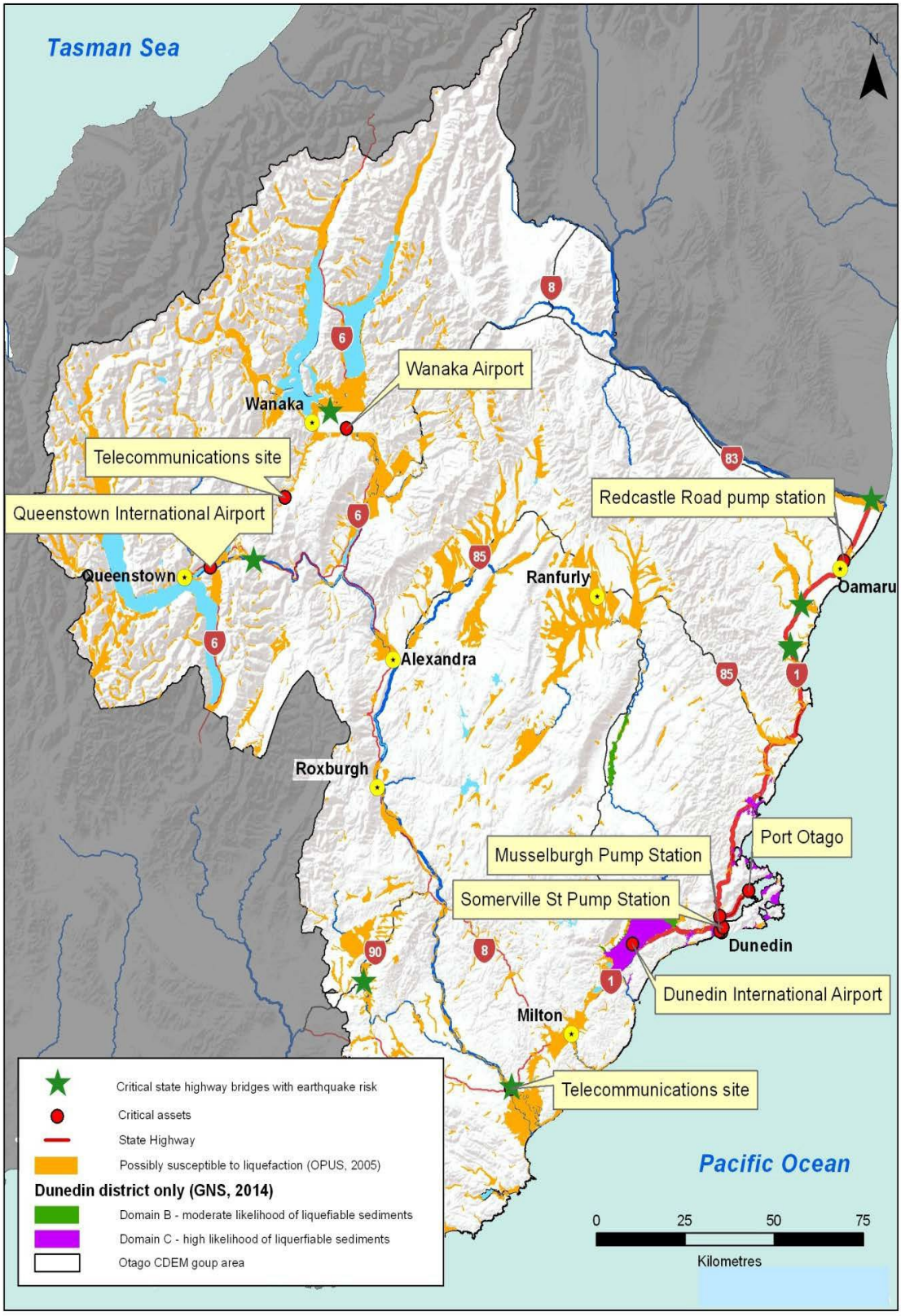


Figure 28 - Map of key assets in liquefaction prone areas

Road Hot Spots

All Central Otago Roads are critical infrastructure, as Cromwell can be a staging point if Queenstown is affected.	
State Highway 1	Waitaki River Bridge
	Katiki Coast
	Kilmog / Northern Motorway
State Highway 86	Dunedin Airport
State Highway 88	Dunedin to Port Chalmers
State Highway 6	Haast Pass to Hawea
	Kawarau Gorge
	Frankton to Kingston
State Highway 6A	Frankton to Queenstown
SH 8	Cromwell Gorge / Clyde Dam
	Cromwell to Milton (Manuka Gorge)

Geographic Hotspots

South Dunedin/Portsmouth Drive

The low-lying South Dunedin and Harbourside area is at risk of flooding either due to runoff from the surrounding hills or groundwater ponding from an elevated water table in South Dunedin, storm surge, tsunami and liquefaction and contains several critical utilities, including:

- The South Dunedin sub-station GXP, which services 17000 customers.
- The Tahuna wastewater treatment plant and the Musselburgh pumping station pump Dunedin's wastewater to the treatment plant.
- The main telecommunications exchange.

Future mitigation plans:

Delta is evaluating a project to link the Halfway Bush and South Dunedin substations to provide back-feed options if the South Dunedin substation is not operating.

Kawarau Gorge

The Kawarau Gorge has numerous locations, such as Nevis Bluff, that are prone to alluvial fan activity, rock falls, and landslides, many of which interact with areas of appreciable seismic risk.

The electricity transmission lines to Queenstown run along or near the Gorge, as does SH6 and the main fibre cable owned by Chorus.

SH6 through the Kawarau Gorge is the main route from Cromwell to Queenstown, with alternative State Highway routes adding around 4 hours to the journey.

Roxburgh Dam

Transpower's Roxburgh substation/switchyard and three major electricity transmission lines through the area make this a key electricity hub for the South Island. Loss of the switchyard would cause significant disruption to the electricity supply on the South Island. However, the criticality of the transmission lines

depends on the time of year (demand is high in winter, and the Aurora transmission lines through the area provide some diversity).

SH8 passing by the Dam is also part of the key roading route from Dunedin to Cromwell (the alternative route of SH 85 adds at least another 30 minutes to the journey)

The main risks to the area are landslides, and those located on the slopes above Lake Dunstan are monitored on an ongoing basis.

Waitaki Bridge

The Waitaki Bridge area is at risk of flooding from the Waitaki River, tsunami and liquefaction during an earthquake. SH1, Transpower overhead transmission lines, the Chorus fibre cable and the main South Railway line all pass over the river nearby. The alternate route to SH1 via Kurow adds 1.5 hours to the journey.

Haast Pass

The Haast Pass is a key inter-regional link to the southern portion of the West Coast and becomes increasingly mountainous and remote around the divide. The area is prone to tree fall due to strong winds, snow, ice and heavy rain. There are significant areas of rockfall hazard around the shores of Lake Wanaka and the upper reaches of the pass. Heavy rainfall can result in several creeks and streams crossing the highway, depositing a significant amount of material. Other critical infrastructure assets, such as fibre, utilise the road network.

Lindis Pass

The area is most vulnerable to snow due to its altitude, but parts of the road can be affected by flooding and alluvial fan activity during times of heavy rainfall. Several landslides are mapped over the Pass, and strong seismic shaking may trigger them.

Significant assets crossing the Lindis Pass include one of two Chorus fibre cables supplying Otago, SH8 and Transpower transmission lines, and it is a significant freight route for food and fuel from and into Central Otago.

Taieri Plain

Assets on the Taieri Plains include SH1 and SH86, KiwiRail's main trunk railway line, Dunedin International Airport, critical Transpower transmission lines and Berwick Switchyard and transmission lines connecting Mercury's Mahinerangi power generation assets (Wind Farm) to the grid.

Many of these assets rely on the Taieri flood protection and drainage schemes for flood protection; however, larger 'super-design' events are still possible and could potentially inundate large amounts of the Taieri Plains. The basin is bound by active faults to the north and south and consists of fine silts and sands that are potentially susceptible to liquefaction.

West Taieri is especially low-lying and may be affected by tsunami and storm surge events that restrict the passage of water down the Taieri River during high flows. Alluvial fans and landslides have been mapped on the margins of the Taieri Plains, although most assets are sufficiently set back from slopes to be directly affected.

Future mitigation plans:

ORC has an ongoing programme of work to ensure there is backup generation available at pump stations across the Taieri.

Katiki Strait

Assets passing through this area include SH1, Transpower overhead transmission lines supplying areas from Waitaki to Oamaru and Chorus's trunk telecommunications cable.

This area is most susceptible to coastal hazards, including coastal erosion, storm surges, and tsunamis, and will be increasingly affected by such hazards under the predicted rise in future sea levels.

Three Mile Hill – Dunedin

Three Mile Hill is a critical road route into Dunedin from the south, as well as having Transpower transmission lines and a switchyard supplying a significant portion of Dunedin's electricity. Three Mile Hill is most susceptible to closure due to snowfall and ice.

Clyde and northwards to Cromwell Gorge

Clyde is a significant electricity hub, and SH8 passes through the area. Northwards from Clyde is the Cromwell Gorge, which has a large exposure to landslide risk.

The Clyde switchyard feeds power into the National Grid for the supply of electricity north or south, as well as the local distribution network from Alexandra to Raes Junction and out towards the Maniototo. There is some local generation (Pioneer) that can supply a small area. Clyde PowerStation has the ability to Black Start in case of a total South Island national grid blackout.

Pinch Points (Single Sector)

Upper State Highway 8 main route from Christchurch to Central Otago

SH 8 is a key regional transport route and the main route from Christchurch to Queenstown. It is highly vulnerable at several points to slips and flooding, and the alternate route is via SH1/SH85, which adds approximately 1 hour to the journey if leaving from Christchurch but could add as much as 2.5hrs if the closure is at Omarama.

