Climate Adaptation & Resilience Plan

2024

POWERCO

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Foreword from our CEO

Kia ora koutou

We connect nearly one million Kiwis across the North Island to electricity and gas. We deliver energy through more than 29,000km of lines and cables, and more than 6,000km of pipes, making us the largest distributor – by network length – of electricity and gas in Aotearoa New Zealand. We have an important role to play enabling Aotearoa New Zealand's efforts towards climate adaptation and strengthening the resilience of our infrastructure sustainably.

Our Future Ready Networks Strategy outlines how our networks will play a key role in helping New Zealand strengthen resilience, while we continue to ensure energy remains affordable for our customers, is delivered in an environmentally conscious way, and provides security of supply every step of the way. Energy resilience means ensuring Powerco has the capacity to anticipate, withstand, quickly recover, and learn from events that impact our ability to serve our customers. To achieve this, we are investing in our electricity and gas networks to address the impacts of weather events fuelled by climate change, including disruption and damage to electricity and gas infrastructure.

We are already experiencing more frequent severe weather events, causing significant damage to infrastructure and interrupting electricity supply. Recent events have also highlighted the value of communities having access to multiple energy sources. When cyclones Dovi and Gabrielle damaged infrastructure and disrupted power supplies across the country, our gas network remained intact and gas customers were able to cook their food, heat their home and have hot water.

This Climate Adaptation & Resilience Plan is a snapshot of the climate change risks for our network, and documents our approach to proactively identify, mitigate, and adapt to climate risks. Sharing our understanding of those risks, and our approach to planning and responding, is an important part of working with communities on adaptation and resilience strategies.

In developing and documenting our adaptation and resilience approach, there are some learnings of note. One of those was the minimal difference in sea level rise (on the area impacted) between the moderate and worst-case scenarios for the Socio-economic Shared Pathways (SSPs). We found that planning to the worst-case scenario drives up cost for our customers and may not provide an equivalent benefit. We want to plan for appropriate scenarios and avoid imposing unnecessary added costs. We have highlighted in this document some community-specific responses, and working with communities on resilience options will be a key input to future planning.

While we have modelled our electricity and gas networks to specifically identify assets vulnerable to inland inundation and sea level rise in the future, further engagement with local government and other essential infrastructure asset owners is required. New Zealand’s infrastructure is a complex web of inter-related services and local planning efforts, all at different stages of maturity and collaboration. Strengthening resilience or working with communities on adaptation plans means we need much greater understanding of local plans and improved coordination across infrastructure services and providers.

We will continue to build on this work to ensure our planning and investment reflects not only how we will keep the energy flowing to our customers into the future, but also new information on climate change risks; development of policy, regulatory and local planning settings; and our unwavering commitment to enable Kiwis to thrive as we respond to our changing climate.

Ngā mihi nui

James Kilty
Chief Executive Officer

Purpose of this Climate Adaptation & Resilience Plan

2. Purpose of this Climate Adaptation & Resilience Plan

2.1 Planning in response to increasing climate challenges

This document outlines how Powerco is navigating the uncertainty and challenges of climatic extremes caused by a warming climate. Planning for resilience is not new, but the risks and expectations are changing, and it is important for us to document our approach – leveraging Aotearoa's energy resources to 'grow to zero'. We believe Aotearoa is well placed to grow its economy while reaching its net-zero 2050 target.

Our Climate Adaptation & Resilience Plan sets out our analysis and approach to proactively identify, mitigate, and adapt to climate risks, fostering resilient infrastructure to provide continuity, sustainability, and security of energy supply. Through collaborative efforts and strategic measures, we aim to enhance preparedness, reduce our vulnerability to disruptions, and foster transparency as we work with local communities on adaptation strategies.

This document relates to both our electricity and gas networks, and was initially designed for internal resilience planning purposes. Over time, this will be updated as more data becomes available, national policy drivers are confirmed, and outcomes from community engagement are incorporated.

Our Climate Adaptation & Resilience Plan informs our strategic priorities and electricity and gas Asset Management Plans (AMP). It also supports Powerco's sustainability strategy (sustainability pou) and is to be read in conjunction with our climate-related disclosure report available on our website.

Powerco's focus for this plan is understanding "significant event" climate risks that our energy systems are vulnerable to, caused by climate drivers, and determining responses based on our Asset Management System.

Our plan includes our geographic and climate variables related to our networks, recent weather events, and climate hazard exposure and vulnerability assessments using a range of climate scenarios over specified time horizons. Our material climate hazards addressed in this plan include:

- Inland and river flooding
- Sea level rise
- Coastal and river erosion and landslides
- High winds (storms)
- Fire risk (including vegetation management)

Priority assets exposed and vulnerable to these climate hazards are further addressed in Section 6 of the report, along with supporting regional maps of our asset exposures, available in Appendix 5.

2.2 Direction through Powerco business model and strategies

To achieve our purpose of connecting communities, we need to take measured risks to deliver value for our customers, communities, and partners by ensuring the safe, reliable, sustainable, and future-focused provision of services from quality, long-life infrastructure. This includes our governance, appetite, and management processes.

The "impact of climate change" (including physical and transitional risks) is one of the highest risks in our enterprise risk register. Our risk categories align on an environmental, social, governance and operational basis, where our physical climate-related risks are categorised as environmental.

Powerco's integrated strategic framework embeds integrated thinking in our strategic and business planning activities. It encompasses our strategic vision, purpose, and strategic priorities, and provides a structure for our business priorities. This framework ensures alignment between our strategic direction and the work we undertake to ensure there is focus on the right areas.

Powerco's Future Ready Networks Strategy outlines how our networks will play a key role in helping New Zealand meet its net-zero carbon emissions goals while continuing to ensure safe, cost-effective, reliable, and resilient energy delivery to our customers of today and tomorrow.

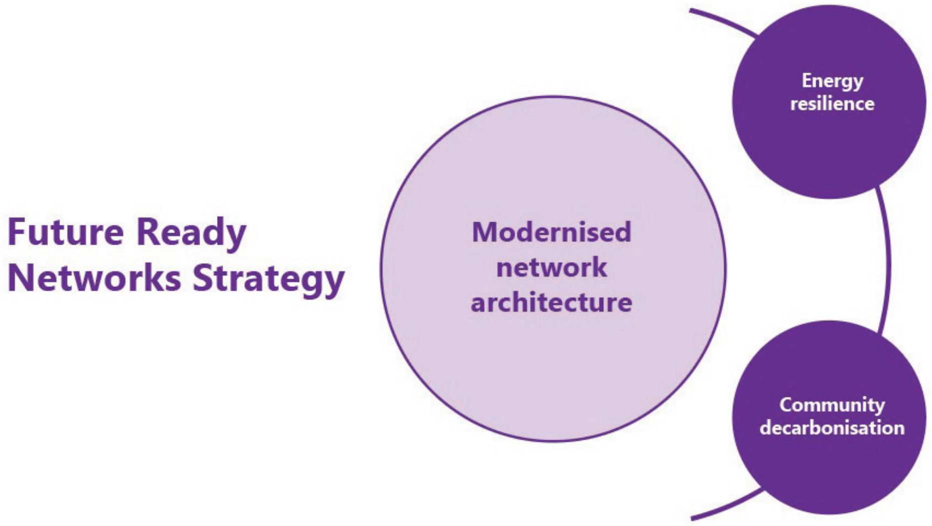


Figure 1 – Powerco's Future Ready Networks Strategy priorities (source – Powerco Integrated Strategic Framework).

All Powerco electricity and gas infrastructure, assets, and activities are publicly disclosed as part of the Commerce Commission information requirements (electricity and gas assets are disclosed separately). Powerco's Electricity AMP and Gas AMP include our 10-year plan for managing our electricity and gas assets to meet the needs of our customers. The Gas AMP runs from 1 October 2023 to 30 September 2033, and the Electricity AMP from 1 April 2023 to 31 March 2033.

Powerco's asset management strategies take into consideration those climate-related risks facing our business and inform our capital and operational expenditure forecasts (published publicly in our gas and electricity AMPs). Our goal with these strategies is to manage asset performance within acceptable bounds, ensure assets are safe and in a suitable condition to remain in service, and minimise the total lifecycle cost of ownership.

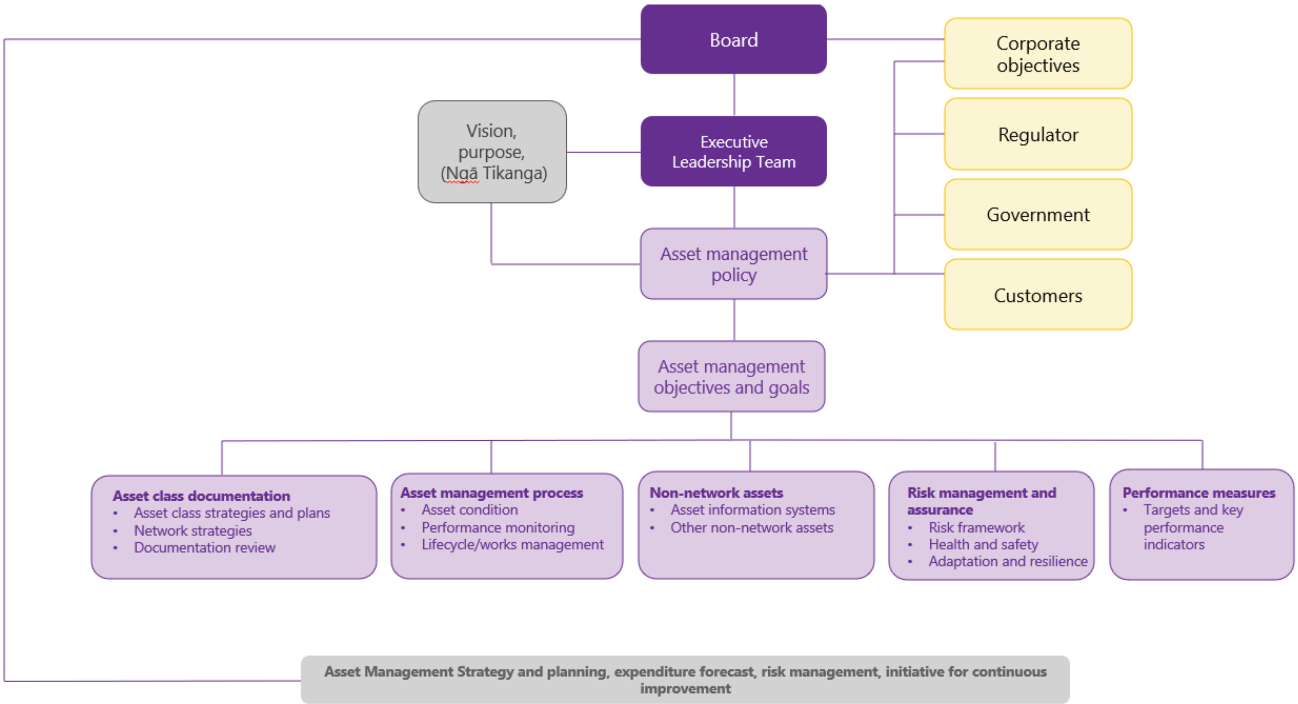


Figure 2 – Powerco Asset Management System (source Powerco gas and electricity AMPs).

Our Asset Management System enables effective decision-making through six asset management planning activity levels, ranging from strategic direction by the Board and CEO, to the approval of works delivery by the Operations team. Each level is designed to provide a clear line of sight between our corporate objectives, asset management activities and investment into our network resilience programme.

Table 1 – Overview of Asset Management System activity levels and responsibilities.

Level	Purpose	Responsible	Documentation
Corporate Strategy	Set high-level objectives and targets for the company.	CEO, executive	Ngā Tikanga, purpose, values Asset Management Policy, Business Plan
Asset management objectives	Support corporate objectives, set asset management direction and goals.	General Manager (GM) Gas GM Electricity	Gas Asset Management Plan Electricity Asset Management Plan
Asset Management Plan	A summary of our strategies and plans for providing a safe, reliable, resilient, and cost-effective energy supply for the next 10 years.	GM Gas GM Electricity	Gas Asset Management Plan Electricity Asset Management Plan

Level	Purpose	Responsible	Documentation
Gas Te Puni Kāpuni (TPK) planning	Detailed planning of project needs, registration, and prioritisation, giving effect to the 10-year investment plan.	Gas Asset Strategy Manager Gas Operations Manager Contract & Field Services	SAP notifications Te Puni Kāpuni (Issues Register)
Electricity Fleet Management Plans **Network Development Plans**	Electricity has a range of 10-year Regional Network Development Plans and Fleet Management Plans.	Network Development Manager East Network Development Manager West Power Asset Fleet Manager Overhead Asset Fleet Manager	Network Development Plans Fleet Management Plans
Gas Works Plan (GWP)	Defines the list of projects to be delivered in the next financial year.	Gas Asset Strategy Manager (with Gas Operations support)	Annual GWP-approved document Investigation reports, project briefs Maintenance plan, non-network plan(s)
Electricity investment pipeline	Consists of two years of "executing" work and three years of work in "short-term planning".	Network Planning & Operational Technology team	Approved programme of works Investment summaries
Gas works delivery and field operations	Oversight of capital project and maintenance delivery.	Gas Operations Manager Gas Projects Delivery team Contract & Field Services	Project delivery framework Gas project brief Gas leadership team reports Monthly Board reports
Electricity service delivery	Oversight of capital project and maintenance delivery.	Regional Works Delivery Managers Maintenance Delivery Manager	Project work proposals Programme reporting

2.3 How this aligns with our Future Ready Networks Strategy

Energy resilience is a key strategy for Powerco, but 'resilience' is a broad topic and cannot be covered in a single document, so understanding the scope of this Climate Adaptation & Resilience Plan is important. There are significant resilience challenges to our gas and electricity energy networks beyond climate resilience. This plan excludes the following:

- Economic resilience (such as funding)
- Geopolitical resilience (such as global supply and demand)
- Supply chain resilience (ease of procurement)
- Security resilience (such as cyber threats)
- Natural hazard resilience (such as volcanic or seismic events)

These are being addressed as part of our overall Resilience Strategy. This plan is focused on resilience to climatic factors, in particular physical risks, how we currently manage these risks and our plans to improve. While it includes some aspects of the broader strategy, it does not intend to cover comprehensively those broader resilience approaches.

We have prepared this plan at a time when there is considerable national effort and change being made regarding climate data, risk identification, and policy settings, and local government focus on adaptation. This plan will be updated as more data becomes available, any national policy drivers are confirmed, and outcomes from local government planning or our own community engagement are incorporated.

What climate adaptation and resilience means for us is described further in the following section.