Dunedin's highway network

Dunedin's highway network is a critical transport route and is vulnerable to landslides and snow/ice. There is alternate access via the Mount Cargill route, but this may be unsuitable for larger vehicles. Kilmog Hill, north of Waitati on SH1, is also vulnerable to landslides and snow/ice. The alternate route via the Coast Road is suitable for light vehicles but also has a number of mapped, active landslides present.

Bulk fuel storage - Port Otago

All regional fuel is brought in and stored at the facility in Port Otago. The inability for vessels to offload, or access the port by tankers, could have significant impacts on the region. While alternative storage facilities are in Bluff, Timaru and Lyttleton, these are a significant distance to transport the volumes of fuel needed.

Responding to Emergencies

Principles and Priorities

When responding to emergencies that involve impacts on lifeline assets and services, the Otago CDEM Group Lifeline Response Protocols should be referred to as the basis for coordination. This document should be used to provide additional context.

While the priorities will vary according to the specific nature of the disaster, resource priority should be given to the following services to ensure the community disruption is minimised (Guide to the National CDEM Plan, 2015):

- critical health services (hospitals, ambulance, public health)
- emergency management (Police, Fire, EOCs, welfare centres)
- lifelines infrastructure
- vulnerable sectors (e.g.: immobile or vulnerable groups of people such as rest homes or prisons)
- isolated communities
- key areas (e.g.: CBDs)
- commercial producers
- residential zones.

To support a coordinated and effective regional response, lifelines agencies will, unless otherwise directed by the lead agency:

- Give priority to restoring services to key response agencies that rely on their service, where practical.
- Be able to quickly mobilise and prioritise the restoration of services in the absence of direction from the lead agency.
- Implement plans and arrangements that are aligned with local, regional and national CDEM processes.
- Operate in accordance with national, regional and local response arrangements such as fuel contingency plans, and sector coordination plans, where they are in place.

The initial priorities of the Group Controller for Lifeline providers are:

- Gain situational awareness of impacts on their service and likely timeframes for restoration or alternatives to be in place.
- Support preservation of life activities where lifeline service is required (e.g. roading access, communications etc)
- Undertake activities to prevent the escalation of impacts to the service and the communities they support.
- Undertake restoration of critical services as soon as practicable according to the priorities established at the time of the event.

Key Agencies with Dependencies

Emergency and Health Services

The emergency services (Police, Fire, Health inc. Ambulance) are often the first to respond to emergencies within the region. As such, there is a huge reliance upon some lifeline assets in order to perform their key functions. In particular, all emergency services rely heavily upon roading, fuel and communications infrastructure in order to respond to issues across the region.

Beyond ensuring that response vehicles are able to operate, all of the emergency services have response facilities located throughout the region (See appendices pg. 103-5 for emergency services facilities within the Otago region). These are also reliant upon electricity, potable water, sewerage and communications infrastructure to operate effectively for sustained periods of time, as well as access to the facilities via roading infrastructure.

New Zealand Police

The New Zealand Police Regional Headquarters is located in Dunedin. The facility is the centre of operations for responding to issues across the Otago region and is critical to supporting the provision of policing.

The facility has redundancy built in to enable it to continue to operate when there is a disruption to key lifeline services. This includes backup power supply through emergency generators and 24hrs supply of potable water. It and communication systems, including repeater stations, have backup battery systems to enable ongoing operation in the first 24 hours until an alternate supply can be established.

There are a number of other police stations located throughout Otago. These are shown on the map on pg. 106 of the appendices. Many of these do not have alternate emergency supplies for electricity and water and would be reliant upon the provision of generators and water to continue operation.

Fire and Emergency New Zealand

Fire and Emergency New Zealand (FENZ) operates 47 fire stations throughout the region, as shown on the map on pg. of the appendices. The Dunedin Fire Station also houses the Regional Headquarters, where response operations across the Otago region are coordinated. As such, this facility is equipped with backup systems to enable continued operation where key lifeline connections have been lost, including a Uninterrupted Power Supply (UPS) provided by a large diesel generator.

Other stations within the region have been equipped to enable the connection of portable generators and all fire appliances carry small portable generators and a limited drinking water supply.

Health services

St. John Ambulance operates 16 stations throughout the region. These provide storage for the appliances and facilities for staff. They are reliant upon power, water and communications to function. As with the other emergency services, access via a roading network is also critical to their effective operation.

There are a number of key health facilities located within the Otago region. These include the main hospitals located in Dunedin and Queenstown and medical centres in Balclutha, Oamaru, Clyde and Ranfurly.

The main hospital in Dunedin has backup generators to supply essential power with an estimated running time of up to 95 hours. There are a number of water supplies on site that can provide water for up to 20 hours. Stored medical gases on site can provide up to 13 days' supply.

The Queenstown hospital has backup power generation that can provide up to 71 hours of supply. Water storage on site will supply for up to 12 hours.

Other major health facilities (level 2 hospitals) in the region have generators providing essential power supply, fuel storage of 12 – 24 hours, water storage for 24 – 48 hours and several days supply of medical gases on site.

There are also a number of private hospitals throughout the region, including the Mercy Hospital in Dunedin and the Southern Cross Central Lakes Hospital.

Heli Otago provides emergency health flights within the Otago region and rescue helicopter operations. These are on call to be airborne within 10 minutes during the day and 20 minutes during the night, aiming to get top-level medical care to the patient within the critical golden hour. They have independent supplies of fuel located throughout the region and are able to operate largely independent of main fuel supplies if required.

Civil Defence Emergency Management

Depending on the scale of the event, local, regional and national CDEM operations may be activated to support and coordinate the response to the emergency across all agencies and the wider community.

Across the region there are a number of Emergency Coordination facilities:

Emergency Management Otago (EMO)

Emergency Coordination Centre (ECC) – Otago Regional Council Head Office, Stafford Street, Dunedin.

Central Otago

Emergency Operations Centre (EOC) - Council Head Office, Alexandra

Clutha District

EOC - Council Head Office, Balclutha

Dunedin City

EOC – Moray Place, Dunedin

Queenstown Lakes District

EOC – Council Head Office, Gorge Road, Queenstown

Waitaki District

EOC – Centennial Building, Severn Street, Oamaru

The primary ECC/EOCs are set up to operate under emergency conditions with necessary facilities including backup power generation, telephone, data, radio and satellite communication systems and provision for catering, etc.

Welfare Agencies

While CDEM Groups have the legislated responsibility for Welfare (National CDEM Plan 2015) the sub-functions of welfare are still the responsibilities of the relevant welfare agencies and have an important role in supporting people that require assistance such as well as supporting the longer-term recovery. Many of these agencies operate from existing facilities and these have varying levels of alternatives for the supply of critical lifelines, including electricity, water and communications.

Response and Restoration

In general, the main priorities for lifeline service restoration are:

- Re-establishment of power supplies, whether permanent or alternate
- Provision of emergency telecommunications networks and critical broadcast facilities
- Establishing of alternate routes to enable access to critical assets and impacted communities.
- Securing of fuel supplies to support response activities.
- Provision of water for sanitation and drinking

Electricity Sector

Electricity Sector priorities are covered in Participant Outage Plans. Where a major shortage requires planned, rolling outages, customers on higher-priority feeders are less likely to be cut off.

Under these arrangements, residential consumers are typically on the lowest priority feeders. However, in an emergency, priorities may change and the sector would expect to take direction from CDEM agencies as to whether their normal prioritisation protocols need to be modified.

Telecommunications Sector

Prioritisation is based on the criticality of the node and trunk.

Water Sector

Prioritisation is typically asset-based – trunk supplies are restored first (from treatment plants to reservoirs), then would consider prioritisation of supply to critical customers.

Road Sector

The Priority Routes programme is used to prioritise the restoration/response of key assets following an event. Other factors to be considered would be the availability of alternate routes and traffic volumes (triage phase).

Communications in response

In response the communication between responding agencies is critical. This includes communications between lifeline agencies that share interdependencies, lifeline agencies and Civil Defence Coordination Centres, and Lifeline agencies and impacted communities.

Inter-lifeline provider communication

With regards to the communication between lifeline agencies, it is critical that those who share interdependencies for service restoration are in regular communication with each other to ensure minimal delay in the restoration of services. This may be directly with each other via liaison personnel, or through the Regional Lifeline Utility Coordinator (LUC).

Lifeline provider to CDEM

The provision of information from lifeline providers to CDEM is critical to enable the effective planning and coordination of response operations. The loss of critical assets can have a significant impact on the ability to provide access and services to those most impacted by the emergency. Therefore, the following information is important to be provided as soon as possible to the Otago CDEM Lifeline Utility Coordinator:

- What impact has occurred to the service, alternatives available and likely restoration times (via a Status report to the LUC at the Otago CDEM ECC)

- Potential impacts on interdependent services and providers
- Issues that may cross boundaries, either district, or inter-region
- Where possible, GIS layers or images showing where outages have occurred and impacted communities

Critical Resources

A critical resource can be defined as "Resources that are not available in sufficient quantity to meet all demands, and which have a direct, material impact on a response."

The resources that are generally critical for lifeline utilities and key response agencies during a major event (as well as for other response partners and the wider community) are summarised below.

Demand for any of these resources is likely to exceed immediate supply in a major disaster.

Fuel

Fuel (Petrol, Diesel, AvGas, Jet-1A) is required to fuel vehicles, aircraft, and (in the event of power failure) generators. Fuel needs to be available at service stations and by tanker deliveries to key sites. There are logistical issues in the Otago Region such as a number of remote areas with significant distances between fuel stations and areas such as Queenstown that may be cut off in a major event.

Work needs to be done to better understand service station capacity and locations, availability of other stocks that could potentially be used (such as on large farms) and regional processes to ensure fuel is available to key response agencies.

The Otago CDEM Group has developed a Regional Fuel Plan to support the management of fuel in an emergency and this can be made available upon request.

Air Assets

Given the nature of some lifeline infrastructure being very spread out and sometimes located in remote areas of the region (e.g. electricity, telecommunications, roading), the use of aircraft to perform impact assessments is critical to gaining a timely understanding of the scale of impact of an emergency. In addition to needing the aircraft themselves, there is also a requirement for the supporting infrastructure to be available, including refuelling, landing and air traffic control.

The use of aircraft in response requires careful coordination to ensure that assets are being used appropriately. As such, the Otago CDEM Group has developed an Aviation Emergency Support Plan to manage the use of aerial assets, which can be downloaded via the link below:

https://www.otagocdem.govt.nz/media/1570/otago-aviation-emergency-support-plan-aesop-v4.pdf

Personnel

Operating a 24/7 response can stretch staff and contracting resources considerably. A range of formal arrangements (contracts, mutual aid agreements with other organisations) are in place in some sectors. There is also a less formal understanding that support will be available from others where needed – and this was evidenced in many ways following the Canterbury and Christchurch earthquakes 2010/11 and later in the Kaikoura Earthquake in 2016. There are many issues that need to be dealt with such as use of different equipment, standards, safety procedures, etc. Sector mutual aid agreements would be useful in all sectors (though practical only in non-competitive sectors) including protocols for managing resources from other organisations.

Strategic Spares

While many fault contractors have the likes of power poles, cables and fuses in stock, 'strategic spares' such as power transformers, high-capacity underground cables, ring main units, and critical protection and control equipment, aren't easily sourced – with lead-in times of many months.

A large-scale event has the potential for the immediate needs of utilities to exceed the initial response phase. The electricity sector identified the need to better understand the collective need for and availability of spares (such as electricity poles)[22] and consideration of the benefit of moving to a more standardized approach to equipment, parts, etc.

Other Needs

Other critical resources, in no order of priority, include:

- Generators: It is recommended that the Otago CDEM Group plans for the acquisition and management of generators required for response.
- Communications equipment: VHF and satellite communications.
- Vehicles.
- Food and water.
- Bottled water/tanker water.
- Contractors.
- Specialist equipment.
- Plant: Diggers etc.
- Temporary traffic signs, cones and barriers.
- Social media.
- Portable heating.
- Mobile catering.
- Portaloo's and showers (ablutions).
- Accommodation.

[22] Outcome of Hawke's Bay/ Taupō plains severe weather event 2016 where over 150 poles were damaged.

Future Work / Opportunities

A number of future opportunities have been identified through the development of this study. These are briefly outlined below:

Otago CDEM Group Catastrophic Planning

Lifeline providers will play a huge part in the response and recovery to major events within the region. It is therefore essential that the CDEM Group is provided with information pertaining to the restoration of services to support the preparation and planning for any significant event within the region.

Identification of impacts of lifeline infrastructure failures on the wider environment

The identification of the social, economic and natural impacts of lifeline utility failures can provide the CDEM Group and partner lifeline organisations with critical information to support the prioritisation of reduction and mitigation works and planning for service restoration in an emergency. This may include the use of systems such as RiskScape to provide analysis of the impacts of outages and identification of critical assets.

Emergency Debris Management Plan

Debris management in an emergency event is critical to the recovery of impacted communities. Often the debris created by emergencies requires specific processes and management to ensure the risk to people and environment is minimised. The development of a waste management plan can support the identification of processes for different waste streams and ensure effective management of assets in response and recovery.

Development of a regional generator plan

There is a high reliance across lifeline providers for backup power generation. These resources are limited within the region and will require significant coordination to ensure their placement and use is prioritised for maximum effect in response and recovery. As such, the Otago region should strongly consider developing a regional generator plan that identifies the requirements across lifelines and other key response organisations, coordination and logistical arrangements and prioritisation for specific hazards and their impacts.

Further development of the GIS portal

The inclusion of lifeline utility data in the GIS portal can assist the CDEM Group in identifying where gaps in resilience exist and planning for response and recovery. While this is a solid step forward for situational awareness, further efforts are required to best leverage the collected information, such as refining what is displayed/clarifying what needs to be viewed.

Future work should include further identification of assets likely to be impacted by specific hazards, integration with the Southland Priority Routes project, and the locations of alternate/backup utilities to support community facilities (such as Civil Defence Centres (CDCs).

Ensuring this is accessible to all lifeline members will increase the understanding of key interdependencies between agencies.

Otago CDEM Group Regional Communications plan

Communication in an emergency is critical for clear coordination and the sharing of information. This is supported by a number of methods, as illustrated in this study. Therefore, it is critical to understand where key communications equipment is located, who owns and operates the resource, which agencies have access to which services (e.g. VHF/UHF/Satellite etc), which frequencies are currently being used and the

contacts within each organisation (both personnel and call signs). This would enable a clear communications plan for use in emergencies to be established and provide prioritisation for restoration of critical sites to enable its enactment.

Lifelines Group training and exercising

The coordination of lifeline utility providers in response is critical to ensuring effective response and recovery. Familiarity with the systems and requirements of response, as well as the current plans and procedures, is vital to enable this to occur. Training and exercising are a key way to ensure readiness for response and this should be encouraged across the Lifelines Group, both with utility providers to test their individual arrangements and across the wider Lifeline Group to ensure effective coordination. Where possible, collaboration should be sought between Otago Lifelines Group members when organising training events such as CIMS, to further develop relationships and reduce the cost of training to each participating organisation.

Appendices

References

Report: National Lifelines Vulnerability Assessment Part B: Main Report

https://www.civildefence.govt.nz/assets/Uploads/documents/lifelines/NVA-Part-B-Main-report-v1.0-Sept-2023.pdf

Glenorchy Airstrip Reserve Management Plan August 2016

Alexandra Airport Master Plan 2022

Wanaka Airport Master Plan 2008

Queenstown Airport Master Plan 2021

Oamaru Health and Safety Management Plan 2024

Alpine Fault SAFER Framework 2018

Community vulnerability to elevated sea level and coastal tsunami events in Otago – July 2021

Emergency Management Otago – Coastal Tsunami Plan

Otago region hazards management investigation: tsunami modelling study – NIW / Otago Regional Council – September 2007

Primary Supermarket Locations (Otago)

Foodstuffs (Top 30)

Store Name	Property Type	Longitude	Latitude	Landlord	Lines Company	Est. Generator Size (kVA)	Territorial Authority
Trents Central Otago	Cash'n Carry	169.39568	-45.24508	R J Carey Limited	Aurora Energy		Central Otago District
Trents Dunedin	Cash'n Carry	170.51002	-45.89253	Chalmers Properties Limited	Aurora Energy		Dunedin City
PAK'nSAVE Dunedin	Supermarket	170.49924	-45.89274	Foodstuffs (SI) Properties Limited	Aurora Energy	750	Dunedin City
PAK'nSAVE Queenstown	Supermarket	168.74917	-45.01065	Foodstuffs (SI) Properties Limited	Aurora Energy	750	Queenstown-Lakes District
New World Alexandra	Supermarket	169.38696	-45.24974	Foodstuffs (SI) Properties Limited	Aurora Energy	500	Central Otago District
New World Centre City	Supermarket	170.50839	-45.87113	Foodstuffs (SI) Properties Limited	Aurora Energy	500	Dunedin City
New World Mosgiel	Supermarket	170.34933	-45.87223	Foodstuffs (SI) Properties Limited	Aurora Energy	500	Dunedin City
New World Queenstown	Supermarket	168.74156	-45.02556	Foodstuffs (SI) Properties Limited	Aurora Energy	500	Queenstown-Lakes District
New World Three Parks	Supermarket	169.15528	-44.69886	Foodstuffs (SI) Properties Limited	Aurora Energy	500	Queenstown-Lakes District
New World Wanaka	Supermarket	169.13479	-44.69562	Foodstuffs (SI) Properties Limited	Aurora Energy	500	Queenstown-Lakes District
New World Balclutha	Supermarket	169.74369	-46.23796	Foodstuffs (SI) Properties Limited	OtagoNet (by PowerNet)	350	Clutha District
New World Cromwell	Supermarket	169.19427	-45.03741	Foodstuffs (SI) Properties Limited	Aurora Energy	350	Central Otago District
New World Gardens	Supermarket	170.51966	-45.85487	Foodstuffs (SI) Properties Limited	Aurora Energy	350	Dunedin City
Albert Town Four Square	Supermarket	169.18893	-44.68306	Alison Avenue 2017 Lp	Aurora Energy	100	Queenstown-Lakes District