What climate adaptation and resilience means for us

3. What climate adaptation and resilience means for us

3.1 Defining climate risk and resilience

The energy systems that we operate to serve communities cannot be separated from the physical environment where they are built. Therefore, physical risks pose challenges for network infrastructure.

During the next century, the risk of increasing storms, flooding and wildfires will impact the integrity of our network infrastructure.

As a mature asset owner, we understand the external risks to our networks, and we expect to invest prudently to ensure a safe, sustainable, resilient, reliable and affordable service. Our customers and regulators certainly expect this too. The majority of our engineered network have long lifecycles – up to 80 years for some major assets, such as substations and special crossings (depending on the pipeline diameter), and 35-45 years (standard asset life) for district regulator stations and substations. As such, it is important to consider the potential climate impacts over that period and beyond.

For Powerco, resilience is the capacity to anticipate, withstand, quickly recover, and learn from events that impact our ability to serve our customers, while considering the impact of maintaining safety and reliability. Where we identify the need, we will adapt our network and operations to prepare for the increasing risks of changing weather and the related impacts to our operating environment. The more rapid recovery of a high resilience community is illustrated in Figure 3.

Resilience and reliability are not the same. Reliability focuses on the prevention and minimisation (in duration and extent) of outages because of network failure. The focus is on maintaining smooth operation and minimising the chances and impact of failure. Resilience focuses on minimising the consequences of any event and, most importantly, enabling the system to bounce back if an event does happen. It's about planning for the worst and ensuring that the supply system[1] can recover quickly.

[1] The supply system is more than the physical network. It includes non-network services and the organisational capability to recover after an event.

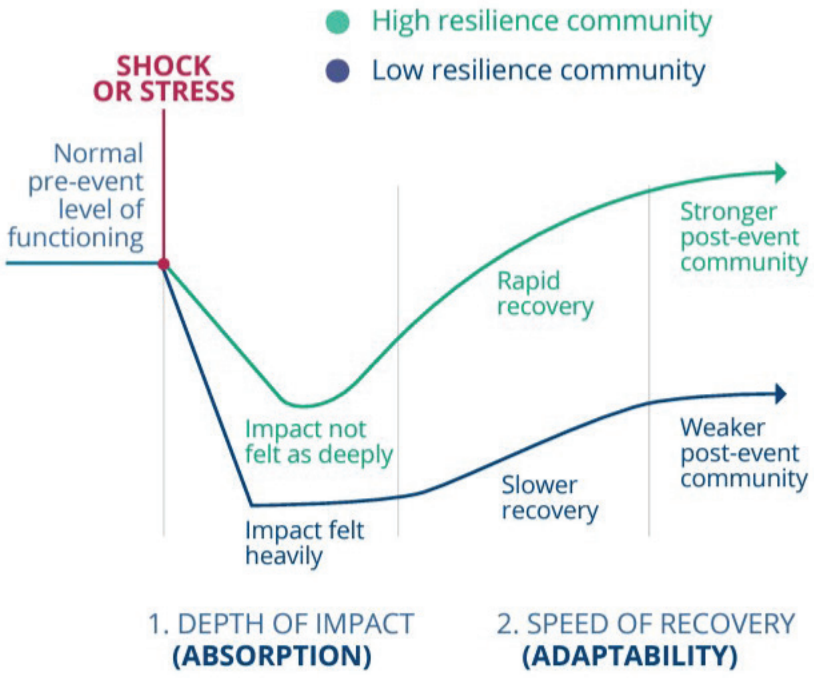


Figure 3 – Resilient communities recover faster (source National Disaster Resilience Strategy 2019).

3.2 Defining adaptation and community resilience

As the energy supplier, Powerco has an important role contributing to community-level planning for adaptation and resilience, but we are aware many others are also involved. For this reason, planning is usually led by local government. Community-level response to climate drivers also requires coordination between other infrastructure, such as water, transport, and telecommunications, and it encompasses homes, businesses, property, community services, cultural assets, the natural environment and more.

A key responsibility for Powerco is to improve understanding of how our energy networks will perform to climate hazards, share that understanding with the communities we supply, and work with customers on resilience requirements and possible actions.

Adaptation is the process of changing the way we do things to reflect the changing climate. At a physical asset level this may relate to (refer to Section 6.3 for more information):

- **Proactive** – such as investing in specific parts of vulnerable network to decrease the impact of hazard events, eg strengthening or relocating an asset.
- **Organic** – such as changing our design standards to allow gradual strengthening of the network to projected climate impacts. This strengthening would occur as parts are replaced or upgraded because of age or capacity.
- **Redevelopment** – while climate impacts to existing assets are minor, land use or other public infrastructure changes might drive the need to replace an asset, eg road raising, or relocation works to allow for adaptation to sea level rise.

3.3 Critical infrastructure interdependencies

We believe at the core of resilience is understanding and planning for the shared dependencies between our energy networks and other critical infrastructure, such as roading, communication networks, water, cloud services, media, and fuels etc. Modern services have significant overlaps and interactions, which means during significant events there are risks of cascade failures of critical infrastructure and essential services. This can have a much greater impact on the health and wellbeing of New Zealanders.

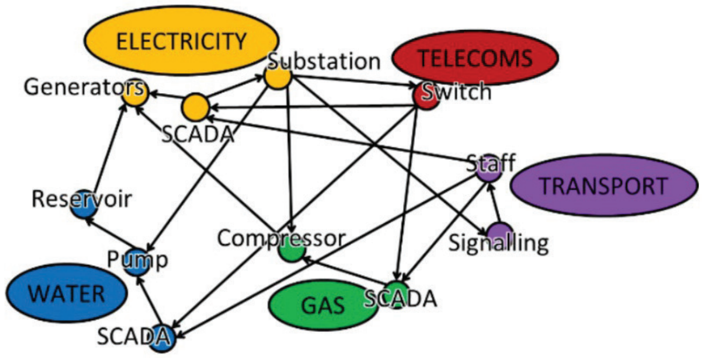


Figure 4 – Interdependence in critical infrastructure – showing electricity needs across different infrastructure (source CIGRE WG C4.47).

Across our footprint, we actively engage with various regional lifelines groups, which highlight our interdependencies and enable planning at a regional level. The groups are established as part of New Zealand's civil defence and emergency management system and are primarily focused on emergency response rather than adaptation and resilience, although they do have an interest in the latter. The groups we engage with are:

- Waikato Lifeline Utilities Group
- Bay of Plenty Lifeline Utilities Group
- Hawke's Bay Engineering Lifelines Group
- Taranaki Lifelines Advisory Group
- Manawatū-Whanganui Lifelines Advisory Group
- Wellington Lifelines Group
- Wairarapa Lifelines Group

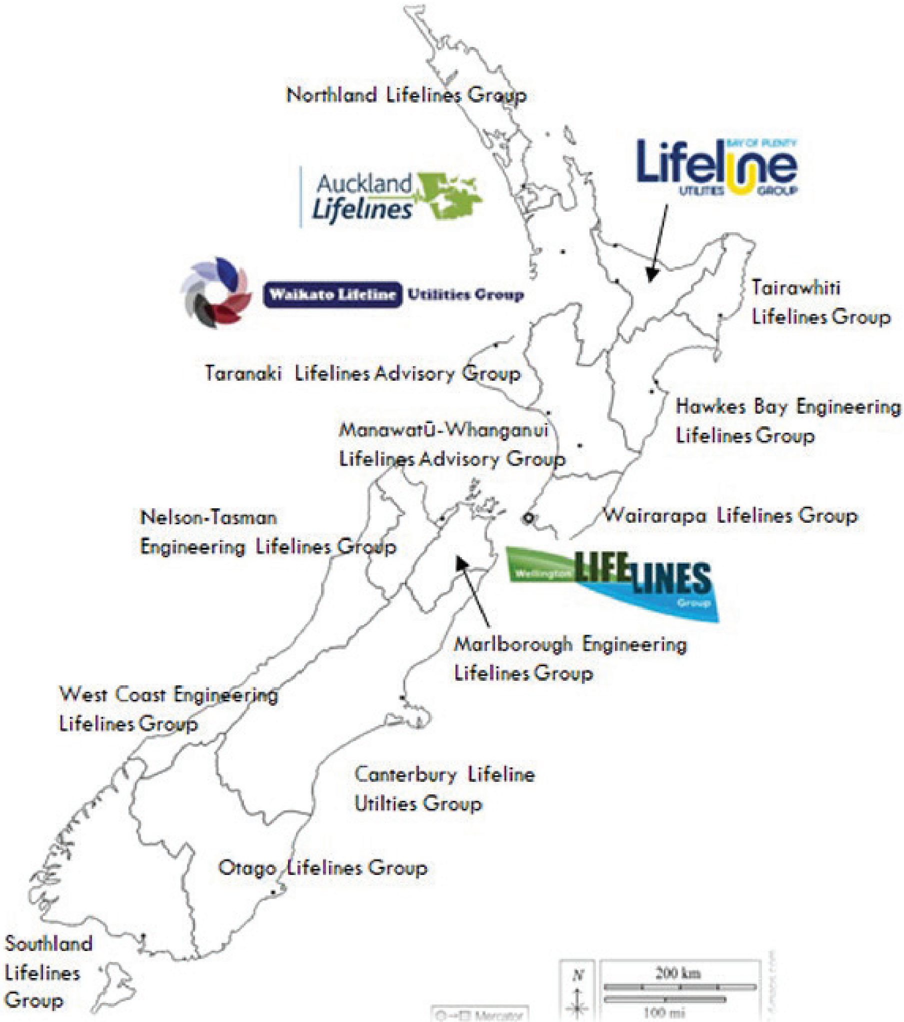


Figure 5 – New Zealand's lifelines groups (Source: New Zealand Lifelines Council)

The number of system interconnections across our electricity and gas networks is significant. We also supply energy to many essential service providers, as shown in Table 2. These providers commonly identified the loss of transport, electricity and communications as having major impacts on their capacity to provide services (see Figure 6 from the New Zealand Lifelines Council 2017) during a post-disaster event.

The nature of our gas operations is such that, if an outage occurred, it would have a significant impact on the community. We operate under the Gas Governance (Critical Contingency Management Amendment Regulations 2023), which sets out critical care and essential service designations to manage the supply of gas to essential services.

The degree to which the utilities listed to the right are dependent on the utilities listed below	Fuel	Roads	Telecomms	Electricity	VHF Radio	Broadcasting	Air Transport	Solid Waste	Financial&Cash Payments	Water Supply	Stormwater / Flood Protection	Wastewater	Sea Transport	Gas	Rail	**Total Dependency**
Fuel		3	3	3	3	3	3	3	3	3	3	3	3	3	3	**42**
Roads	3		3	3	2	2	3	3	3	3	3	3	3	3	3	**40**
Telecomms	2	3		3	3	2	2	2	3	3	3	3	2	3	2	**36**
Electricity	2	2	3		3	3	3	2	2	3	2	3	3	2	2	**35**
VHF Radio	2	2	2	2		2	3	1	2	2	2	2	3	2	2	**29**
Broadcasting	2	2	2	2	2		2	1	2	2	2	2	2	2	2	**27**
Air Transport	2	2	2	2	2	2		1	2	2	2	2	1	2	1	**25**
Solid Waste	1	3	2	2	1	1	1		1	2	2	2	1	2	2	**23**
Financial&Cash Payments	3	1	1	1	1	1	3	3		1	1	1	1	1	1	**20**
Water Supply	1	1	2	1	1	1	2	1	1		1	3	1	1	1	**18**
Stormwater / Flood Prot.	1	2	1	1	1	1	2	1	1	1		1	1	1	1	**16**
Wastewater	1	1	1	1	1	1	2	1	1	1	1		1	1	1	**15**
Sea Transport	1	1	1	2	1	1	1	1	1	1	1	1		1	1	**15**
Gas	1	1	1	1	1	1	1	1	1	1	1	1	1		1	**14**
Rail	1	1	1	1	1	1	1	1	1	1	1	1	1	1		**14**

Figure 6 – Degree of interdependency of utilities during/post event – 3: Required for service to function, 2: Important but can partially function and/or has full backup, 1: Minimal requirement for service to function (Source: National Infrastructure Vulnerability Assessment 2023 - New Zealand Lifelines Council).

Table 2 – Number of critical infrastructure and essential services customers on our network.

	Industry classification[2]	**Electricity – number of ICPs**	**Gas – number of ICPs**
Lifelines	Wastewater and water supply	917	3
	Health	237	64
	Oil and gas	29	19
	Transport/logistics	21	18
	Telecommunications	7	8
	Electricity generation	12	1
Essential customers	Retirement, age care	235	54
	Emergency services	224	18
	Educational service providers	-	189
	Council	83	56
	Food processing/agriculture farming	27	105
	Product manufacturing		103
	Government	24	81
	Total	**1,816**	**719**

[2] We are aware that the categories for lifelines or essential customers are subject to review and may become broader. The review of emergency management legislation is uncertain and the classifications in the table reflect current regulation.

Improving our understanding of infrastructure interdependencies, and working with these groups, is central to our resilience approach. This means we will continue working with critical infrastructure owners and liaise with other infrastructure providers to communicate our network vulnerabilities and realistic outage times, to understand criticalities in our services, and coordinate our work with other organisations' climate-related investments, where possible.

On our electricity network, we have several substations in the Hauraki plains that are protected from flooding during heavy rainfall by Waikato Regional Council flood protection canals, pumping systems, and flood gates. As this region develops a regional Climate Adaptation Plan and considers flood protection options, we will need to work closely with the council to improve resilience for communities, critical infrastructure, and essential services reliant on these substations.

3.4 Resilience measures and targets

To ensure our network infrastructure supports community resilience, we have developed deterministic response targets for various customer groups we consider to be high priority during a significant event. These groups include interdependent utilities, such as lifelines organisations, that rely on electricity and gas to function, as well as critical customers, such as health and welfare, community hubs, emergency services etc. The initial response targets set a baseline that will be further enhanced through ongoing community consultation.

We plan to assess our capabilities against these targets through regional event simulation exercises. The outcomes of these tests will inform further community consultation and enable us to develop both network and non-network solutions to ensure we can meet the expectations of the community.

As part of the gas infrastructure planning emergency levels of service (PELOS) framework, we worked with Wellington Lifelines Group and published a 'how to make a PELOS framework' paper[3]. This outlined the process by which the framework was created and explored various themes. To improve recovery following a major natural disaster, changes to gas network configuration will be investigated to improve network resilience for critical customers. This includes connection of these customers to strategic pipelines. Where this option is not practical, we will look to reconfigure the network with the installation of mainline valves allowing prioritisation of supply. Refer to Section 3.3 Table 2 for a list (ICP count) of gas critical customers on our network.