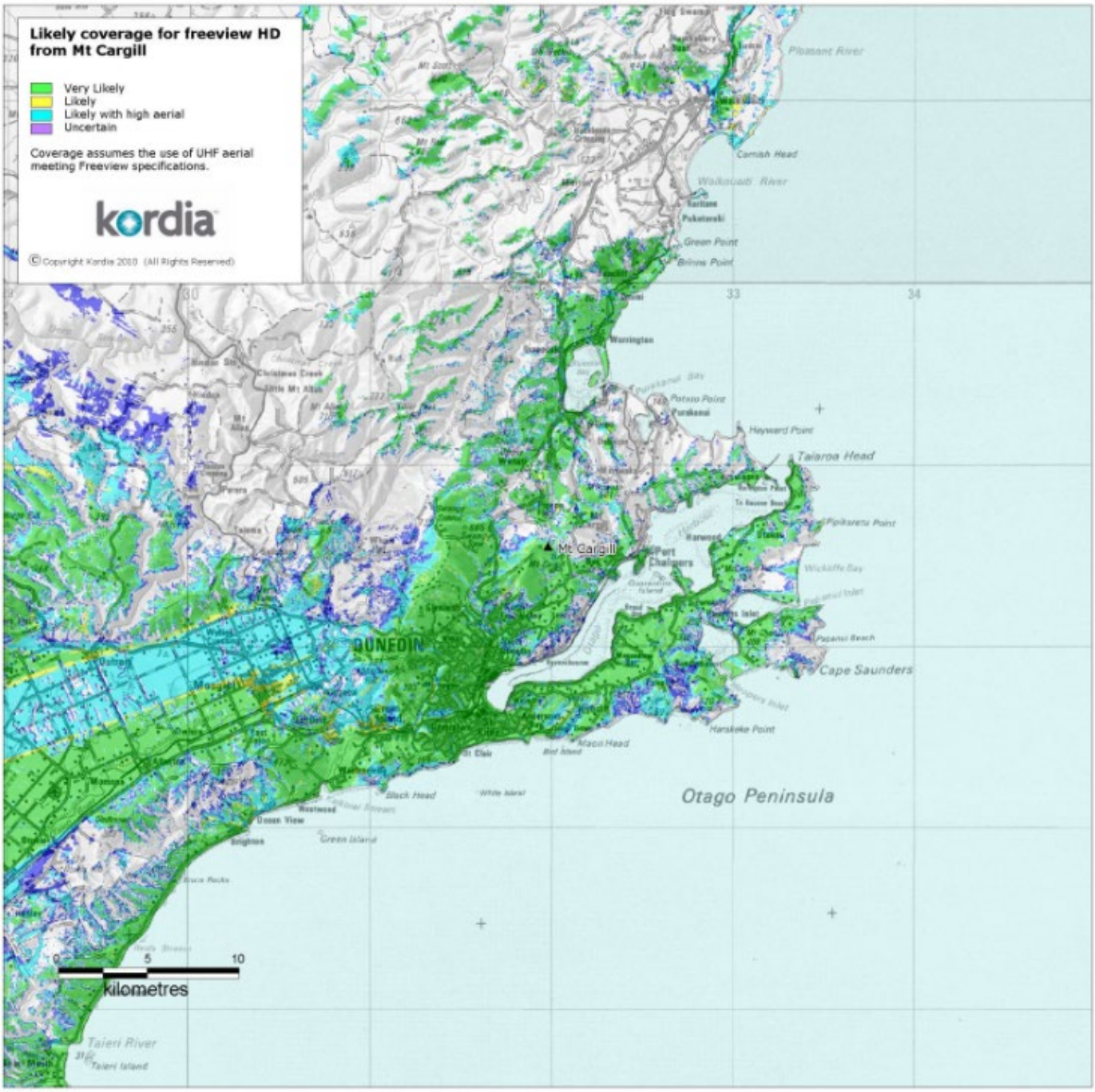
Foodstuffs (Top 30) Continued

Store Name	Property Type	Longitude	Latitude	Landlord	Lines Company	Est. Generator Size (kVA)	Territorial Authority
Alexandra Four Square	Supermarket	169.39469	-45.25305	La Villette Holdings Limited	Aurora Energy	100	Central Otago District
Arrowtown Four Square	Supermarket	168.8355	-44.94509	Southern Property Holdings Limited	Aurora Energy	100	Queenstown-Lakes District
Clyde Four Square	Supermarket	169.3193	-45.18818	Judith & William Crosbie	Aurora Energy	100	Central Otago District
Lawrence Four Square	Supermarket	169.68671	-45.91286	Foodstuffs (SI) Properties Limited	OtagoNet (by PowerNet)	100	Clutha District
Maniototo Four Square	Supermarket	170.10004	-45.12995		Aurora Energy	100	Central Otago District
Outrum Four Square	Supermarket	170.23085	-45.85644		Aurora Energy	100	Dunedin City
Owaka Four Square	Supermarket	169.66049	-46.45085	Foodstuffs (SI) Properties Limited	OtagoNet (by PowerNet)	100	Clutha District
Port Chalmers Four Square	Supermarket	170.61997	-45.8171	Foodstuffs (SI) Properties Limited	Aurora Energy	100	Dunedin City
Queenstown Four Square	Supermarket	168.6614	-45.03029	Foodstuffs (SI) Properties Limited	Aurora Energy	100	Queenstown-Lakes District
Rosebank Four Square	Supermarket	169.72857	-46.24207		OtagoNet (by PowerNet)	100	Clutha District
St Clair Four Square	Supermarket	170.48735	-45.9068		Aurora Energy	100	Dunedin City
Tapanui Four Square	Supermarket	169.2617	-45.94304	Foodstuffs (SI) Properties Limited	OtagoNet (by PowerNet)	100	Clutha District
Tokomairiro Four Square	Supermarket	169.96464	-46.11614	Foodstuffs (SI) Properties Limited	OtagoNet (by PowerNet)	100	Clutha District
Wanaka Four Square	Supermarket	169.13714	-44.69221		Aurora Energy	100	Queenstown-Lakes District
Raeward Fresh Queenstown	Supermarket	168.66121	-45.02594	Foodstuffs (SI) Properties Limited	Aurora Energy		Queenstown-Lakes District
DC Dunedin	Supply Chain	170.50873	-45.893	Chalmers Properties Limited	Aurora Energy		Dunedin City

Woolworths (Top 12)

Store Name	Remote Store?	Location Indicator	Critical Store (can support others)	Full Site Generator?	Essential-Only Generator?	Hazard Exposure Risk
Freshchoice Roxburgh	Yes	Regional town	No			Medium – Flood, Transport
Freshchoice Roslyn	No	Regional town	No			Medium – Flood, Transport
Freshchoice Queenstown	No	Regional town	No			Medium – Flood, Transport
Freshchoice Milton	No	Regional town	No			Medium – Flood, Transport
Woolworths Queenstown	No	Regional town	No	Yes		Medium/**High** – Flood, Transport, **Seismic**
Woolworths Mosgiel	No	Major city	No	Yes		Medium-**Low** – Flood, Transport, Seismic
Woolworths Wanaka Metro	No	Regional town	No			Medium – Flood, Transport, Seismic
Woolworths Oamaru	Yes	Regional town	No			Medium-**Low** – Flood, Transport, Seismic
Woolworths Mailer Street	No	Major city	No		Yes	Medium-**Low** – Flood, Transport, Seismic
Woolworths Dunedin Central	No	Major city	Yes		Yes	Medium-**Low** – Flood, Transport, Seismic
Woolworths Balclutha	No	Regional town	No	Yes		Medium – Flood, Transport, Seismic

Kordia: Digital Television Coverage – Dunedin (Mt. Cargill)



Broadband, Fibre, and Satellite Retailers (Otago Region, 2024):

[Note: owing to the rapid growth of this sector, this list may not be exhaustive/complete]

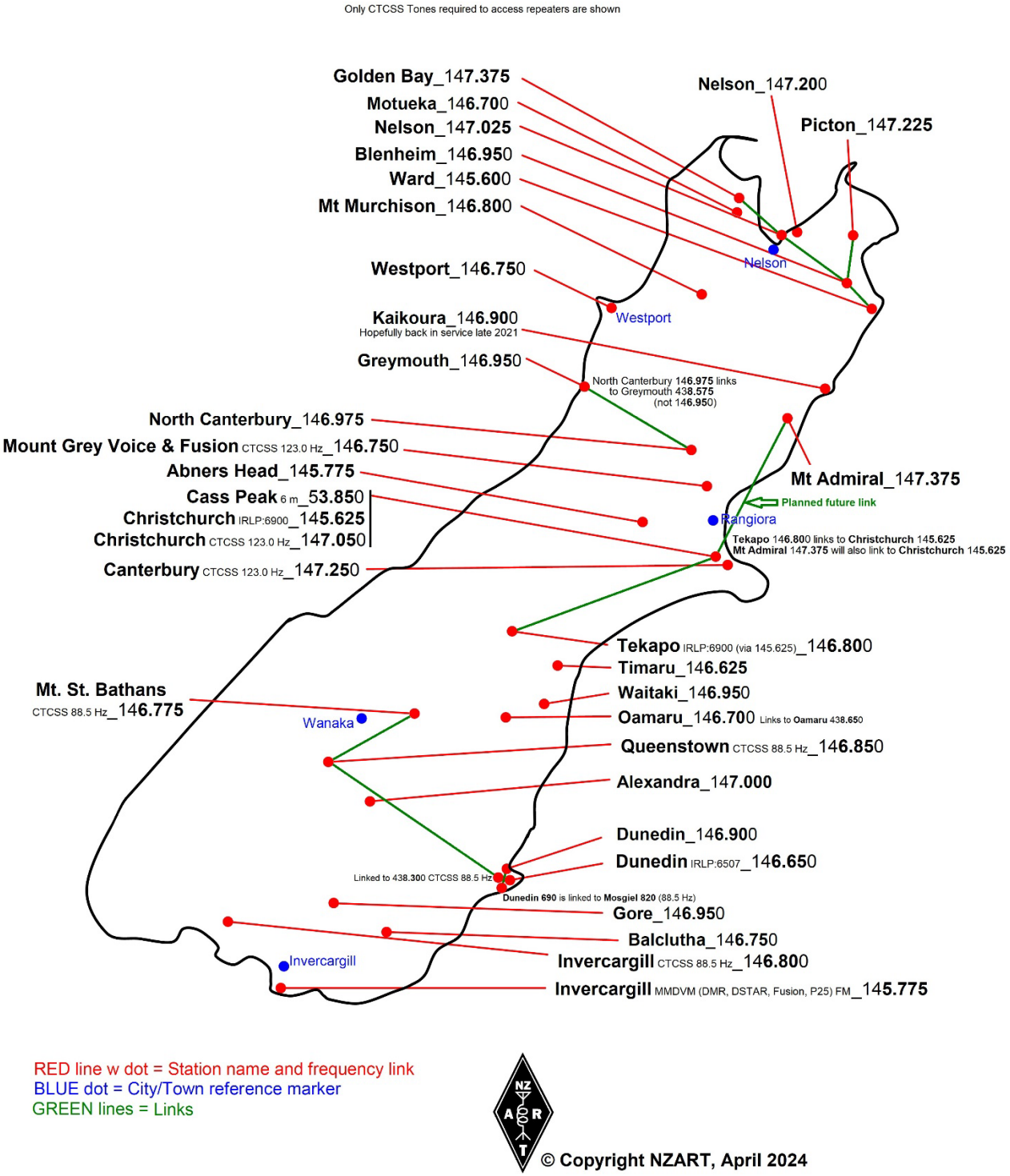
Maritime Radio VHF Coverage

Note: gaps in coverage may exist within the areas shown, due to terrain 'shadows' (which can occur under cliffs close to the shore or in bays and fiords) and occasional system maintenance.

NZART Repeater sites

South Island Amateur Radio 6 m & 2 m (VHF) Repeaters

Note: 1. The **naming system** is explained on the map **NZ South Island AR UHF Repeaters**
2. Repeater Offsets **are explained on the map** Wellington & Wairarapa AR UHF & VHF Repeaters



RED line w dot = Station name and frequency link
BLUE dot = City/Town reference marker
GREEN lines = Links

NZ South Island AR UHF Repeaters

Notes: 1. The **naming system** is explained on the map **NZ South Island AR UHF Repeaters**
2. Repeater **Offsets** are explained on the map **Wellington & Wairarapa AR UHF & VHF Repeaters**

National System repeaters are listed on their own page

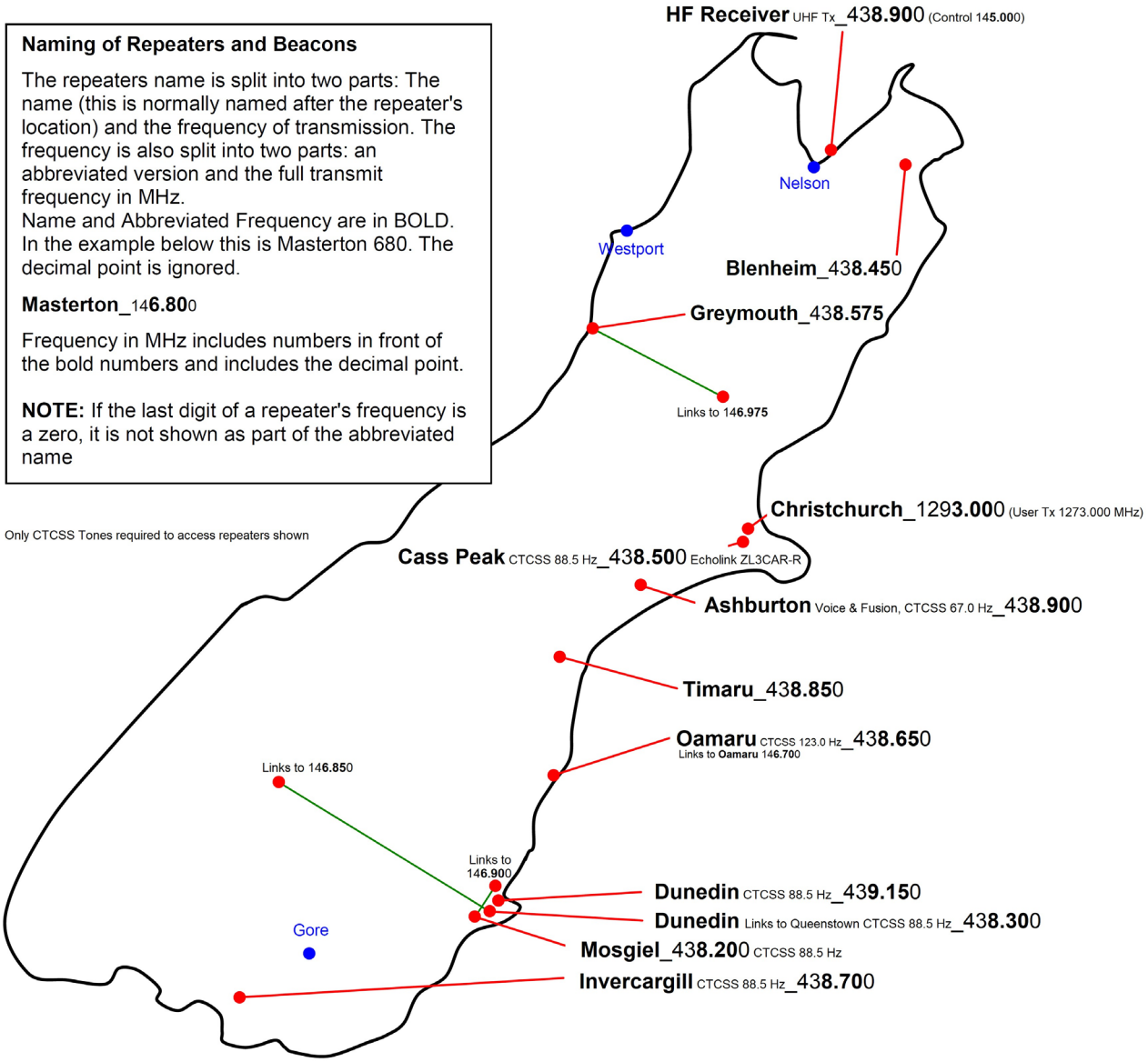
Naming of Repeaters and Beacons

The repeaters name is split into two parts: The name (this is normally named after the repeater's location) and the frequency of transmission. The frequency is also split into two parts: an abbreviated version and the full transmit frequency in MHz.
Name and Abbreviated Frequency are in BOLD. In the example below this is Masterton 680. The decimal point is ignored.

Masterton_146.800

Frequency in MHz includes numbers in front of the bold numbers and includes the decimal point.

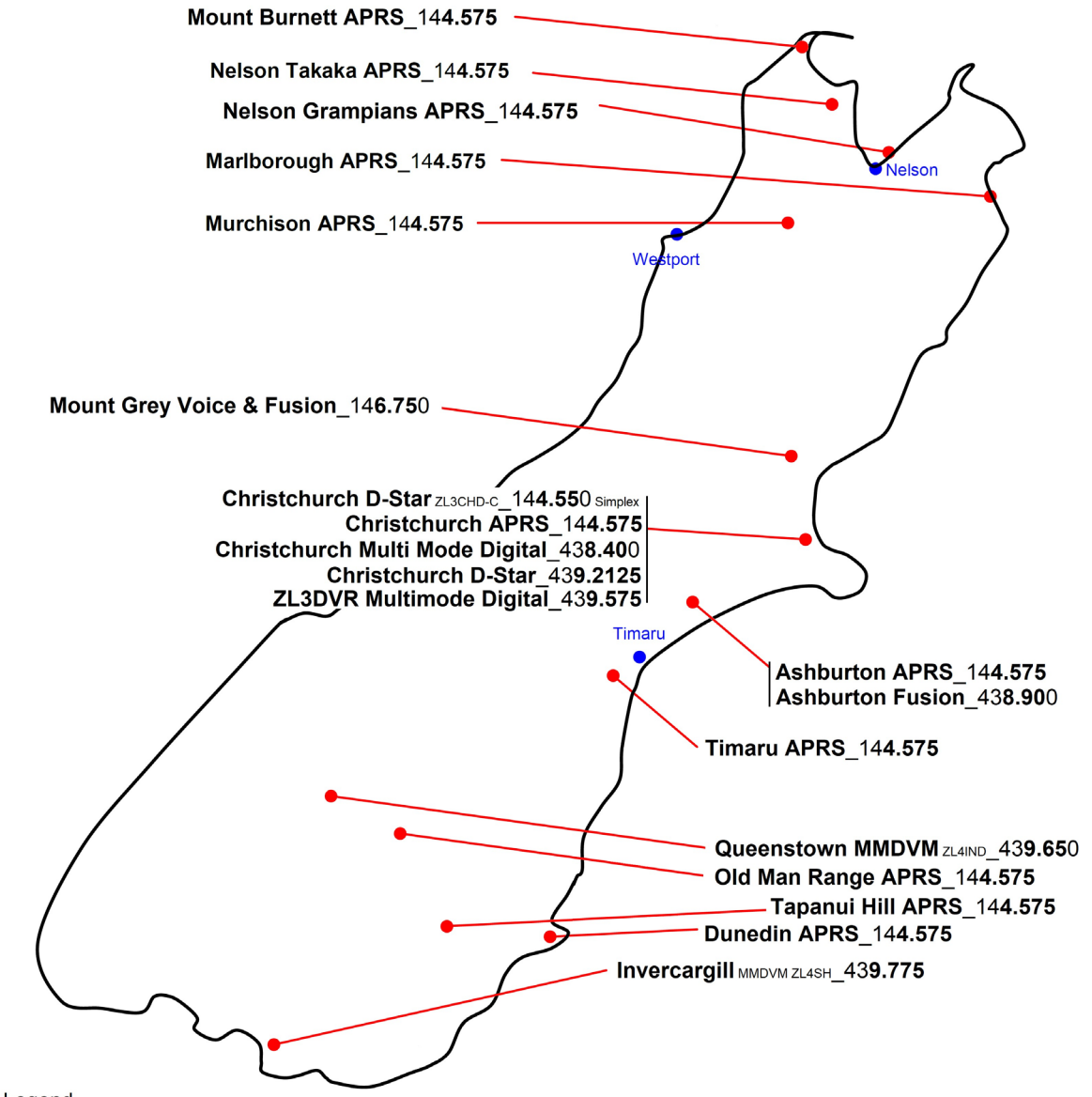
NOTE: If the last digit of a repeater's frequency is a zero, it is not shown as part of the abbreviated name



Legend
RED line w dot = Station name and frequency link
BLUE dot = City/Town reference marker
GREEN lines = Links