As this work progresses, we intend to adapt our existing value framework so that it adequately reflects the value communities place on a resilient energy supply, and their willingness to pay for that. This will enable investment in resilience to be optimised alongside traditional investment programmes.

3.5 Regulation and government expectations

Powerco is a regulated electricity and gas distributor under the Commerce Act 1986. This operating environment, alongside national and local policy, standards and guidelines, provides important context for our resilience and adaptation planning. The regulatory and policy context for infrastructure investment, community planning and climate response is complex. There are also many reviews under way and changing expectations around resilience. The Commerce Act drives our investment levels and asset management planning, and in the 2024

[3] Creating a 'planning emergency levels of service' framework – a silver bullet, or something useful for target practice? - ScienceDirect

default price-quality path (DPP4) review, there is increasing focus on resilience. However, there are many other regulatory and policy influences. This operating environment is described further in Appendix 3.

Our Asset Management System and electricity and gas asset management approach aligns with the regulatory requirements, industry codes and guidelines, including:

- AS/NZS 4645.1 Gas Network Management
- AS/NZS 2885 Pipelines – Gas and liquid petroleum
- Cadastral Survey Act 2002
- Climate Change Response (Zero Carbon) Amendment Act 2019
- Commerce Act 1986 (Part 4)
- Civil Defence and Emergency Management Act 2002
- Electricity (Hazards from Trees) Regulations – 2003
- Emissions Reduction Plan – 2022
- Gas Act 1992 and Gas Amendment Act 2006
- Gas Industry Company Determinations, Guidelines and Notices
- Gas Governance (Compliance) Regulations 2008
- Gas Governance (Critical Contingency Management) Regulations 2008
- Gas (Levy of Industry Participants) Regulations 2022
- Gas (Safety and Measurement) Regulations 2010
- Government Roading Powers Act 1989
- Hazardous Substances and New Organisms Act 1996
- Health and Safety at Work Act 2015
- Heritage New Zealand Pouhere Taonga Act 2014
- Local Government Act 2002
- National Adaptation Plan – 2022
- New Zealand Standard (NZS) 7901:2008 – Electricity and Gas Industries – Safety Management Systems for Public Safety
- NZS 5263:2003 Gas Detection and Odorization
- Privacy Act 2020
- Railways Act 2005
- Resource Management Act 1991
- Utilities Access Act 2010

Powerco networks and assets

4. Powerco network and assets

4.1 Powerco distribution network

Powerco is a privately owned utility with two shareholders[4]. We operate the largest network of electricity and gas distribution services in New Zealand by geographical area and network length, serving about one million consumers. This section provides an overview of the geographic regions and network footprint.

Electricity network

Powerco is New Zealand's largest electricity utility by the area we serve. We have more than 29,000km of electricity lines and cables connecting approximately 357,000 homes and businesses. The Powerco electricity network includes two isolated geographies, referred to as the Eastern and Western regions. Both networks contain a range of urban and rural areas, although both are predominantly rural. Geographic, population, and load characteristics vary significantly across our supply area. The maps below show the Eastern and Western network footprint and planning areas.

The **Eastern region** consists of two zones – Valley and Tauranga – which have differing geographical and economic characteristics. For planning and pricing purposes we divide this region into two zones:

- Valley includes a diverse range of terrain, from the rugged and steep forested coastal peninsula of Coromandel, to the plains and rolling country of eastern and southern Waikato. Economic activity in these areas is dominated by tourism and farming, respectively.
- Tauranga is a rapidly developing coastal region, with horticultural industries, a port, and a large regional centre at Tauranga city.

The **Western region** comprises the four network zones described below. Like the Eastern region, these zones have differing geographical and economic characteristics, presenting various asset management challenges. Because of the age of the network and the declining asset health of some overhead lines, extensive asset renewal is required in this region.

- Taranaki, which is situated on the west coast plains, is exposed to high winds and rain. The area, which includes the large regional centre of New Plymouth, has significant agricultural activity, oil and gas production, and some heavy industry.
- Whanganui includes the surrounding Rangitīkei and is a rural area exposed to westerly sea winds on the coast and snowstorms in high-country areas. It is predominantly agriculture-based with some industry.
- Manawatū includes rural plains and high-country areas exposed to prevailing westerly winds. It is mainly agricultural in nature, but the large regional centre of Palmerston North has significant logistical industries, a university and associated research facilities.
- Wairarapa is more sheltered and is predominantly plains and hill-country. It has a mixture of agricultural, horticultural and viticulture industries.

[4] Queensland Investment Corporation (58%) and Dexus (42%)

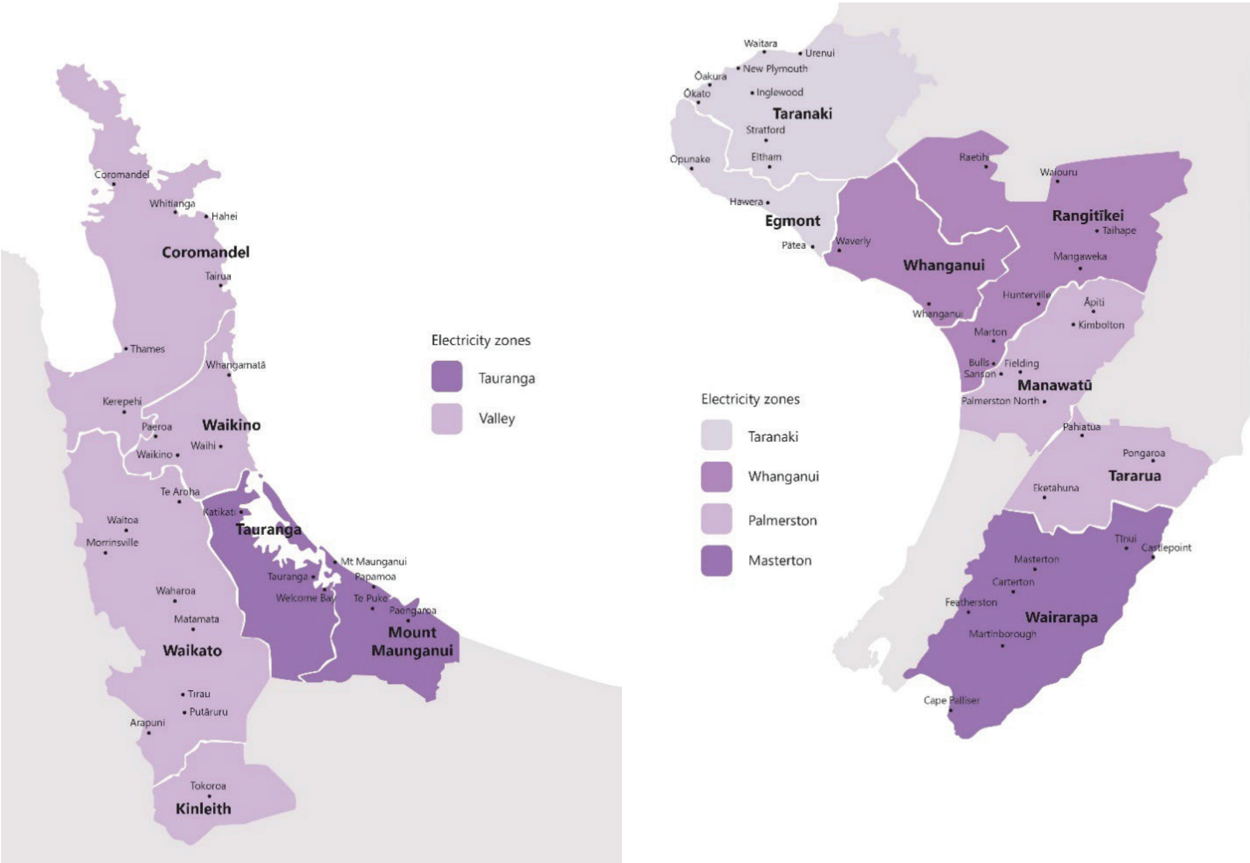
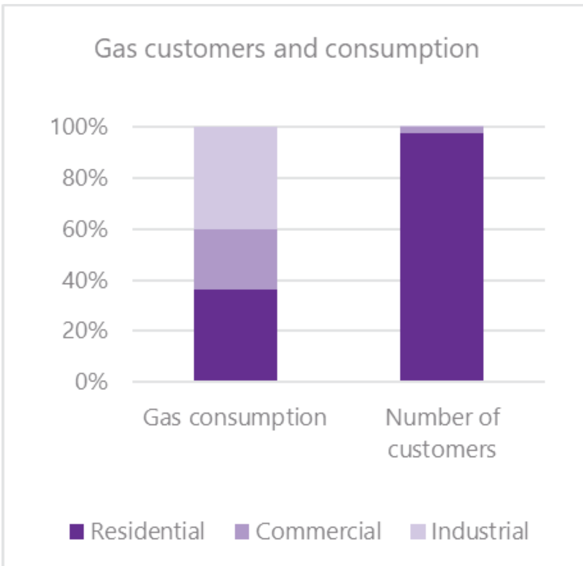


Figure 7 – Powerco map of the Eastern region, left, and Western region.

Gas network

Powerco is one of New Zealand's largest gas distribution utilities. Our gas pipeline networks are in Wellington, Hutt Valley, Porirua, Taranaki, Manawatū, and Hawke's Bay regions, as shown in Figure 8. We have over 6,200km of pipes connecting approximately 114,000 urban and rural homes and businesses to gas. Our customers consume about 8.6 petajoule (PJ) of gas per year.

Our gas network provides a critical lifeline service to many households and businesses across the North Island. As long-term stewards of the network assets, our aim is to deliver a better energy future to our customers by providing a safe, reliable, resilient, and cost-effective gas distribution network.



Our industrial customers are less than 1% of our customer base and consume approximately 40% of gas on our network. Our residential customers are 97% of our customer base and consume approximately 35% of gas on our network. The remaining 25% of gas is consumed by our commercial customers. About 30% of our larger customers are in the food processing sector, about 20% in the manufacturing sector and approximately 10% in the healthcare sector.

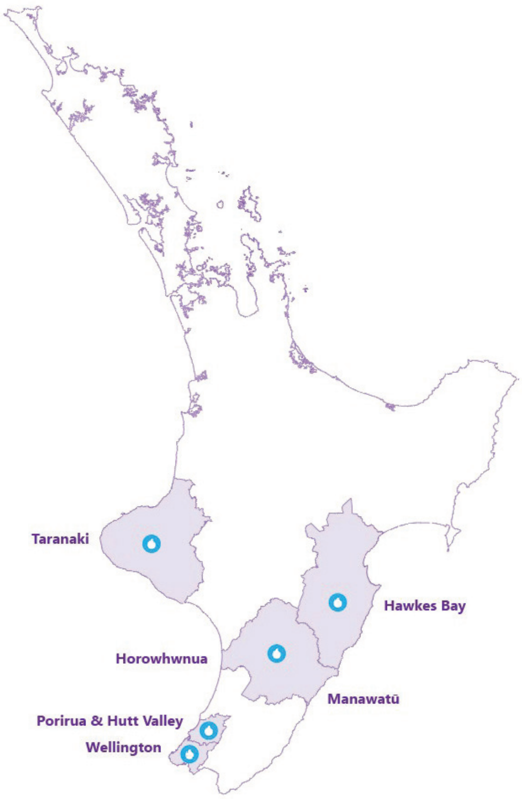


Figure 8 – Powerco gas distribution network.

Our network of underground gas infrastructure represents about 39% of all the gas connections in Aotearoa. With a network covering different geographic areas and supporting diverse communities, the risks to the network can be varied. However, as it is underground, it is more resilient and less vulnerable to high wind or storm events.

Our gas network assets consist of:

- Main and service pipes
- Regulator stations
- Line and service valves
- Special crossings
- Monitoring and control systems
- Cathodic protection systems

4.2 Regional climate variables

Table 3 outlines the geographic network areas and the climate variables associated with these areas. In Section 5 is a summary of our climate risk assessment and future network vulnerabilities.

Table 3 – Geography by region and historical climate variables (Source: Te Ara https://teara.govt.nz/).

Region	Geography	Climate variables	Network
Taranaki	Situated on the western coast of the North Island, the region is dominated by Mt Taranaki and the ring plain that surrounds it, which is largely a product of eruptions from the mountain and its predecessors, Kaitake and Pouākai. The other main landscape features are the marine terraces of the northern and southern Taranaki coasts, a product of rising and falling sea levels, and the dissected hill-country inland, which is part of a much larger expanse of hill-country reaching into inland Whanganui and the King Country.	Exposed to weather systems from the Tasman Sea. It is usually sunny (averaging 2,200 hours annually at New Plymouth) and windy, with year-round rainfall and moderate temperatures. Annual rainfall ranges from 8,000mm at North Egmont to 2,000mm at inland Whangamōmona, 1,400mm at New Plymouth, and 1,200mm at Pātea. Mt Taranaki causes a rain-shadow effect, with less rain to its south and east. In the early 2000s, intensified dairying and horticulture put pressure on the water table.	
Manawatū	Manawatū and Horowhenua are a series of longitudinal landforms – the main ranges, the dissected hill-country of the upper Manawatū, tracts of river and marine terraces and alluvial plains, and the dune country along the coast.	The Manawatū-Whanganui region has experienced numerous historical extreme weather events, with significant damage and disruption caused by flooding and high winds.	