South Island APRS, Data (& Voice), Digipeaters

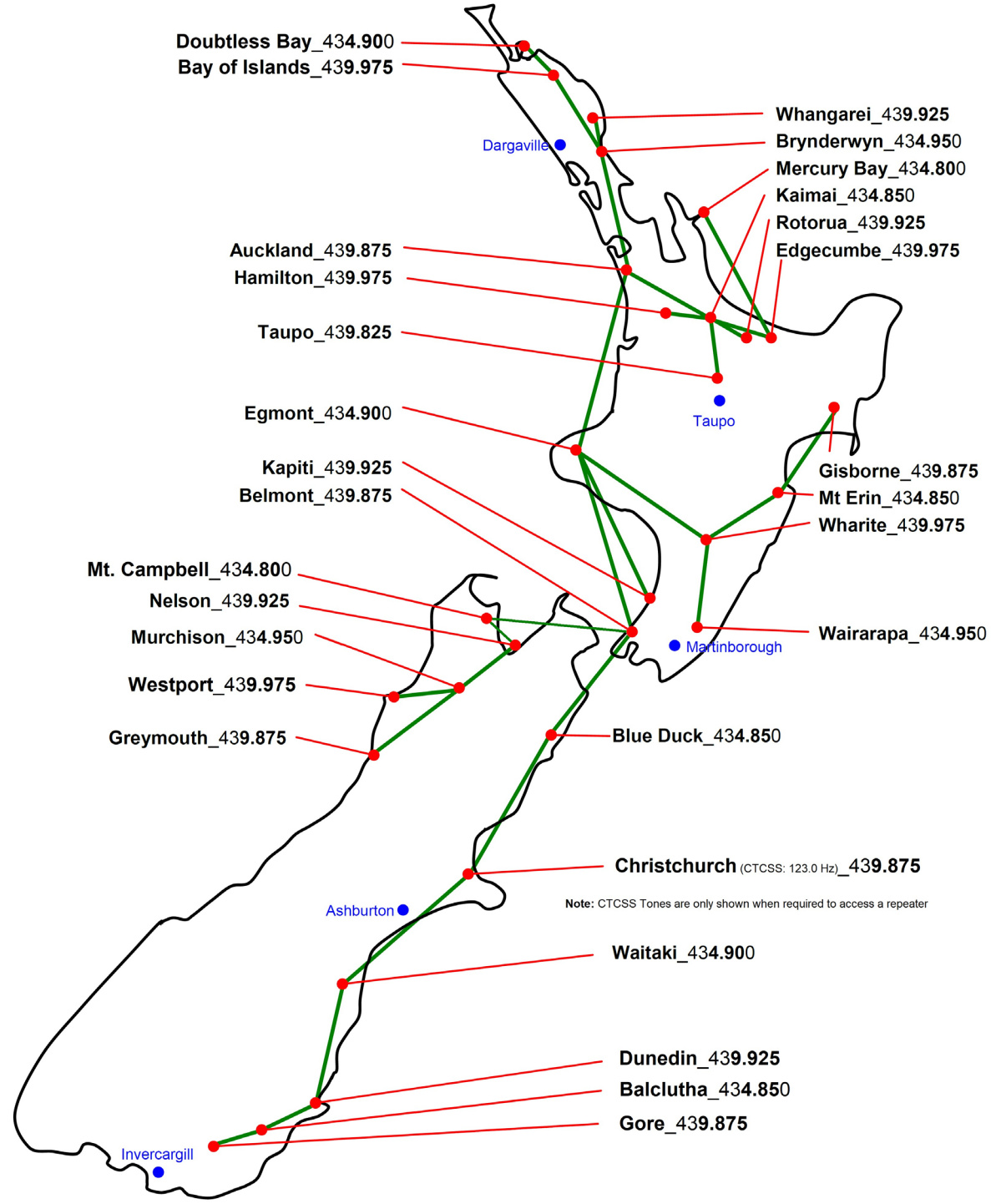
Notes: 1. The **naming system** is explained on the map **NZ South Island AR UHF Repeaters**
2. Repeater **Offsets** are explained on the map **Wellington & Wairarapa AR UHF & VHF Repeaters**



Legend
RED line w dot = Station name and frequency link
BLUE dot = City/Town reference marker

New Zealand Amateur Radio National System

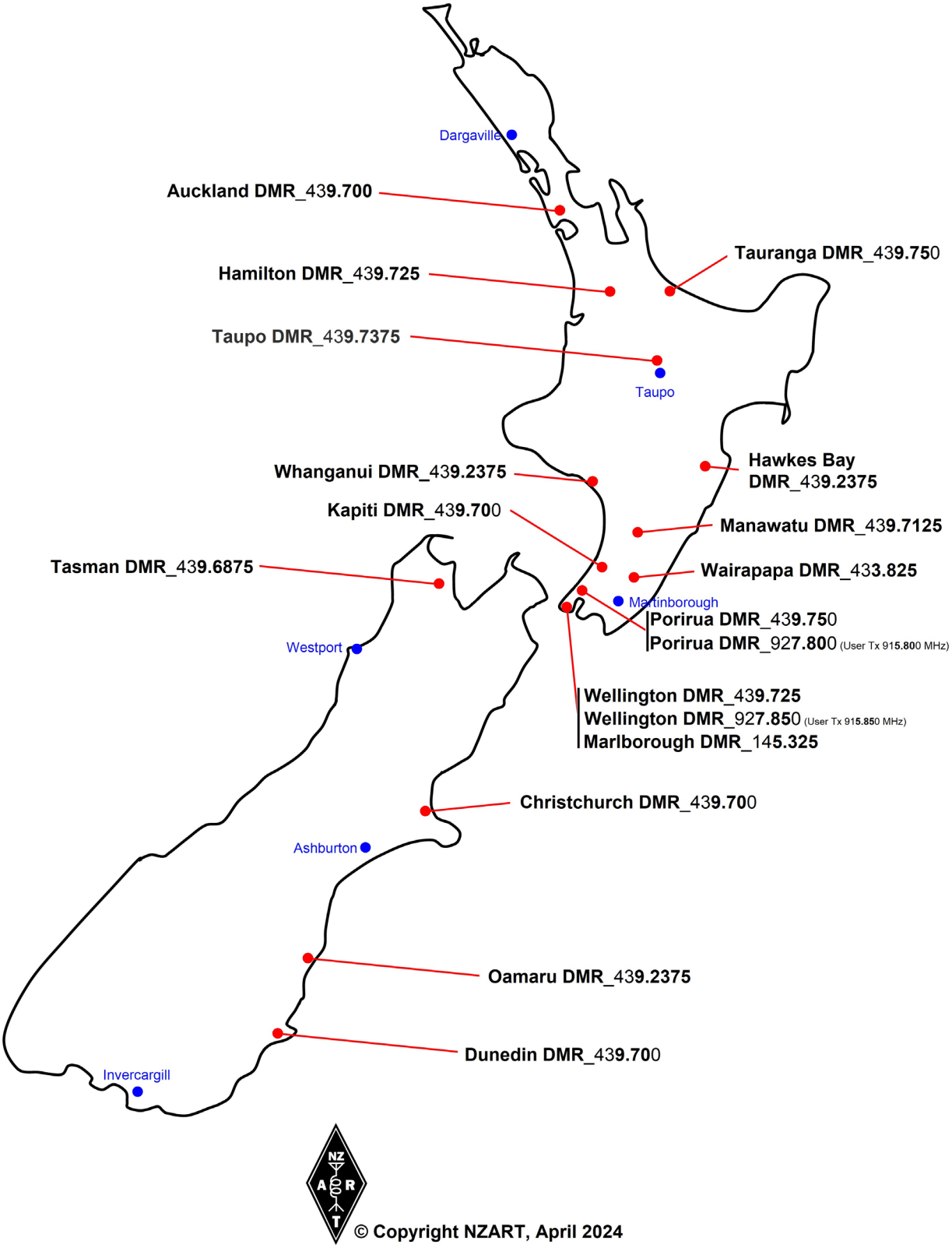
NOTE: 1. **The naming system** is explained on the map **NZ South Island AR UHF Repeaters**
2. Repeater **Offsets** are explained on the map **Wellington & Wairarapa AR UHF & VHF Repeaters**



Legend
GREEN lines = National System Links
RED line w dot = Station name and frequency link
BLUE dot = City/Town reference marker

AREC ZL TRBO (MARC) DMR Network

NOTE: 1. **The naming system** is explained on the map **NZ South Island AR UHF Repeaters**
2. Repeater **Offsets** are explained on the map **Wellington & Wairarapa AR UHF & VHF Repeaters**



Genesis Reticulated Gas Network (Dunedin City):

Central / North Dunedin

South/West Dunedin

Financial sector

Location of bank branches

Area	Bank	Address	Vulnerability to natural hazards*
Alexandra & Clyde	ANZ Alexandra Branch	37 Tarbert St	Earthquake
	BNZ Alexandra	45 Tarbert St	Earthquake
	Rabobank Alexandra	89 Tarbert St	Earthquake
	Westpac Alexandra	40 Tarbert St	Earthquake
Balclutha & surrounds	ANZ Balclutha	33 Clyde St	Flooding (River)
	Westpac Balclutha	39 Clyde St	Flooding (River)
Cromwell	ANZ Cromwell	3 The Mall	Earthquake
	SBS Bank Cromwell	21 The Mall	Earthquake
Dunedin	ANZ Dunedin Branch	71 George St	Earthquake
	ANZ South Dunedin	165 King Edward St	Earthquake
	ASB Dunedin	299 George St	Earthquake
	BNZ Dunedin Central	98 Geoge St	Earthquake
	BNZ South Dunedin	159 King Edward St	Earthquake
	Dunedin Kiwibank	310 Moray Place	Earthquake
	Gardens Kiwibank	6 North Rd	Earthquake
	Green Island Kiwibank	216 Main South Road	Earthquake
	Rabobank Dunedin	399 Moray Place	Earthquake
	SBS Bank Dunedin	304 George St	Earthquake
	Westpac Moray Place	106 George St	Earthquake
	Westpac South Dunedin	216 King Edward St	Earthquake
Mosgiel	ANZ Mosgiel	103 Gordon Road	Earthquake
	Westpac Mosgiel	112 Gordon Road	Earthquake
Oamaru	ANZ Oamaru	11 Thames St	Earthquake
	BNZ Oamaru	80 Thames St	Earthquake
	Rabobank Oamaru	12 Wear St	Earthquake
	Westpac Oamaru	155 Thames St	Earthquake
Queenstown	ANZ Five Mile Branch	34 Grant Rd	Earthquake
	ANZ Queenstown Branch	17A Camp St	Earthquake
	ASB Queenstown Branch	Five Mile Centre, 20 Grant Rd	Earthquake
	BNZ Queenstown	36 Grant Rd	Earthquake
	Queenstown Kiwibank	19 Grant Rd	Earthquake
	SBS Bank Queenstown	19 Grant Rd	Earthquake
	Southland Building Society	7 Shotover St	Earthquake
	Westpac Queenstown Junction	1092 Frankton Rd	Earthquake
Wanaka	ANZ Wanaka Branch	58 Ardmore St	Earthquake
	BNZ Wanaka	93 Ardmore St	Earthquake, Flooding (Lake)
	Wanaka Kiwibank	39 Ardmore St	Earthquake
	Westpac Wanaka	15 Helwick St	Earthquake, Flooding (Lake)