Wellington, Hutt Valley, Porirua	Most of Wellington is hilly and mountainous. The main areas of flat land are the Hutt Valley basins, parts of Porirua and the Kāpiti coastal plain.	Wellington city receives an average of 1,207mm of rain each year, while the national average is about 1,400mm. The amount of rain Wellington receives, makes the Hutt Valley basin vulnerable to slips and flooding.	
Hawke's Bay	Hawke's Bay comprises a central belt of flat land flanked by hills and ranges. Mountain ranges form a boundary to the west and north-west. Running from northern Wairarapa into Hawke's Bay is a belt of flat land made up of soft, sedimentary rocks deposited by rivers. It is hemmed in by mountain ranges and hills on either side. The plains are narrow in southern Hawke's Bay but widen into the Ruataniwha and Heretaunga plains south of Napier. The hills and ranges in central and northern Hawke's Bay are made of mudstone, limestone, sandstone and argillite. The mudstone hills, which predominate, erode easily. The land between Lake Tūtira and Wairoa is particularly vulnerable to slips. The limestone ranges and hills from Havelock North south are harder rock.	Rainfall in Hawke's Bay is highly variable, both where and when it falls. The mountains and some coastal ranges receive the most rain, while the plains between Napier and southern Hawke's Bay (particularly the Heretaunga plains) receive the least. Summer can have either droughts or heavy rain. Floods are the most common form of natural hazard. When a depression moves over northern New Zealand and moist easterly air is forced to rise when it reaches the western ranges, this causes heavy rainfall, which flows down rivers and streams to the lowlands.	
Wairarapa	Wairarapa has three main landscapes – the western mountainous zone, the central lowlands and rivers, and the eastern uplands. The lowlands comprise three basins: • The Pahiatua basin extends north-east from Mt Bruce into southern Hawke's Bay. • The Masterton basin reaches from Mt Bruce to Carterton. • The Wairarapa basin stretches from Carterton to Palliser Bay. All were created during the past one million years from alluvial gravels carried by rivers from the Tararua range. The rivers cut valleys and gorges to the basins, where they formed large fans, terraces and flood plains. The main rivers are the north-flowing Mangatainoka and Mangaone, and the south-flowing Ruamāhanga, Waingawa, Waiohine and Tauwharenīkau. The Mangatainoka and Mangaone rivers flow into the Manawatū River. The others drain into Lake Wairarapa or Lake Ōnoke, on the edge of Palliser Bay. Wairarapa's eastern uplands, including the Waewaepa and Puketoi ranges, are made of uplifted sandstone, mudstone and limestone. The landscape has broad valleys and steep hill-country, rising to 800m. Many slopes are unstable. Landslides are common after heavy rain, a problem made worse by deforestation and overstocking.	Partially sheltered by the Tararua range, Wairarapa has a dry, warm climate. It receives between 800 and 1,200mm of rain each year, with western areas wetter than the east. Masterton's annual sunshine hours average just under 2,000. Summer weather is warm, dry and mostly settled. Typical maximum daytime temperatures range between 20 and 28°C, sometimes rising above 30°C. Winters are cool to mild, but frosts are common. Maximum winter temperatures are usually between 10 and 15°C. Strong north-west föhn winds can occur in spring and summer. These gather strength as they come down the Tararua range, and can reach 170kmh at Castlepoint. Wairarapa is exposed to heavy rain from the south and east, which can cause flooding.	
Valley	The Hauraki Fault, which runs down the west side of the Coromandel Peninsula, is the axis of the Hauraki-Coromandel region. Movement on the fault line created both the mountains to its east and the basin to its west.	Hauraki-Coromandel has a moist to wet climate resulting from elevation and exposure to rain-bearing winds. Annual rainfall varies from 1,150mm in low-lying areas to 2,500mm at higher altitudes.	

	The Hauraki plains, a drained swamp, are part of the largest single area of flat land in the North Island – the 1,600km^2 Hauraki depression or basin.	Summer droughts result when anticyclones become stationary for extended periods. Sustained heavy rainfall occurs at higher altitudes as a result of intense cyclones. If soils are already saturated, runoff from the Coromandel and Kaimai ranges causes flooding on the plains.	
Bay of Plenty	The western Kaimai and Mamaku ranges are almost entirely volcanic. They are older, lower, and more weathered than the eastern ranges. To the east lie the Raukūmara, Huiarau and other ranges in Te Urewera. They are a continuation of the chain of greywacke mountains that run from Cook Strait to East Cape. They have several distinctive features: • The climate is harsher than on the coast, with higher rainfall and much colder winters. • The rivers run swift. They are aligned north–south in the eastern ranges, flowing along major fault lines. The Matahina dam on the Rangitāiki River was built across a fault. Apart from the Rangitāiki, major rivers are the Whirinaki (a tributary of the Rangitāiki), the Whakatāne and its tributary the Waimana–Tauranga. The Waiotahe, Waioeka, Ōtara, Mōtū and Raukōkore rivers all rise in the dividing range. They flow through deeply dissected hill-country before reaching either the low country around Whakatāne and Ōpōtiki, or the sea itself. The course of the Mōtū River is the most dramatic and was protected from development in 1984. The watersheds of the western ranges are closer to the coast than those of the eastern ranges. None of the rivers in the western Bay of Plenty are as substantial as those in the east.	Coastal Bay of Plenty has one of New Zealand's mildest and sunniest climates. Tauranga's mean annual rainfall is 1,198mm, and it averages 2,260 hours of sunshine.	

4.3 Event experience and response

We anticipate that major weather events will increase in intensity in the future. Climate variability increases the vulnerability of the Powerco electricity and gas networks, even as we work towards mitigating the impacts and improving the resilience of our assets.

This section outlines our experience and response to recent major weather events on our electricity and gas networks.

Electricity network response to major events

Recent severe storms, such as cyclones Dovi and Gabrielle, caused significant damage to our electricity network, with flooding, fallen trees and high winds causing large numbers of outages, as shown in Figure 9. Storms are a normal consideration for network management, and our operational response capability has developed over time, including the adoption of the coordinated incident management system (CIMS) structure. However, our internal reviews, particularly against the EEA RMMAT,[5] have highlighted more work could be done on understanding external risks to the network and looking to mitigate these risks ahead of time.

Horizontal above-ground infrastructure already experiences significant disruption from climate events, be it heavy rainfall/flooding or high winds. The figure below illustrates the recorded base SAIDI (system average interruption duration index) compared with the SAIDI on major event days (MED). As all our climate scenarios show a moderate to extreme increase in tropical storms, we expect damaging events will happen at a greater frequency. Resilience is therefore central to our Modern Network Architecture Strategy.

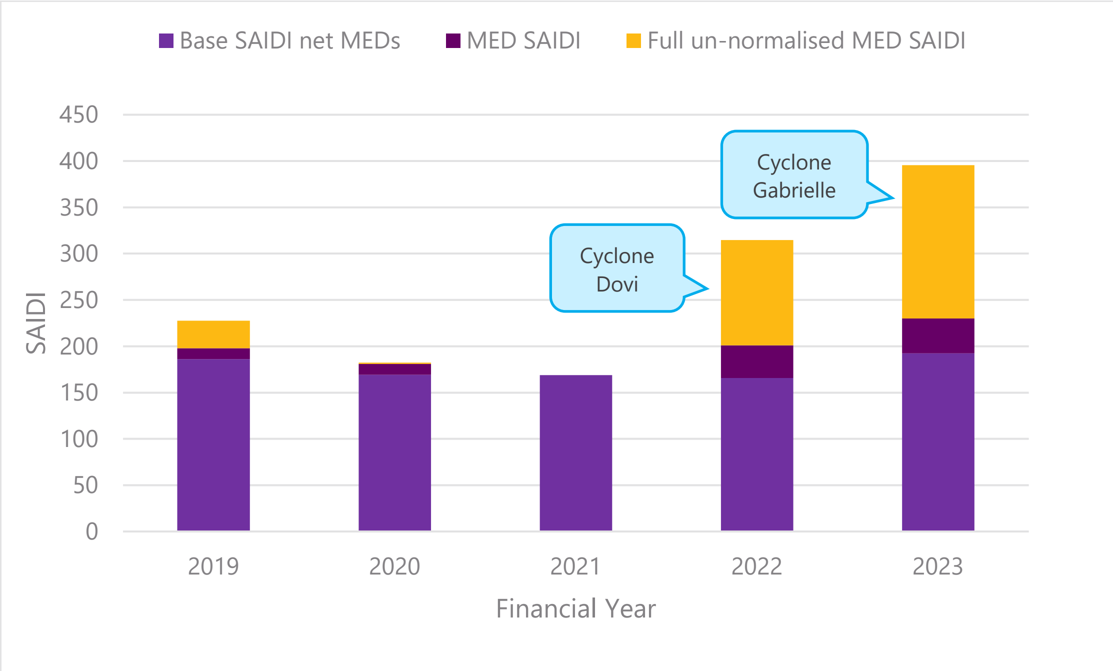


Figure 9 – Severe storms continue to have a major impact on electricity supply.

During Cyclone Gabrielle, the main cause of electrical network outages from the extreme winds and rain was trees falling through lines. The figures and table below show the frequency and types of damage from a range of major events.

[5] The Electricity Engineers' Association has produced a Resilience Management Maturity Assessment Tool and Resilience Guide (2022). This resilience guide was developed to cover the principles of emergency management preparedness and to provide a practical self-assessment tool that enables EDBs and other EEA members to rate their organisation's degree of overall resilience. An overview is available here and the full guide here

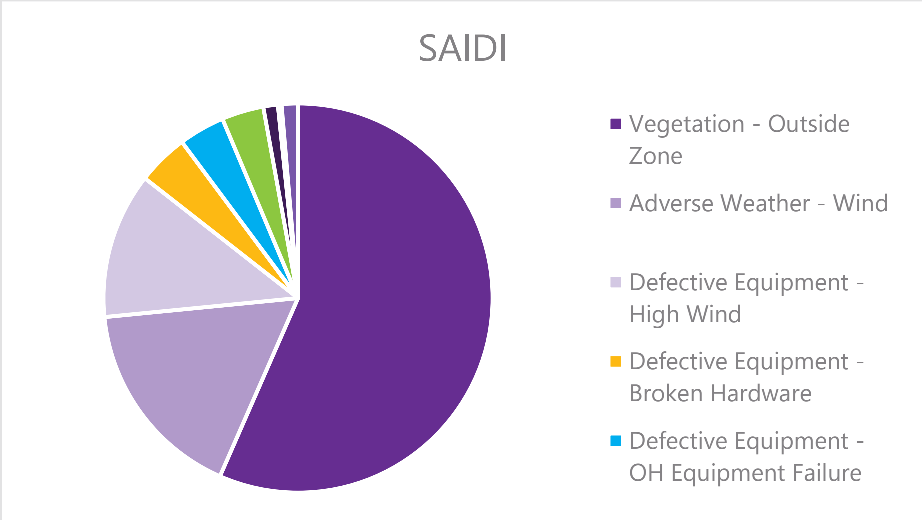


Figure 10 – Key causes of network outages during Cyclone Gabrielle.

Table 2 – Storms damaging networks and cutting off customers is a regular occurrence.

Events	Impact
2008 Lower North Island storm	Huge swells caused havoc on lower North Island coasts, along with heavy rain and high winds, mainly in the Wellington and Taranaki regions.
2008 North Island weather bomb	The first of three storms in a one-week period. A deep low brought high winds, seas and rainfall to the upper North Island, causing widespread power outages as well as flooding and damage to trees and buildings. Three people drowned in Bay of Plenty.
2012 North Island storm	Heavy rain caused flooding, and high winds caused damage and disruption in many North Island areas. The worst affected were Northland, Gisborne, Taranaki, and Wellington.
2012 North Island weather bomb	High winds during one day caused damage and disruption in many North Island areas. The worst affected were South Taranaki and the lower North Island.
2017 storm	A winter storm moved over New Zealand from 12-14 July. The central and lower North Island were the worst affected, experiencing snow, rain and gales.
2018 Cyclone Gita	Ex-tropical cyclone Gita brought very heavy rain and severe gales, and caused severe damage to many areas of New Zealand. The worst affected were north-west Nelson/Golden Bay, the Kaikoura coast, and Taranaki.
2022 Cyclone Dovi	Heavy rainfall caused widespread surface flooding, slips and strong wind gusts in the North Island. There were power outages in Taranaki, parts of Northland and Waikato.
2023 Cyclone Gabrielle	Historic extreme rainfall caused river flooding. Destructive wind damage caused power outages, storm surges and loss of life in the North Island. The main areas impacted were Napier, Auckland, Whangarei, Gisborne, and Tauranga.

Figure 11 – During Cyclone Gabrielle, slips and trees damaged the network and put assets at risk. The slips undermined key circuits in the Coromandel, up the coast in Colville, and river scouring put nearby subtransmission structures at risk of collapse, right.

Figure 12 – Flooding is a major risk to underground networks and substations. During Cyclone Gabrielle, our Tīnui substation, left, was flooded, and stormwater blockages during the Whanganui floods in 2015 impacted our Peat St substation, right.

Figure 13 – Winter snow storms have also had major impacts on our rural networks. In 2017, the central north island experienced a heavy snow storm, where high winds and snow caused cascade failures of lines and failure of river crossings. We replaced more than 80 structures, and 15km of line was rebuilt. The damage included trees collapsing through lines, top left, snow loadings leading to shocks on poles, which caused concrete poles to snap, top right, and cascade failures of some lines, bottom.

Gas network resilience to events

In general, our gas networks demonstrate high reliability because most of the assets are underground. Using the Powerco Wellington gas network and the Wellington electricity network for comparison, in Figure 14 the average number of minutes of disruption per customer in the 2022 reporting year[6] shows a vast difference in the duration of unplanned interruptions. Duration data is a priority measure for the Commerce Commission.

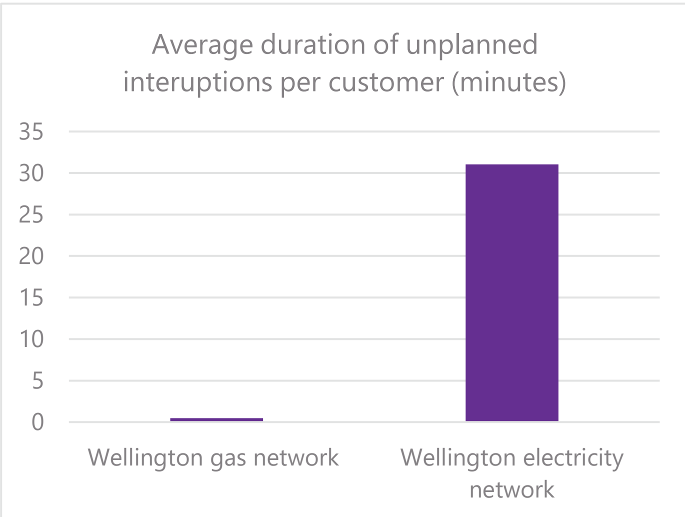


Figure 14 – Network reliability reported for Wellington gas and electricity networks 2022.

We are already seeing the effects of climate change through more frequent severe weather events, which are causing significant damage to infrastructure and interrupting electricity supply. These events also highlight the resilience of gas networks. When recent cyclones Dovi and Gabrielle damaged infrastructure and disrupted power supplies across the country, the gas network remained intact and continued to supply homes and businesses. Gas customers were able to cook their food, heat their home and have hot water. While these events highlight the resilience of gas networks, we have strategies (see Section 5.5) in place to improve the resilience of our special crossings and regulator stations that have been identified as vulnerable to the impacts of climate change, as shown on network maps by region in Appendix 5 of this plan.

This is why we are undertaking further investigation to understand the options for strengthening the resilience of special crossings and regulator stations, and the costs associated with future investment needed.

[6] Source: 2022 reporting year information disclosure schedule 10, Powerco gas Master - 2022 GDB ID schedules 1-10 (excl. 5f-5g).xlsx (powerco.co.nz) and Wellington Electricity 292 (welectricity.co.nz).