*__Note:__ All banking assets are also exposed to risk from loss of power supply and cyber attack

Location of Automated Transaction Machines (ATM's)

Area	Bank	Address	Vulnerability to natural hazards*
Alexandra & Clyde	ATM	40 Tarbert St	Earthquake
	ANZ ATM	37 Tarbert St	Earthquake
	BNZ ATM	45 Tarbert St	Earthquake
	BNZ ATM	New World, 89 Centennial Ave	Earthquake
Balclutha & surrounds	ANZ Balclutha ATM	9 Lanark St	Flooding (River)
	BNZ ATM	33 Clyde St	Flooding (River)
	BNZ ATM	53 Clyde St	Flooding (River)
	Westpac ATM	39 Clyde St	Flooding (River)
Cromwell	ANZ Cromwell ATM	3 The Mall	Earthquake
	BNZ ATM	2 Murray Terrace	Earthquake
	BNZ ATM	1 The Mall	Earthquake
	ATM	48 The Mall	Earthquake
Mosgiel	ANZ Mosgiel ATM	103 Gordon Rd (Cnr. Gordon Rd and Cargill St)	Earthquake
	BNZ ATM	10 Hartstonge Ave	Earthquake
	BNZ ATM	132 Gordon Rd	Earthquake
	Westpac ATM	112 Gordon St	Earthquake
Dunedin	ATM	560 Andersons Bay Rd	Earthquake
	ATM	216 King Edward St	Earthquake
	ANZ BP Connect Bays Junction	574 Andersons Bay Rd	Earthquake
	ANZ BP Connect Dunedin ATM	52 Cumberland St	Earthquake
	ANZ Dunedin ATM	71 George St	Earthquake
	ANZ Fresh Choice Roslyn ATM	279 Highgate	Earthquake
	ANZ Golden Centre ATM	251 George St	Earthquake
	ANZ North Dunedin ATM	300 George St	Earthquake
	ANZ Port Chalmers ATM	22 George St	Earthquake
	ANZ South Dunedin ATM	165 King Edward St	Earthquake
	BNZ ATM	98 George St	Earthquake
	BNZ ATM	267 George St	Earthquake
	BNZ ATM	201 Great King St	Earthquake
	BNZ Centre City ATM	133 Great King St	Earthquake
	BNZ ATM	6 North Road	Earthquake
	BNZ ATM	118 High St	Earthquake
	BNZ ATM	86 Hillside Rd	Earthquake
	Next Payments ATM	269 Princess St	Earthquake
Oamaru	ANZ Oamaru ATM	11 Thames St	Earthquake
	ANZ Oamaru North ATM	197 Thames St	Earthquake
	BNZ ATM	72 Wansbeck St	Earthquake
	BNZ ATM	80 Thames St	Earthquake
	Kiwibank ATM	105 Thames St	Earthquake
	Westpac ATM	155 Thames St	Earthquake
Queenstown	ANZ Five Mile ATM	34 Grant Road	Earthquake
	ANZ Queenstown ATM	Cnr Ballarat and Camp Sts – 17a Camp St	Earthquake
	ANZ BP Connect ATM	1094 Frankton Road	Earthquake
	BNZ Queenstown ATM	10 Hawthorne Dr	Earthquake
	BNZ Wakatipu ATM	36 Grant Road	Earthquake

Area	Bank	Address	Vulnerability to natural hazards*
Alexandra & Clyde	ATM	40 Tarbert St	Earthquake
	ANZ ATM	37 Tarbert St	Earthquake
	BNZ ATM	45 Tarbert St	Earthquake
	BNZ ATM	New World, 89 Centennial Ave	Earthquake
Balclutha & surrounds	ANZ Balclutha ATM	9 Lanark St	Flooding (River)
	BNZ ATM	33 Clyde St	Flooding (River)
	BNZ ATM	53 Clyde St	Flooding (River)
	Westpac ATM	39 Clyde St	Flooding (River)
Cromwell	ANZ Cromwell ATM	3 The Mall	Earthquake
	BNZ ATM	2 Murray Terrace	Earthquake
	BNZ ATM	1 The Mall	Earthquake
	ATM	48 The Mall	Earthquake
	BNZ ATM	30/35 Camp Street	Earthquake
	BNZ ATM	302 Hawthorne Drive	Earthquake
	Travelex ATM	Terminal Building, Queenstown Airport	Earthquake
	Travelex ATM	Visitor Information Centre, Queenstown CBD	Earthquake
	Westpac Queenstown Junction ATM	1092 Frankton Road	Earthquake
Wanaka	ANZ Wanaka ATM	58 Ardmore St	Earthquake
	ANZ Wanaka ATM	3 Helwick St	Earthquake, Flooding (Lake)
	ANZ BP Connect Wanaka	135 Sir Tim Wallis Drive	Earthquake
	BNZ ATM	93 Ardmore St	Earthquake, Flooding (Lake)
	BNZ ATM	20 Dunmore St	Earthquake, Flooding (Lake)
	Westpac ATM	13 Helwick St	Earthquake, Flooding (Lake)

*__Note:__ All banking assets are also exposed to risk from loss of power supply and cyber attack

Risk assessment Maximum Credible Event (MCE) scenarios.

Earthquake – Alpine Fault	A magnitude 8.2 earthquake occurs in the portion of the Alpine Fault that runs from Fiordland to Kelly (Otira), with the fault rupturing for approximately 400km from the south to the north. This results in up to 9m of surface displacement. Shaking in the Otago region lasts for several minutes and intensities range from MMI 5 in the east of the region (Dunedin) to MMI 7-8 (damaging to heavily damaging) in Queenstown, Alexandra, Cromwell and Wanaka. Following the long shaking, a range of building damage will occur, from structural damage to potential building collapse in areas closer to the fault rupture. There are likely to be deaths, and injuries because of the earthquake. The earthquake results in other hazards including landslides, landslide dams forming in the high country catchments, rockfall and liquefaction (where shaking exceeds MMI 7). Seiche's (large waves on lakes as a result of shaking) occur, resulting in some inundation of low-lying land around Queenstown and Wanaka. Critical Infrastructure will be impacted across the region, with the worst damage occurring closest to the Alpine Fault. Many key routes across the region will be impacted, isolating communities across Central Otago. Air transport is suspended across all airports and aerodromes within the region, with varying degrees of damage. Three waters, energy and telecommunications infrastructure are all likely to be damaged in the region, particularly in areas which have experienced the highest level of shaking. Power loss and supply is experienced immediately following the earthquake, due to shutdown of the major hydro dams. Several river flood schemes are also damaged. The Alpine Fault earthquake impacts all the South Island and lower North Island. A state of national emergency is declared to manage the impacts of the earthquake including damage to nationally significant critical infrastructure and transport hubs, disruption to fast moving consumer goods, and the welfare of those impacted including the mass displacement of people. many aftershocks on the Alpine Fault will occur following the mainshock including on average two Mw7+ and twenty Mw6.0-6.9 aftershocks in the first seven days.
Severe weather – Flooding	A severe weather event occurs over 5 days within the region, resulting in widespread flooding and landslides, as a result of heavy rain and snowmelt. The weather system is accompanied by strong southerly gales, with gusts up to 130km/h. A sub-tropical low in the Tasman sea moves onto the west coast of the lower South Island, resulting in significant rainfall in Fiordland and the Otago headwaters. Combined with snow melt, this leads to a large influx of water into the river catchments. As this system moves away a second system of rain moves in from the North-west, depositing large amounts of rain across Central and Eastern Otago. In the Queenstown Lakes District the water level increases significantly after 2 days of heavy rainfall and snow melt entering the catchments, with peak flooding on Lake Wakatipu causing inundation as deep as 1.5m in parts of Queenstown, including properties along Beach Street, Rees Street, Church Street and Shotover Street. Inflows into Lake Wanaka exceed previous records and result in high water levels inundating lower parts of Wanaka and isolating the town. As the water levels increase in the Clutha River, flows downstream of the Clyde Dam significantly increase to 4000m3/s, resulting in flooding to parts of Alexandra. Increased flows into the Lower Clutha River coincide with heavy rain in the lower Clutha catchment on days 3 and 4 and result in flooding across large parts of the Southeast of the region. Balclutha, Stirling, Inch Clutha, Kaitangata, Matau and Paratai all experience severe flooding (5600m3/s at Balclutha), with some stop bank failures, resulting in numerous properties being inundated and access routes significantly impacted.