Climate-related hazards and asset vulnerability

5. Climate-related hazards and asset vulnerability

5.1 Climate scenarios

Powerco is driven by its purpose of connecting communities. This means ensuring we continue to thrive as a climate resilient business in a low-emissions world. But what could that future world look like? This section describes our climate change scenarios – these are the plausible but challenging future scenarios that we are testing our business resilience against.

Climate scenarios can help Powerco to explore and develop an understanding of how the physical impacts of climate change might plausibly affect our assets and business operations over time. Powerco has developed four challenging and unique scenarios, specific to the Powerco gas and electricity networks. They are centred on how New Zealand and the global transition to a net-zero carbon future (or lack of) will plausibly impact us over the short (2035), medium (2050) and long term (2080). Previous scenarios have been developed by both the energy sector and Powerco. This project has utilised and leveraged this previous work and aligned scenarios where appropriate. These existing scenarios helped provide useful context and identify relevant drivers for the scenarios.

Our scenarios describe the driving forces of climate change, building high-level assumptions about each of the plausible worlds. The warming scenarios include several representative concentration pathways (RCP) forecasts adopted from the Intergovernmental Panel on Climate Change (IPCC) and consider a range of possible greenhouse gas (GHG) concentration trajectories. These are also aligned with the Socio-economic Shared Pathways (SSPs) of the recent IPCC AR6 report.

The short-term time horizon (2035) aligns with our asset management planning period (10 years) and a variety of transitional risks and opportunities. The medium-term planning horizon (2050) aligns with New Zealand and international emissions targets. The long-term planning horizon (2080) accounts for the lifecycle of our network assets and the variety of physical risks that we might encounter when we replace these assets.

Global Alignment
The globe and New Zealand pursue aggressive emissions reductions, and this succeeds in limiting global temperature increases to 1.5°C (above pre-industrial temperatures), with global net-zero emissions being achieved by 2050. The transition occurs in a coordinated manner across government and the energy sector, with clearly signalled policy changes.

- 1.5˚C policy ambition
- RCP 2.6 (0.9-2.3˚C by end of century)
- Lower increase in severe weather events
- Policy change is clearly signalled and smooth

Hothouse
Global emissions continue to grow unabated largely due to a failure (reversal) of key emissions reduction policies both in New Zealand and in key developed, high-emitting countries. This leads to warming levels that reach 2°C by 2050, and continue to increase steeply thereafter, reaching 4°C by end of century. Climate 'chaos' enters mainstream

- No ambition
- RCP 8.5 (3.2-5.4˚C by end of century)
- Extreme increase in severe weather events
- No new policies, possible reversal

Global Delay
The globe and New Zealand are delayed in their transition, resulting in a steady increase in temperature between 2020-2030. The New Zealand energy sector direction is unclear, and decisions are protracted. Realisation occurs in 2030 that action is urgently needed. However, this results in abrupt and poorly coordinated policy and market changes.

- 2˚C policy ambition
- RCP 4.5 (1.7-3.2˚C by end of century)
- Moderate increase in severe weather events
- Policy change is delayed and chaotic

New Zealand Greenhaven
New Zealand and most of the developed world continue to pursue net-zero targets by 2050. However, the rest of the developing world do not follow suit, leading to a rise in global temperatures between 2-3°C by end of century. New Zealand is viewed as a 'greenhaven' by many in the world and attracts investment and immigration as a result.

- 1.5˚C policy ambition
- RCP 4.5 (1.7-3.2˚C by end of century)
- Moderate increase in severe weather events
- Policy change is indicated and smooth for New Zealand

5.2 What climate hazards are material to us?

As climate change progresses, certain physical risks to our networks are expected to increase significantly because of changes in acute weather events and longer-term chronic shifts in climate patterns. The National Climate Change Risk Assessment defines risk as the relationship of hazard, vulnerability, and exposure. When considering sea level rise for example, this may lead to rising sea levels (hazard) that can impact underground cables (exposure). Dependent on the design, construction, and maintenance (vulnerability), this scenario will result in a risk. The magnitude of this risk is key.

Physical risks in the context of this assessment, are those associated with climate change that have a direct impact on Powerco's assets or wider operation. These risks are event driven (acute) or from longer-term shifts (chronic) in climate patterns.

- Acute physical risks are event-driven, including increased severity of extreme weather events, such as cyclones, high winds, or floods.
- Chronic physical risks are longer-term shifts in climate patterns (eg sustained higher temperatures) that may cause sea level rise or chronic heat waves.

The methodology we have used for identifying our material climate change hazards, includes:

- Historical climate-related hazards and impacts we have observed on our network, including impacts from recent events such as Cyclone Dovi and Cyclone Gabrielle (outlined in Section 4).
- Previous engagements with external climate specialists to determine asset exposure and vulnerability to a range of climate-related hazards using data publicly available from NIWA[7].
- Internally completed asset and operational climate risk hazard and vulnerability assessments[8].
- Analysis of climate data available in our Geographical Information System (GIS) and Light Detection and Ranging (LiDAR) data of our network and surrounding environment, available in our 3D Network viewer called Neara (all detailed in Table 8).

Where appropriate, our risk assessment is based on representative concentration pathways to ensure consideration of low-range, mid-range, and worst-case warming scenarios over short, medium, and long-term time horizons. The risk evaluation criteria used for this assessment are set out in our risk management framework (aligned to the principles of ISO 31000:2018 Risk Management Guidelines and with the values of Ngā Tikanga). Risks must be acceptable in terms of Powerco's risk appetite, and depending on the risk evaluation, risk reduction measures may be required:

- A low risk level is acceptable, risk reduction is considered unnecessary, and no formal intervention is required
- A medium risk can be pursued, but is subject to appropriate risk reduction measures
- A high risk is considered unacceptable, and significant risk reduction measures are required to make it tolerable. Risk avoidance or substitution may also be appropriate.

Results of the assessment are shown in Table 4 and include a high-level summary of the climate change hazards that impact our network now and in the future. This highlights the following climate-related hazards for further analysis and risk reduction:

- **Inland and river flooding** – the main climate hazard currently impacting our network is inland and river flooding. By proxy, extreme rainfall causes river erosion, landslides, and flood inundation to ground-mounted assets.
- **Coastal flooding** – the climate change effect with the most damaging potential in the future is coastal flooding (sea level rise), causing increased coastal erosion, and water inundation in low-lying coastal areas.

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[7] Internal documents:
Climate Change Risk Screening and Exposure Assessment, prepared for Powerco by T&T Ltd – March 2020 – Job Number 1012773.v.01.
Powerco Natural Hazard Exposure and Loss Modelling, prepared by Marsh & McLennan Companies - Final V1 2022.
[8] Internal documents:
Underground Asset Vulnerability Assessment: Climate Change Underground Workshop, prepared for Powerco, 27 January 2021.
Climate Change Electricity Actions – complete Set, prepared for Powerco, 22 December 2021.
Report to Electricity Networks Aotearoa, Electricity Distribution Sector Cyclone Gabrielle Review, Version 1 Issued July 2023.
Powerco Wildfire Risk Assessment: Strategic Priority: Future Ready Networks, prepared for Powerco, February 2024.

- **Vegetation** – vegetation control is an important aspect to reduce risk of wildfire and damage of falling trees from extreme wind, both of which are a high risk to our electricity network.

Table 4 – Physical climate-related hazards and the potential impact on the Powerco network.

Acute physical risks	**Description of impact**	**Current operational risk 2024-2035**	**Future operational risk 2035, 2050, 2080**
Extreme weather events			
Extreme wind (Cyclones and ex-tropical cyclones)	Extreme winds cause damage to overhead distribution lines and supporting infrastructure.	During Cyclone Gabrielle, overhead electricity infrastructure was impacted by falling trees (outside the hazard zone). **Electricity networks** Risk: Medium **Gas networks** Risk: Low	Wind speeds are expected to increase in frequency and intensity up to 10% by 2050, especially for the southern North Island. **Electricity networks** Risk: High **Gas networks** Risk: Low
Extreme rainfall (Proxy for river and inland flooding, river erosion and landslides)	Heavy rainfall causes flash flooding, with significant impacts to ground-mounted assets. This extends to erosion, particularly in areas of high flow near rivers.	Critical gas and electricity infrastructure is currently exposed to, and impacted by, flooding. As experienced during Cyclone Gabrielle. **Electricity networks** Risk: High **Gas networks** Risk: High	Increases in rainfall intensity projected across all regions (~5%), short and long duration events to increase by 2035. **Electricity networks** Risk: High **Gas networks** Risk: High
Chronic physical risks	**Description of impact**	**Current operational risk 2024-2035**	**Future operational risk 2035, 2050, 2080**
Sea level rise			
Coastal and estuarine flooding (Proxy for coastal and river erosion)	Potential for flooding of coastal infrastructure and erosion of assets near rivers and coast. Exacerbated by storm surge.	Some electricity network sites near rivers are currently exposed. **Electricity networks** Risk: Medium **Gas networks** Risk: Low	Sea level rise is projected to increase causing coastal erosion and water inundation in low-lying coastal areas. Under scenarios SSP 1-1.9, SSP 2-4.5 and SSP 5-8.5 (electricity network) and SSP 1-1.9 and SSP 2-4.5 (gas network). **Electricity networks** Risk: High **Gas networks** Risk: High
Other variables	**Description of impact**	**Current operational risk 2024-2035**	**Future operational risk 2035, 2050, 2080**
Temperature variables			
Increased fire-risk weather (Exacerbated by extreme temps, increased wind and lower rainfall)	Fire-risk weather presents a risk to infrastructure. Electricity assets can also cause fire risk.	Adequate mitigation currently in place. **Electricity networks** Risk: Low **Gas networks** Risk: Low	Increase in number of days with very high and extreme fire danger index. Between 44-48 more days of fire risk by 2080. The risk increases for the Wellington region. **Electricity networks** Risk: High **Gas networks** Risk: Low
Increasing temperatures	High temps will increase customer demand and	Adequate mitigation in place.	Anticipated increase in temperature of 0.7-1.0°C (RCP 4.5) to 0.9-1.1°C (RCP

(Including heat waves, and drought)	impact infrastructure ratings and capacity to meet demand. Can also reduce the clearance of overhead lines.	**Electricity networks** Risk: Low **Gas networks** Risk: Low	8.5) by 2050. Further investigation required to determine if current mitigation is sufficient in the future.
Reducing frost, snow and ice cover.	Cold nights may decrease, which will change demand on our network. Historically, snow storms have caused significant damage to the overhead network. Changes to storms are less certain, but milder winters could have less impact on our electricity network from loading and access issues.	Adequate mitigation in place. **Electricity networks** Risk: Low **Gas networks** Risk: Low	Decrease of cold nights with a minimum temperature of 0°C or lower (% decrease). Further investigation required to determine if current mitigation is sufficient in the future.

5.3 What assets are vulnerable to these climate hazards?

Vulnerability is the predisposition to be adversely affected by a particular hazard. Measuring the vulnerability of an asset helps to inform the susceptibility of that asset to damage, the likelihood of failure, and the adaptive capacity of the asset when exposed to climate change-related hazards.

For this assessment, vulnerability was determined in a qualitative manner – derived from previous studies (such as the EPRI Climate READi work[9]), experience of our own network performance during storms and flooding events, known threats gathered from our expertise and data (such as defects data), and future anticipated issues, as per the Powerco scenarios. When considering vulnerabilities of assets under all exercises, consideration was given to asset capability, asset reliability, asset life, operational responses, and lifecycle costs.

Table 5 and Table 6 outline each asset fleet and the vulnerability to the climate-related hazard (eg the likelihood that the asset will be damaged or not function).

Table 5 – Electricity assets vulnerability matrix – See next page.

[9] Climate READi (epri.com)

Asset fleet	Definition	Sub-fleet	Flooding (inland, river and sea level rise)	Storm (high winds)	Heat wave (including fire risk)	Snow storm	Landslide
Overhead structures 	Pole and tower structures supporting overhead network.	Poles	X[10]	X	X[11]	X	X
		Crossarms		X	X[11]	X	
Overhead conductors 	Lines that make up the network that conveys electricity.	Subtransmission overhead	X[12]	X	X[11]	X	
		Distribution overhead	X[12]	X	X[11]	X	
		Low voltage overheard	X[12]	X	X[11]	X	
Cables 	Insulated distribution conductor conveying energy, generally running underground.	Subtransmission cables	X[13]		X[14]		X
		Distribution cables	X[13]		X[14]		X
		Low voltage cables	X[13]		X[14]		X
Zone substations 	Major sites for control/operation of the network, as well as stepping down of transmission voltage for local distribution networks.	Power transformers	X		X		X
		Indoor switchgear	X				X
		Outdoor switchgear	X				X
		Buildings	X			X	X
		Load control injection	X				X
		Other zone substation assets	X				X
Distribution transformers 	Local distribution sites that transform voltage to a local low voltage network.	Pole-mounted transformers		X			X
		Ground-mounted transformers	X				X
		Other distribution transformers					X

Distribution switchgear 	Equipment that physically switches the network for protection or isolation of sections of network. Predominantly overhead in rural areas and ground-mounted in urban areas.	Ground-mounted switchgear	X				X
		Pole-mounted fuses					
		Pole-mounted switches					
		Circuit breakers	X				
		Reclosers and sectionalisers					
Secondary systems 	Generally low voltage relays and control equipment for control and monitoring of power equipment.	SCADA and comms	X		X		
		Protection	X		X		
		DC supplies	X		X		
		Metering	X				

Table 6 – Gas assets vulnerability matrix.

Asset type	Definition	Sub-material	Flooding (inland, river and sea level rise)	Storm (high winds)	Landslide
Main and service pipe (M&S)	**Main** – pipeline that transports gas from the bulk supply transmission system to each service main. **Service** – pipeline that transports gas from the main to the customer, ending at the meter control valve.	Cast iron	X		X
		PE80 – Post-85	X		X
		PE80 – Pre-85	X		X
		PE100	X		X
		Steel yellow/grey jacket	X		X
		Steel galvanised	X		X
		Copper	X		X
		Asbestos	X		X
District regulator station (DRS)		Above ground DRS		X[15]	

[10] Specifically, bank erosion can undermine pole foundations, although flooded roads can delay access to the network to repair damage caused by other issues. Flood-borne debris has damaged and brought down low-level river crossings.

[11] Evidence from Australia and North America that significant bushfire events can significantly damage wooden poles. Equipment operation and line clash can cause sparks resulting in bushfire.

[12] We have observed that low-level river crossings can be damaged/pulled down if woody vegetation/flood-borne debris travels down rivers.

[13] Some bridges are prone to washouts. Discussions with NZTA has determined there could still be seismic or washout risks for many bridge assets.

[14] Higher ambient temperatures increase risk of soil dry-out, which can affect cable ratings and, in a small number of cases, can contribute to failure of the asset. See 1998 Auckland blackout https://en.wikipedia.org/wiki/1998_Auckland_power_crisis.

[15] Exposure to falling trees increases in areas that are subject to high winds.

Asset type	Definition	Sub-material	Flooding (inland, river and sea level rise)	Storm (high winds)	Landslide
	An installation designed to reduce the pressure of gas.	Below-ground DRS (Cocons)	X		
		Pressure regulation station (PRS)		X	
Line and services valve (VAL)	A fitting installed in a pipeline designed to control the flow of gas.	Main	X[16]		
		Service			
Special crossing (SPX)	An installation designed to provide above or below-ground passage for a pipeline across a river, road (national significance) or railway.	Below ground			X
		Above ground	X	X	X
Monitoring and control system (MCS)	A monitoring and control system architecture that incorporates sensors, remote terminal units, networked data communications and computers for high-level process supervisory management.	SCADA	X	X	X
		Data loggers	X	X	X
Cathodic protection system (CPS)	A corrosion-inhibiting system that ensures buried metallic pipelines are permanently cathodic, ie electrically negative to the surrounding soil.	Galvanic system	[17]		
		Impressed current system	X		

The assessment and approach to this vulnerability is addressed in Section 6. The vulnerable asset types selected from this exercise for further assessment are:

- Electricity zone substations (inland flooding and sea level rise)
- Electricity ground-mounted transformers (inland flooding)
- Electricity overhead poles and conductor (high winds)

[16] Flooding will impede locating and operating the mainline valve.
[17] Galvanic CPS will continue to operate in a flood. Note: The risk of fire to gas infrastructure is largely associated with above-ground assets located in central business districts. This predominately applies to gas measurement systems (not covered in this plan).

- Electricity overhead lines and underground cables (inland flooding, landslips)
- Electricity overhead lines (fire-risk weather)
- Gas special crossings/strategic pipes (inland flooding and sea level rise)
- Gas regulator stations (inland flooding and sea level rise)

5.4 Current mitigation (standards)

As specified above, Powerco's asset management strategies continually manage network climate-related risk through maintenance and renewals. Based on this, the most efficient way to incorporate climate-related risk mitigation is in our design standards, so that resilience and climate adaption planning is "baked in" to our asset management approach and is not a separate undertaking or consideration. As a result, assets are replaced at the end of their design life with suitable alternatives.

Below are some examples of how we use standards to mitigate risks. A full list of Powerco asset standards relating to management of climate-related risk is included in Appendix 2 of this plan.

Using zone substations as an example, Powerco asset standards mitigate risk of flooding, setting out the design provisions for zone substations to be built to flood return periods of 1:250 years[18]. Powerco acknowledges that some legacy substation sites are in areas now known to flood (historically unknown) and may require risk treatment. For example, in Cyclone Gabrielle, Tīnui substation in the Wairarapa experienced flooding to the yard. As storms increase in severity, we may experience more flooding events above return periods specified in our standards. An example of recent risk treatment was in Whanganui, where as part of asset renewal works, the zone substation switchroom floor was built 1.8m off the ground to help protect it from flooding, and safeguard Whanganui's electricity supply[19].

For our gas network, all designs relating to new mains and services up to 1050kPa maximum allowable operating pressure (MAOP) must comply with standards that mitigate the risk of flooding by determining expected flood water levels. If locations are subject to flooding, the vent height design requires an allowance of 500mm[20] above expected high water.

[18] Powerco Standard 350S006 Zone Substation Design and Construction Requirements, Appendix 2.
[19] Futureproofed switchroom (powerco.co.nz).
[20] GDS-MSS-01 Gas Operations Standard – Mains and Services – Part 2 – Design.

Approach to improving our network resilience to climate risk

6. Approach to improving network resilience to climate risk

6.1 Our strategy for managing climate resilience

At Powerco, we believe New Zealand can grow as it transitions to its net-zero 2050 future. New Zealand's energy system is one of the lowest carbon energy systems in the world – 43% renewable energy compared with the global average of 18%. The electricity system, which is approximately 90% renewable, plays a key role, and its contribution to New Zealand's energy system must grow significantly in the coming years.

We're 100% supportive of a net-zero carbon future for Aotearoa.
To 'grow to zero', New Zealand will need a mix of energy options that includes low and zero carbon gases.

With growing dependence on energy networks, such as the conversion of the vehicle fleet from internal combustion engine to electric, and electrifying process heat, the resilience of our energy systems becomes more important. There will also be a growing need for other energy sources to support our networks as they become exposed to more frequent storm events, and to support security of energy supply.

As New Zealand decarbonises through electrification, availability of natural gas will continue to be a key enabler to support a safe, reliable, resilient, and cost-effective energy system. Our customers tell us they want to continue to use electricity and natural gas, but they want confidence that these energy sources will continue to be reliable, affordable, and that there are sustainable options for them.

Our strategy to improve our network resilience in a decarbonised future incorporates the following themes:

Greening our gas network – to work with the wider eco-system (beyond energy), engaging with others, not just on our own footprint, and to partner with others in the agriculture and waste sectors to identify biogas solutions.

Hardening our network backbone – understanding our network vulnerability to climate hazards, and proactive or remediation investment to lower vulnerability of critical network because of damage during climate events. These will be based on risks/hazards return periods, but we expect they are likely to stand up to "traditional" economic tests for investment. In our network planning we have:

- Modelled our gas network to specifically identify station and special crossing assets vulnerable to flooding and sea level rise in the future. Information from vulnerability analysis will be used to incorporate climate risk management into our asset management planning, strategies, and business-as-usual processes. We will follow this framework to enable us to manage risk across this asset base (refer to Section 5.3).
- Increased investment in our gas asset replacement and renewal ($2m per year). This will support any resilience work required for the relocation of pipe on bridge crossings or holding spares etc.
- Increased investment for purchasing critical electricity substation spares, relocation of at-risk lines vulnerable to slips and flooding ($16m per year).

Creating energy resilient communities – we recognise that energy is essential for communities during significant events, such as severe storms and other natural disasters. We will work with communities to understand their energy expectations and our ability to meet those needs during such events. We will develop performance measures and test our performance against those measures, investing in improved resilience where appropriate, in full consultation with the community and other critical infrastructure providers, to meet the requirements. In many cases, we expect network hardening may not be the best solution.

Sharing data to work interdependently – sharing data and alignment of opportunities with stakeholders, such as science organisations, regional lifelines groups, other critical infrastructure providers and local authorities, to understand their adaptation plans and cooperate in future planning, eg plans for building resilience protection near infrastructure or areas being considered for managed retreat.

Natural gas is a critical part of the energy mix in Aotearoa. Gas will support electrification as we move towards more intermittent renewables, and enable an energy system that is safe, reliable, resilient, and affordable.

6.2 Electricity approach to assess vulnerability and consider options in our decision-making

Our AMPs already show how we manage investment in the networks to ensure they meet our capacity and condition needs. Internal reviews in 2022 against the EEA RMMAT (Resilience Management Maturity Assessment Tool) as part of the EEA Resilience Guide helped to identify that further work could be done to improve our maturity around understanding resilience risks, particularly as we define our climate scenarios and collate more climate hazard data and assessment.

We are focused on improving our management of identifying climate hazards and responding with appropriate strategies. A simplified diagram below, Figure 16, shows our intentions for incorporating known science regarding network exposure related to climate/environmental factors, as part of how we manage our network.

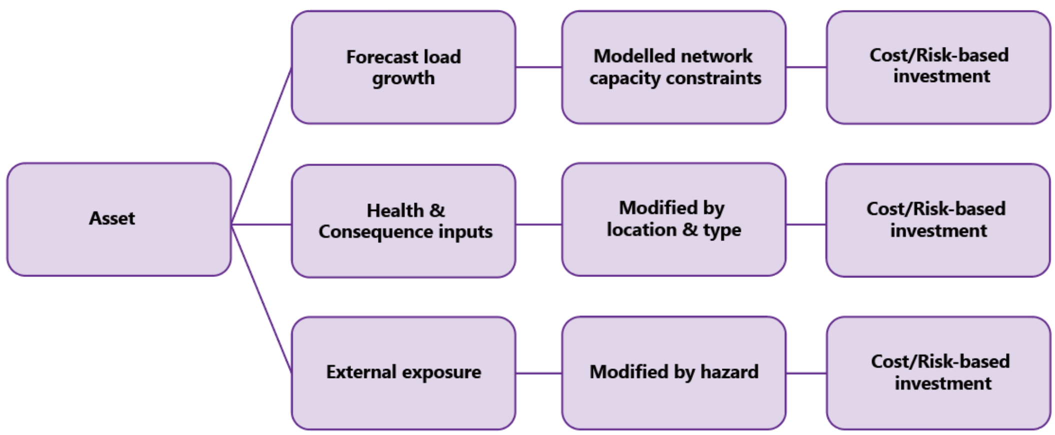


Figure 16 – Asset investment drivers (Asset Management System).

Based on an understanding of impacts to network supply, we apply a range of adaptation strategies for our asset fleets, depending on the expected impacts of failure versus known hazard return periods, as described in Table 7.

Table 7 – Powerco's adaptation approaches.

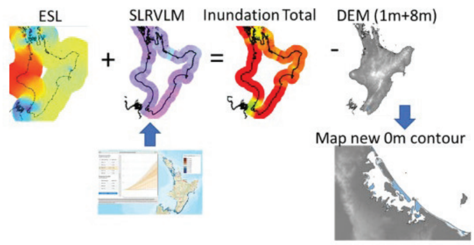
Strategy	Description
Do nothing	Climate change is not considered a threat to this asset class.
Organic	The rate of renewal through age or condition is sufficient to allow adaptation with minor evolutionary changes to asset specifications that marginally affect costs.
Proactive	Because of risk, climate change-related threats require proactive action in the near-term future.

Strategy	Description
Remediation	The asset is already at risk. Improvements can be justified against current climate conditions.
Redevelopment	While climate change drivers may not render the asset unsuitable, land use or other public infrastructure changes may drive the need to replace the asset. For example, road raising, or relocation works to allow for adaptation to sea level rise.

Climate hazard data for vulnerable assets

Our networks cover large geographical areas. Looking at relevant climate hazards and our asset vulnerability (see Section 5.3), we undertook a substantial project in 2022 to collate climate hazard data for our network.

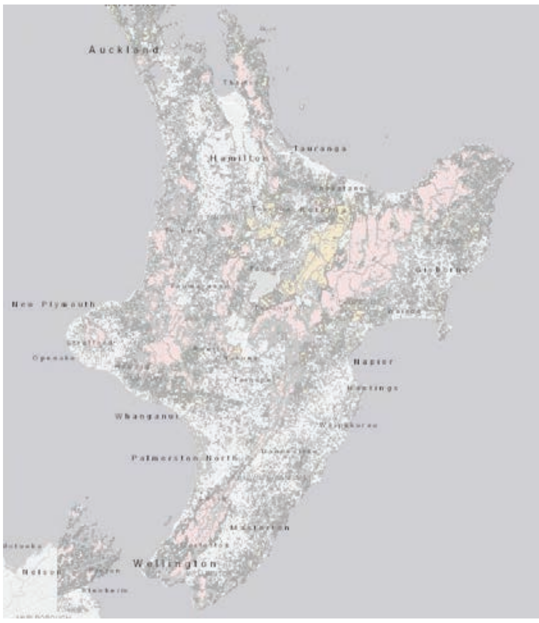
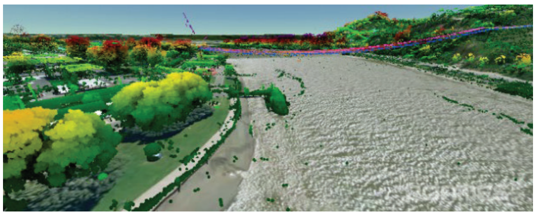
Table 8 – Climate hazards on our network and details on data sources used.

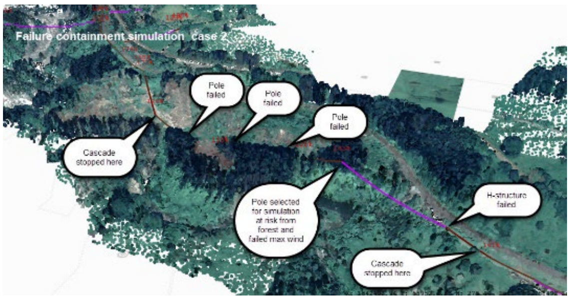
Hazard	Description	Reference
Sea level rise	The methodologies followed are described in the Coastal Flooding Exposure Under Future Sea-level Rise for New Zealand report, published by NIWA in 2019 as part of a Government-funded Deep South National Science Challenge research programme.  • **SSP 1-2.6** Global warming scenario • **SSP 2-4.5** Global warming scenario • **SSP 5-8.5** Global warming scenario **Note:** We have observed some localised differences in sea level rise risk areas compared with those available directly from local and regional council hazard viewers.	• **Extreme storm level (ESL):** Raster is a 2km x 2km grid displaying 1 in 100-year storm inundation heights between 1.51m and 4.15m modelled from tide gauge stations spaced approximately every 25km around the coast of the North Island. • **Sea level rise and vertical land movement (SLRVLM):** SeaRise Research Programme Portal data downloads (NZ SeaRise Programme) included modelled global sea level rise scenarios out to 2150 and New Zealand coastal vertical land movement rates projected out to 2150. Grids have been generated for the SSP 1-1.9, SSP 2-4.5 and SSP 5-8.5 scenarios out to 2100. • **Digital elevation models (DEMs):** The primary source of digital elevation model data is the Land Information New Zealand portal (LINZ Data Service).