	As rainfall into the lower catchments increases many rivers break their banks and flood surrounding farmland. The Taieri River records it's highest ever flow levels of 3200m3/s at Outram and widespread flooding occurs in Momona, Outram and Mosgiel. Many other lower-lying rural areas experience widespread flooding of farmland and many small settlements are isolated.
Drought / Wildfire	After a severe drought within the region the previous year and a very mild winter, the region experiences sustained dry weather leading into the summer months. By January, the soil moisture levels across the region are at a record low and many of the rivers and dams and are the lowest recorded levels. The region is at extreme risk of wildfires occurring and warm north westerly winds accompany the dry and hot weather. In early February a fire breaks out on the lower slopes of Grant Peak in Queenstown. Fanned by strong NW winds and high heat, the fire rapidly spreads, requiring the evacuation of properties. The fire consumes a number of properties in Marina Drive and continues to spread, eventually reaching the Queenstown Hill Recreation Reserve, requiring large scale evacuation of properties at the foot of the hill. The fire continues to burn out of control for a number of days. As Firefighters grapple to control the fire in Queenstown, a second major fire breaks out in Whare Flat. Fanned by strong winds, the fire spreads rapidly, consuming large areas of forestry. The fire spreads to the South east, moving towards the outskirts of Dunedin. Smoke from the fire is pushed across the city and transport routes to the Taieri Plains are closed. As the two major fires burn, many other parts of the region are on high alert for wildfire. Many recreational reserves across Dunedin are closed as a preventative measure to reduce the risk to major assets within the city, including state highways.
Tsunami	A magnitude 8.5 earthquake occurs at the Puysegur subduction earthquake. This is felt as a long or strong earthquake across the region with shaking lasting for several minutes and intensities of MM7-8 experienced in the southwest of the region. Following the long shaking, a range of building damage occurs. The majority of building damage is minor, such as cracks in walls, but a few older buildings suffer some more extensive damage where shaking intensities are higher in the south. Bridge abutments are particularly vulnerable, leading to some separation on weaker bridges. The shaking impacts above ground electricity assets, with the worst impacts to assets in the south of the region. Landslides occur in the high country on unstable slopes where the intensity is above MM7. The earthquake triggers a tsunami that impacts the southern portion of the Otago coastal area. The sea level drops by 0.3 to 0.8m below expected levels. The first wave arrives 1.5 hours after the earthquake, moving north along the Otago coastline and arriving 2.25 hours after the earthquake in Oamaru. The initial wave is small arriving at the southern Otago coastline, and then a larger wave follows. Large waves hit every 30 minutes, with the largest ones passing after 10 hours or so. The largest waves have an amplitude above mean sea level of 3.7m at Papatowai. Dunedin Harbour is relatively protected, but experiences strong surges. Central Dunedin beaches, such as St Clair and St Kilda, experience maximum wave runs up to 2m. The tsunami scours the base of all coastal bridge abutments and, in some areas, affects the bridge superstructure. Some coastal roads are completely washed out, with debris across them. Road access to Brighton from the north and south, Taieri Mouth from the north, Doctors Point, and Evansdale to Warrington is affected by washouts and debris.

	Distribution poles in the inundation areas are damaged, and electricity assets in the inundation are infiltrated by water, causing short-circuiting, buried cables to be compromised, and some saltwater contamination to occur. It is likely that further aftershocks will occur, with the potential for a few to cause further tsunamis in weeks after the initial subduction zone rupture.
Severe weather – Snow storm	During the July school holidays, gale-force southerlies and blizzard conditions cause snow to fall to sea level over the course of two days. The Crown Range Road records up to 1.5m of snow and drifts of more than 4m metres in parts. Queenstown and Wanaka are blanketed in more than 50cm of snow and many large drifts block local roads. Along the coast 30-50cm accumulates down to sea level, with drifts of more than 2m as a result of high winds seen throughout the region. In Dunedin the snowfall and drifts makes many roads impassible. Snow and ice accumulate on state highways, making more remote roads completely impassable and leaving hundreds of people stuck in trucks and cars across the network as the weather worsens and temperatures drop further. NZTA Waka Kotahi and local Councils attempt to clear the major roads, but the dangerous conditions and continued heavy snow fall make it nearly impossible, isolating many communities across the region. Air traffic is suspended, leaving hundreds of tourists stranded in airports. Power is out at Queenstown airport, which is dealing with a high number of international visitors during the school holidays. The railway line between Dunedin and Invercargill is blocked by snow drifts and trees blown down over the line. Heavy snow accumulations and strong winds cause trees to fall, impacting powerlines and causing widespread outages on one of the coldest days of the year. Road closures make some of the sites where lines are down inaccessible. For about an hour, wind speed averaged 89-97 km/hr with wind gusts up to 145 km per hour are reported in Balclutha, causing more tree damage and communication issues in more remote areas. The snowstorm affects most of Otago. Given the damage to power and communications and disruption to the road network, a state of emergency has been declared to manage the impacts of the snowstorm, with thousands having to shelter in place. The weather forecasts an advancing anticyclone, clear skies, and cold temperatures over the coming days. This means that the snow will persist for several days, resulting in frosts and widespread ice.
Coastal Erosion	The region experiences sustained wet weather with soil moisture levels at a record high, with many rivers and dams having the highest recorded levels for all years. An approaching storm brings strong winds generating large waves, and storm surges that pound the shoreline at a perigean (king) spring tide. The high storm waves work to rapidly erode the coast. Areas affected include sand spits within the Otago Harbour (e.g., Harwood), open sea locations (e.g., Warrington), and rocky shorelines capped with loess soil deposits (e.g., alongside Brighton Taieri Mouth Road). Overtopping and inundation occur in coastal areas, particularly along the Clutha Delta coastline. The lower river channels and the Inch Clutha Bypass floodway flood the lower areas, causing seawater inundation, with higher-salinity water upriver and in streams. Stormwater drains are overwhelmed, causing stormwater to be discharged into rivers and the sea, only to be washed back in from the ongoing storm surge. Portsmouth Drive, Teviot and Midland streets, and low-lying parts of Andersons Bay have debris across the roads, and some areas have been washed out completely. The coastal road between Brighton and Taieri Mouth and Port Molyneux and Kaka Point experiences several wash outs and debris across the road.

Cyber Attack	A sustained cyber-attack targeting communications and electrical supply infrastructure leads to widespread power supply issues nationally and across the region with blackouts of 24 hours and up to 48 hours in parts. Finance systems such as banking and EFTPOS are unavailable, fuel supply is limited to sites with generators and some telecommunication sites are impacted due to power loss.
Solar Storm	A significant geomagnetic storm occurs as the result of coronal mass ejections released by the sun. These impact the earth's magnetic field above New Zealand resulting in disruptions to the New Zealand national electrical grid, with damage to key transformers, production facilities and other electrical assets. This results in a national blackout for 24 hours and disruption to other key services including telecommunications.

Consequence Descriptors

Below are the descriptors were used by lifeline utilities during the risk assessment process:

	No impact or negligible impact on the services/functions they provide	Minor impact on the services/functions they provide	Moderate impact on the services/functions they provide	Major impact the services/functions they provide	Catastrophic impact on the services/functions they provide
	Insignificant	Minor	Moderate	Major	Extreme
Lifeline Infrastructure considerations: scale, duration, ability to relocate function/service and recoverability					
Impacts to potable water services (Inc. Water tanks and bores)	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions in part of the region	Widespread short to medium term service disruptions across the region	Widespread, long term service disruption
Impacts to Wastewater services	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions in part of the region	Widespread short to medium term service disruptions across the region	Widespread, long term service disruption
Impacts to Stormwater services	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions in part of the region	Widespread short to medium term service disruptions across the region	Widespread, long term service disruption
Impacts to regional flood schemes - stop banks, retention dams, pumping systems	No impacts	Isolated non-critical damage to part of the flood scheme	Short term critical damage to part of the flood scheme	Long term critical damage to part of the flood scheme	Long term critical damage to multiple parts of the flood scheme
Impact to electricity generation	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions in part of the region	Widespread short to medium term generation disruptions	Widespread, long term generation disruption
Impacts to electricity distribution	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions in part of the region	Widespread short to medium term supply disruptions	Widespread, long term supply disruption
Impact to Roading network - State Highways	Negligible impacts	Short term minor closures	Short term minor closures and/or critical link closure	Medium term closures, including critical links	Long term critical closures

Consequence Descriptors (Continued)

	No impact or negligible impact on the services/functions they provide	Minor impact on the services/functions they provide	Moderate impact on the services/functions they provide	Major impact the services/functions they provide	Catastrophic impact on the services/functions they provide
	Insignificant	Minor	Moderate	Major	Extreme
Lifeline Infrastructure considerations: scale, duration, ability to relocate function/service and recoverability					
Impact to Roading network - Local Authority	Negligible impacts	Short term minor closures	Short term minor closures and/or critical link closure	Medium term closures, including critical links	Long term critical closures
Impacts to Rail Network	Negligible impacts	Short term minor closures	Short term minor closures and/or critical link closure	Medium term closures, including critical links	Long term critical closures
Impacts to Airports	Negligible impacts	Temporary disruption/closures	Short term disruption and/or temporary major hub closure	Major hub - medium term disruption/closure	Major hub - long term disruption
Impacts to Ports	Negligible impacts	Temporary disruption/closures	Short term disruption and/or temporary major hub closure	Major hub - medium term disruption/closure	Major hub - long term disruption
Impacts to Fuel Distribution/Availability (Including LPG and other combustible fuels)	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions in part of the region	Widespread short to medium term service disruptions across the region	Widespread, long term service disruption/closure
Impacts to Fast moving consumer goods	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions in part of the region	Widespread short to medium term service disruptions	Widespread, long term service disruption
Impacts to waste management	Negligible impacts	Isolated & short term increase in waste not affecting BAU services	Increased waste generation requires regional coordination to manage	Waste generation requires new storage sites to enable disposal	Waste generation requires national support to manage