Inland and river flooding	
	From Paulik, R., Craig, H., Collins, D., 2019 New Zealand Fluvial and Pluvial Flood Exposures.
		• **Thames-Coromandel District Council**
		    o Flood hazards
		• **Tauranga City Council**
		    o Flood prone area
		    o Flood plain
		    o Overland flow path
		• **Western Bay of Plenty District Council**

Hazard	Description	Reference
	Technical Report Prepared for The Deep South Challenge. We have sourced our flood maps from a range of sources. These are a mixture of regional scale flood models, 2D river flow models, and historical flood maps, as well as a regional soil model that shows areas where low-level flooding could occur because of soil saturation. Because of the range of modelled approaches, this was further grouped in: • 1 in 5 years • 1 in 10 – 1 in 20 years • 1 in 20 – 1 in 60 years • 1 in 60 – 1 in 100 years • 1 in 100 years **Note:** In using regional and local council information, not all network areas have the same resolution of flooding data. For example, Tauranga City Council hazards maps show inland flood risk aligned to the SSP 8.5 scenario, based off DEM, while others are less advanced. Other regional council flood maps may differ in the modelled scenario.	o Katikati floodable area o Ōmokoroa floodable area o Waihi Beach floodable area o Wairoa floodable area o Rural/small settlements floodable area o Flood hazard • **Bay of Plenty Regional Council** o Historical flood events • **Gisborne District Council** o District plan flood zones o Additional flood zones • **New Plymouth District Council** o Hazard flood o Flooding area • **Hawke's Bay Regional Council** o Flood risk area o Hastings area subject to ponding • **Greater Wellington Regional Council** o Flood hazard areas • **Palmerston North City Council** o Flood prone areas • **Manawatū-Whanganui Regional Council (Horizon)** o Merged 200y o Modelled wet areas • **Waikato Regional Council** o Regional flood hazard • **LRIS Poral – Fundamental Soil Layer**
Coastal erosion		We generated a coastal erosion risk layer based on a 150m buffer from the mean high water spring (MHWS) tide level (used to define the coastline). No new data is available to further refine this, however the LINZ MHWS feature class includes a coastline category attribute. This has been used to symbolise the type of coast and indicate its potential exposure to erosion.
Landslips	**Active slips:** Sourced from GNS, this dataset represents the landslide boundaries present at or near the surface and comprises arcs with attributes describing the type of contact, its accuracy and exposure. The dataset is part of the Geological Map of New Zealand (Mainland) collection produced by GNS Science. The	**Active slips:** https://data.gns.cri.nz/gis/rest/services/NZL_GNS_250K_Geology_2023/NZL_GNS_250K_landslides_FeatureService_NZ/FeatureServer

Hazard	Description	Reference
	mapping frame within which the features have been observed is defined as surface geology (ie the bedrock and superficial deposits that are exposed at the topographic surface or would be visible if the overlying soil was removed). **Slip prone soils:** Sourced from Landcare Research, the NZLRI is a spatial database containing about 100,000 polygons (map units), each of which describes a parcel of land in terms of five characteristics or attributes (rock, soil, slope, erosion, vegetation). This layer represents a GIS dissolve on the erosion attribute of the NZLRI. Rapid assessment of land damage - Cyclone Gabrielle – "The physical mechanism for landslide initiation is well understood. Intense rainfall increases the pore water pressure in the soil, which reduces the effective weight of soil at the failure plane between soil and regolith. On steep hill slopes, this often results in shear stress exceeding shear strength, causing slope failure. If there is woody vegetation growing on the soil, then roots growing through the soil/regolith boundary will increase the shear strength and reduce the probability of failure." **Note:** Excluded from this analysis is earthquake induced landslides, as well as the work GNS is carrying out on a national-scale landslide map. We will be looking to incorporate these data sources when they become available.	**Slip prone soils:** kx-nzlri-erosion-type-and-severity-SHP\nzlri-erosion-type-and-severity.shp

Hazard	Description	Reference
Vegetation	 Native and planted forestry areas are identifiers for potential line damage from vegetation falling within the hazard zone. We have used the LUCAS NZ from Ministry for the Environment, as well as updated carbon forestry maps. **Note:** Additionally, we have started exploring the use of forestry polygons and asset failure types to better quantify potential bushfire risk. These methods are used to highlight areas of potential risk for further analysis in our 3D LiDAR database called Neara to determine level of encroachment and potential risk of vegetation falling in zone. 	Ministry for the Envionment – LUCAS New Zealand Land Use Map (LUM): **Link:** https://environment.govt.nz/facts-and-science/science-and-data/new-zealand-land-use-map/ **Specifics:** mfe-lucas-nz-land-use-map-1990-2008-2012-2016-v011-FGDB\lucas-nz-land-use-map-1990-2008-2012-2016-v011.gdb Feature class: LUCAS_NZ_Land_Use_Map_1990_2008_2012_2016_v011
Fire risk	**Note:** Fires can be caused by the electrical network during dry periods, such as from drop-out fuse operation or overhead line clash causing sparks.	Advanced Earth and Space Sciences – Earth's Future Aotearoa New Zealand's 21st Century Wildfire Climate May 2022.

Hazard	Description	Reference
	We have started to identify areas of potential bush fire risk by combining land parcel information, vegetation datasets (as outlined above) and electricity switch assets with drop-out fuses.	
Snow storm	Our networks in the central plateau are regularly impacted by snow storms, with snow and ice overloading structures to the point of failure. We have carried out assessment of cascade failure risks to more vulnerable network areas, and invested in selective network hardening.  	
High winds	We have used LiDAR information in Neara to determine if existing poles are compliant to our standard and anticipated wind speeds.	Met Service data

Other critical infrastructure providers

Over time, as better data becomes available, we intend to improve our recording of data in our GIS, and improve our assessment techniques to incorporate more detailed information on interdependent infrastructure, such as communications assets, and road vulnerabilities, through tools such as NZTA Waka Kotahi's:
State Highway resilience –
https://nzta.maps.arcgis.com/apps/MapSeries/index.html?appid=5a6163ead34e4fdab638e4a0d6282bd2
Detour routes tool –
https://detours.myworksites.co.nz/

Figure 17 – NZTA Waka Kotahi detour routes tool.

6.3 Engaging with communities and coordinating with stakeholders

Community engagement

We believe engagement with the communities we supply is key to understanding options for improving resilience. Sector reviews[21] [22] suggest network businesses have a critical role to play in supporting local communities plan for improved resilience. Working with National Emergency Management Agency (NEMA) civil defence authorities, we have identified about 150 community emergency hubs across our footprint that rely on a mixture of electricity and gas supplies.

We have been engaging with operators of community centres, marae and schools to help them understand vulnerabilities to their energy supplies, particularly in the event of long duration outages. We intend to extend this engagement approach to other critical infrastructure and essential services. For example, if we are aware of priority fuel sites across the Waikato region, we can share expected service levels for supply to these sites. This may then enable us to identify opportunities for fitting generator plugs/cross-over switches so they can still be operated when electricity supplies are down.

[21] Electricity Distribution Network Resilience Review – May 2022 – Victoria State Government
[22] Report to Electricity Networks Aotearoa – Electricity Distribution Sector Cyclone Gabrielle Review - 13 July 2023

Figure 18 – Community engagement, left, is key to understanding options for improving resilience. An example, right, of a vulnerability map of the community emergency hubs on our footprint. It shows areas of increased vulnerability to power outages because of damage from forestry, slips and flooding. Green areas are expected to be more reliable, while red represents the possibility of long duration outages from storms. Ranking methodology can be seen in Appendix 4. Note, in some cases emergency hubs may be within the same hazard zone.

In order to better understand resilience risks to our network, we have applied an all-hazards view in our GIS and assessed network vulnerability. In terms of climate impacts, our rural communities are likely to be most at risk of extended outages during major weather events.

The map above, and local scale map below, are examples of the type of outputs we have produced to help support our community engagement teams in discussing resilience with those emergency hub sites as indicated by NEMA. The map gives an indication of duration electricity outages because of climate-related risks (storms, flooding, vegetation) – green areas are expected to be more reliable, while red represents the possibility of long duration outages. Ranking methodology can be seen in Appendix 4.

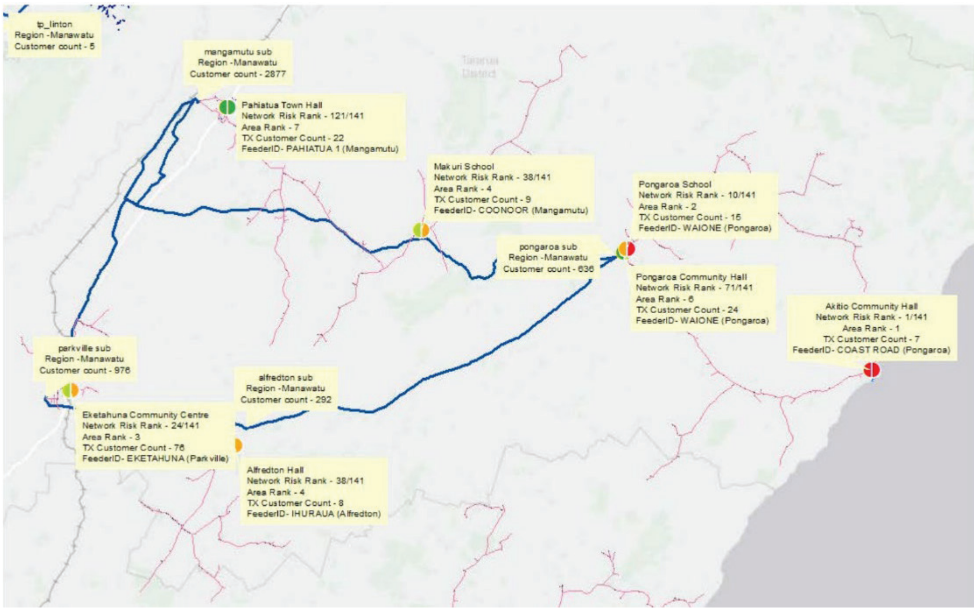


Figure 19 – Example of Tararua supply area, showing the increased risk of extended outages because of challenging hill-country along the eastern coast.

6.4 Coordination with regional adaptation plans, including coastal adaptation

Some of our communities are already disproportionately affected by extreme weather events – generally the more remote rural communities where the network traverses long distances to supply smaller numbers of customers. Our coastal areas, such as southern Wairarapa, Hawke's Bay (eg Haumoana) and the Coromandel coastline are already heavily affected by coastal erosion processes and flooding during storm surges, and the frequency of damaging flooding events, loss of land, and rising groundwater is expected to become more of a concern for these communities in the long term.

Figure 20 – The coastal and river communities we supply will be most severely affected by the increase in climate-related storms, flooding and sea level rise, and coastal erosion processes.

Under the Electricity Industry Act 2010[23], network companies are required to continue to provide a network supply, or equivalent, to customers supplied before an electricity service as of 1 April 1993. Under The Gas Act 1992 and Gas Amendment Act 2006, we work with local bodies to maintain supply where practical to do so. Our obligations for continuance of supply may not align with local community plans for adaptation. As councils work with communities on long-term planning, including adaptation to climate change, coordination with local councils is key to ensuring sensible ongoing investment in infrastructure that reflects potential changes for location of services for local communities.

We are monitoring progress, and engaging with local adaptation plans in development at both local council and regional council levels. At a strategic level, we have developed our approach in response to possible council adaptation options (refer Table 9), based on the adaptation option categories in the National Adaptation Plan (refer Figure 21).

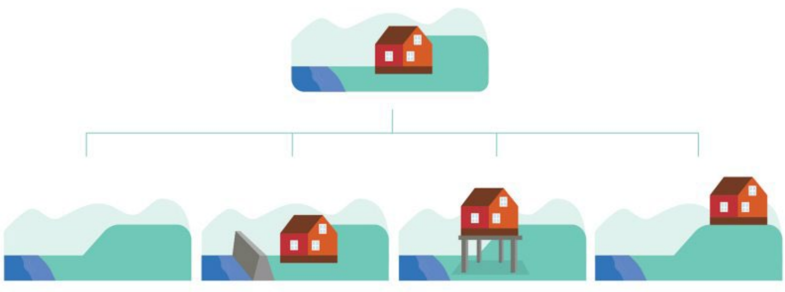


Figure 21 – Identified adaptation options for communities affected by climate change in the National Adaptation Plan.

[23] Section 105: Continuance of distributors' supply obligation

Table 9 – Proposed network response to council adaptation plans.

Council response	Powerco response
 **Protect** Improving flood defence (eg upgrade of stop banks)	**Protect** or **Accommodate** Consider risks of cascade failure of flood scheme/protection failure – strengthen support for defences (eg if flood pumps are required, review adequacy of supply/backups, consider raised district regulator stations).
 **Accommodate** Raising properties (local defence)	**Protect** or **Accommodate** Apply updated design standards and redevelop area to improve resilience over time (eg station floor level above projected flood return, or flood-proof design). Modify design to increase resilience of our assets in the event of flooding (special crossing brackets or move pipe to other side of crossing). Where practicable relocate district regulator station or provide backup supply.
 **Retreat** Managed retreat	**Maintain until Retreat** Maintain assets ("Certificate of Fitness") but avoid large-scale investment in place – consider adaptive redevelopment options out of hazard zone. Decommission of affected assets and removal of above ground gas infrastructure.
 **Unspecified** Council plans undefined but area exposed to hazard	There will be instances where network drivers for renewal or upgrade need to occur where council intentions are unclear. In these cases, any combination of the approaches above might need to be applied.

6.5 Electricity investment decision-making approach

Investment framework

Our electricity investments are tested through our Copperleaf value framework system, which allows us to quantify and, therefore, optimise the value derived from network investment. Figure 22 shows how the value framework connects the impacts of investment on the network and how it connects to our business strategic objectives. These value measures are broadly:

- **Financial** – how the investment can decrease ongoing maintenance or repair costs.
- **Environment** – investments that decrease biodiversity loss or reduce the risk of oil spills.

- **Health and safety** – investments that improve operator or public safety.
- **Customer and reputation** – investments that help improve community standing.
- **Legal and compliance** – investments that are required to meet regulatory requirements.
- **Network performance** – investments that improve network reliability.
- **Future enabling** – investments that help enable future upgrades or expansions.

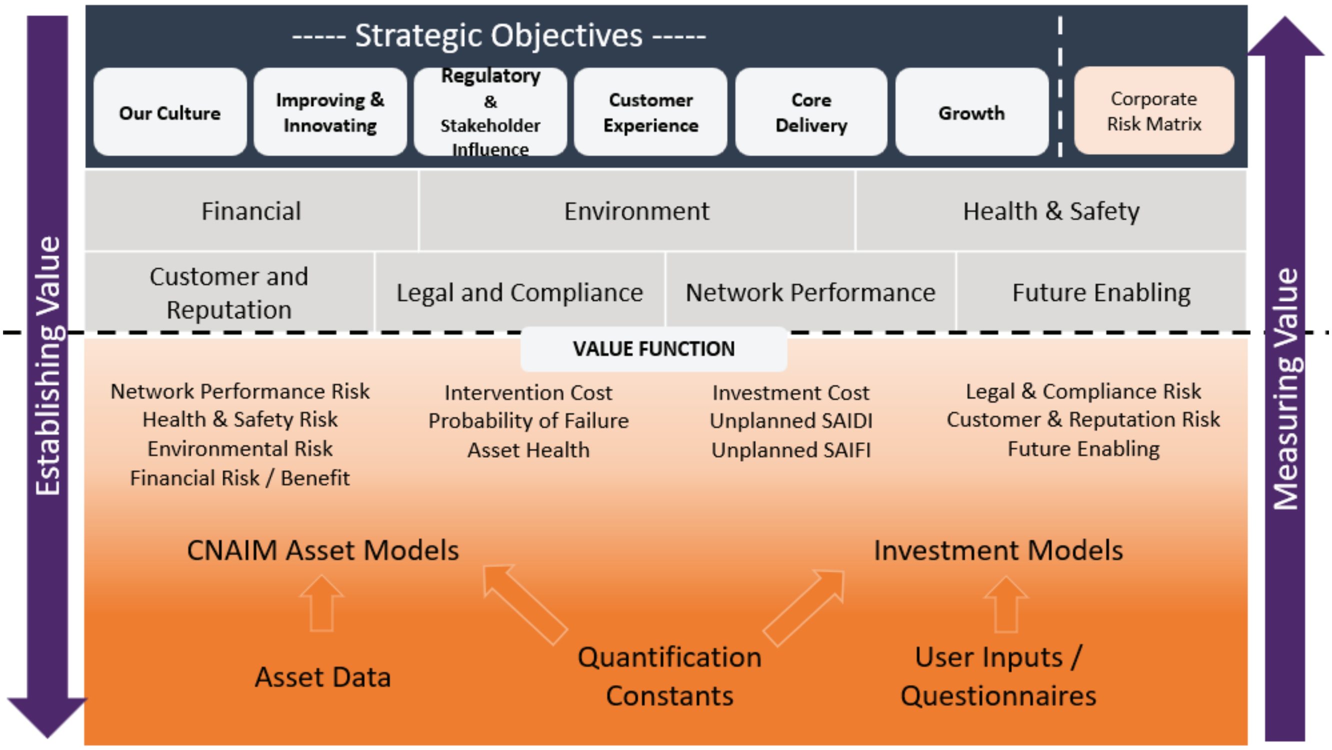


Figure 22 – Powerco's strategic objectives, alignment to our Copperleaf value framework (blue, middle) and how we quantify value ("Value measures") from investments (orange, bottom).

We are working through a process to incorporate our gas and IS investments through a common value framework that will allow improved whole-of-business decision-making.

During the past few years, we have developed a suite of asset models based on the UK DNO Common Network Asset Indices Methodology (CNAIM). This methodology differs from other forecasting methods in that it develops a bottom-up estimate of current and future asset health, probability of failure, and risk for each asset in the fleet. Information used to produce these estimates includes the asset's physical characteristics, the asset's physical condition, and the operational context – how failure could affect safety, network performance, and operational and environmental objectives. See our 2023 Electricity AMP Section 9.3.2.2 for further information about CNAIM.

Historically, we have justified our resilience investments through our existing value framework, primarily driven by our network performance measures, which are based on value of lost load (VoLL), derived from industry "willingness to pay" surveys. These are generally based on customer reported impacts of 10-minute, one-hour, five-hour and eight-hour outages, generally related to single network outages, and may have a weakness in identifying the true cost of impacts during significant climate events. As such, we are exploring augmenting these models to be closer to community welfare value, which differs from community economic value, including factors such as:

- Impacts of longer duration outages (days, weeks).
- Wide-area impacts with multiple supplies affected (over and above traditional N-1 planning).
- Identifying cascading impacts because of failure of other critical infrastructure.

We are aware that some organisations are using the Measuring the Economics of Resilient Infrastructure (MERIT) approach (https://www.merit.org.nz/using-merit/), of which we are looking to build our understanding.

As an example, Figure 23 shows value benefit potential for a proposed community hub development. This illustrates improving supply resilience and reduced customer risk is a significant consideration.

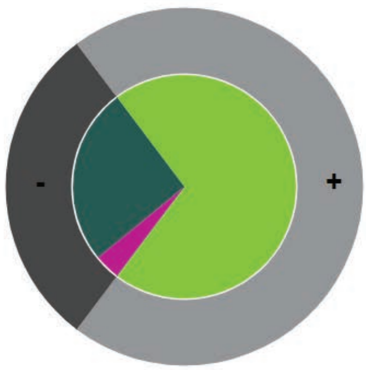
Draft Investment Value

Community Hub - Akitio Basepower

Value Measure	Value
Network Performance Risk	435
Customer and Reputation Risk	284
Financial Risk	12
Environment Risk	0
Legal And Compliance Risk	0
Project Execution Risk	(59)
Investment Cost	(295)
Total	377

Draft Investment Value

West Region, Zone Sub Seismic and Safety Upgrade - Martinborough Construction



Value Measure	Value
Network Performance Risk	822
Project Execution Risk	(45)
Investment Cost	(298)
Total	479

Figure 23 – Examples of application of the Copperleaf value framework in testing investment. At top is a community hub development, while below is seismic strengthening of a substation building.

As we better understand impacts to customers during significant events, this will allow us to embed in our normal investment justification process:

- Measure and value resilience improvements
- These aspects into our tools, such as Copperleaf, so this is part of how we value and optimise our other investment streams.

Strategy for particular areas of vulnerability

Substation flooding

For our Electricity AMP 2024, we have used flooding and storm damage data alongside our backbone network information (subtransmission lines, zone substations and key feeder trunk) to identify potential areas of vulnerability to flooding and storm damage. We have also screened our ground-mounted transformers and zone substation sites potentially exposed to 1% AEP flooding (refer Table 10). That initial screening of hazard and assets is then followed up by desktop assessment using available LiDAR, site photos, and asset health information. A similar process has been used for critical gas assets, special crossings and regulator stations, as described in Section 6.6.

Table 10 – Sites potentially exposed to inland flooding and coastal inundation.

	Ground-mounted transformers*	Zone substations**	
Local government region	**Inland flooding (%)**	**Inland flooding*** Medium/high risk (protected)**	**Coastal inundation**
Bay of Plenty	252 (8%)	1 **(1)**	1
Manawatū-Whanganui	446 (20%)	3 **(3)**	
Taranaki	113 (8%)	1	
Waikato	207 (10%)	**(13)**	1
Wellington	75 (12%)	**(4)**	
Total	1113 (11%)	5 **(21)**	2

* Ground-mounted transformers typically supply several residential streets or a larger commercial or industrial customer. During flooding events, these can become damaged beyond repair, delaying testing/relivening of supplied properties.

** Zone substations are key control and isolation points of our power networks, supplying from hundreds to tens-of-thousands of houses and businesses. The sites listed here have been identified via desktop assessment from available data to potentially be exposed to some level of disruption during flooding events. Further work will take place during FY25 on more detailed site analysis to better quantify risk. Most of the sites identified are protected by local council flood protection schemes (eg stop banks, flood pumps etc) so there is some risk of disruption where storm events exceed the flood design level.

*** Two figures have been provided – whether there is a known flood protection scheme or not. Of particular note is the large number of substations that are present within defended areas covered by the Piako and Waihou flood protection schemes administered by Waikato Regional Council.

Overhead lines exposed to high wind speeds

We undertook a review of a portion of our Coromandel network through Neara, assessing current modelled pole strengths against AS/NZS1170.2:2021. Wind pressures are as below:

Regional Wind Speeds Adopted from Table 3.1(B) AS/NZS1170.2:2021 with calculated km/h and pressure values using a density of 1.225kg/m3			
Average years between exceedance	m/s	km/h	Pressure (kPa)
1	31	111.6	589
5	35	126	750
10	37	133.2	839
20	39	140.4	932
50	39	140.4	932
100	41	147.6	1030

We note that the highest recorded wind speed in this region from 1980-2010 via NIWA was 100km/hr at the Whitianga Aero Automatic Wind Station, which our design standard allows for. In this study, we analysed pole strengths that are below the modern design standard needed for the maximum wind hazard. It shows that many of the poles (particularly many installed more than 50 years ago) are overloaded, sometimes greatly so.

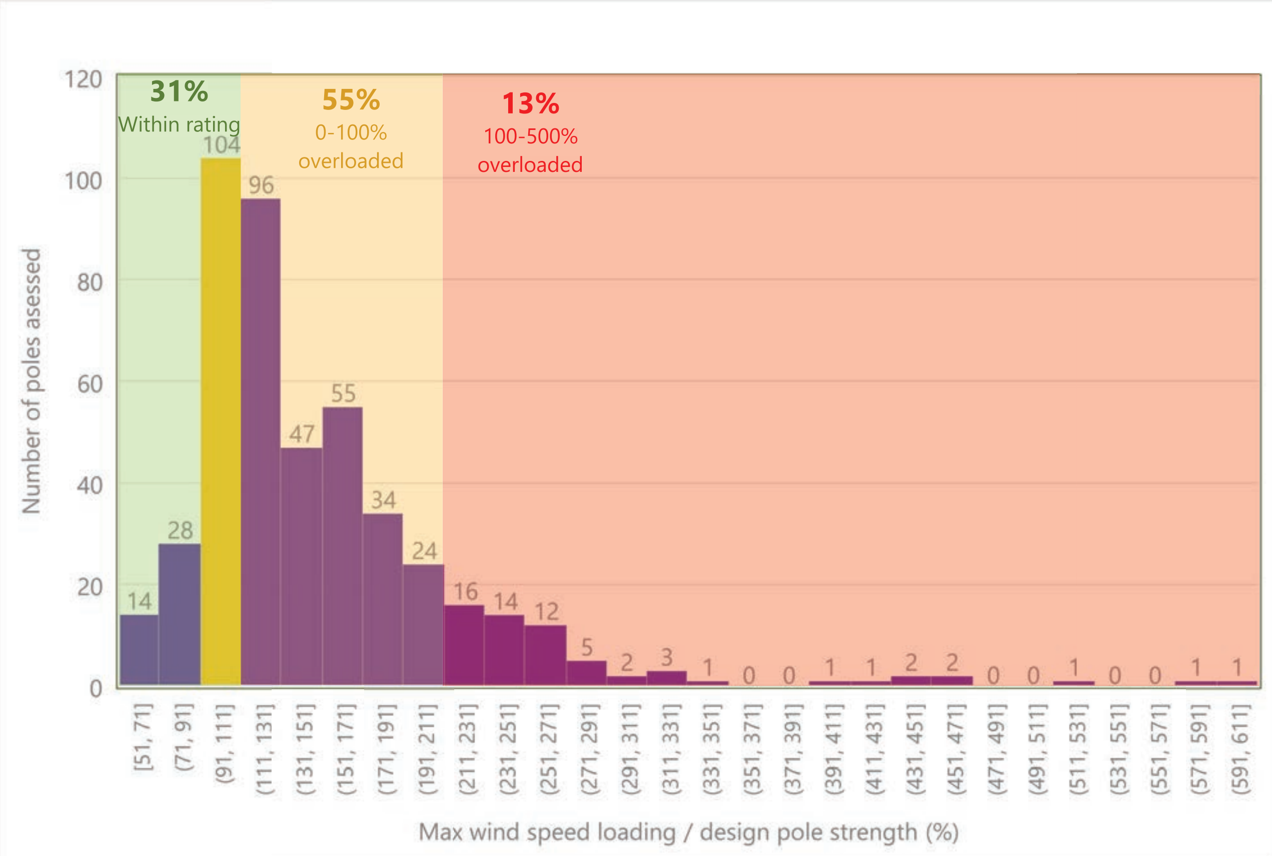


Figure 24 – Overload of pole strengths in Coromandel assessment, showing quantities of poles understrength to current day standards.

We note that we very rarely observed "unassisted" pole failures. In the past, wind-related failures have been related to wear on binders (separating conductors from insulators) and windblown debris. We believe this does provide some indication of the extent of network that could be exposed to failure risk if there are storms of higher intensity.

This is supported by the report to Electricity Networks Aotearoa (ENA) on the Cyclone Gabrielle review, which identified the high number of historical poles unlikely to meet the modern design standard (Figure 9 in report dated 13 July 2023).

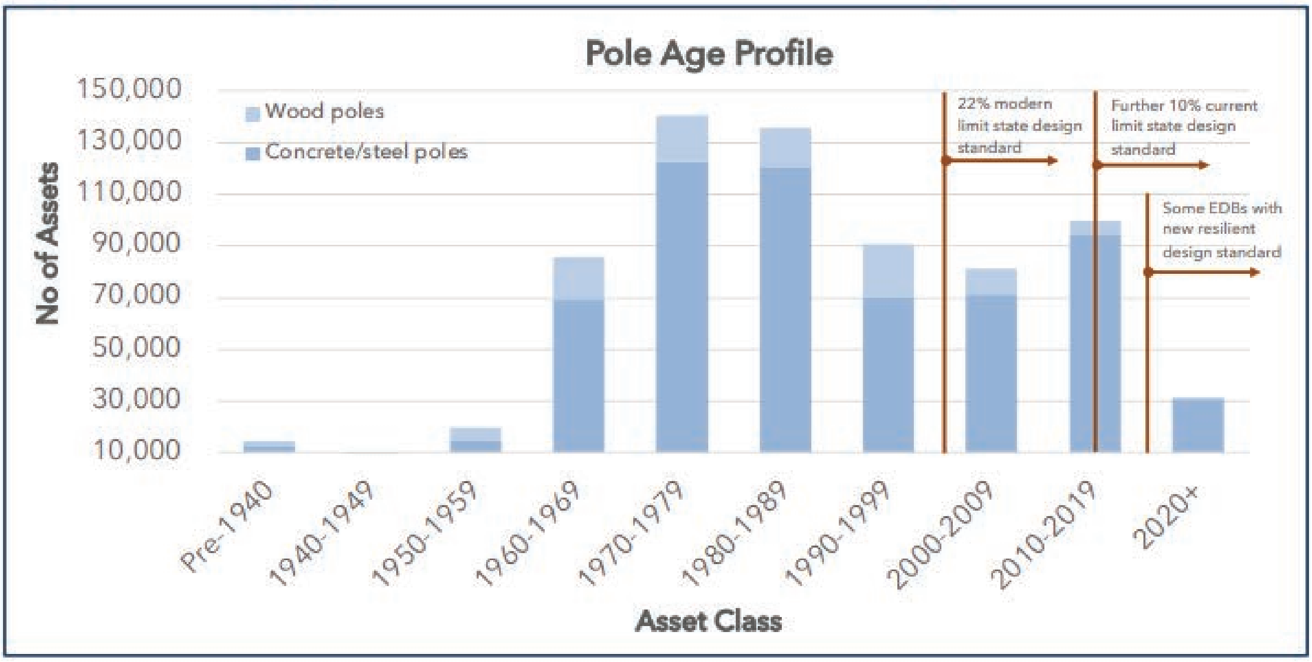


Figure 25 – Pole age profile and number of assets meeting modern design standard (Source ENA report on Cyclone Gabrielle).

As part of forecasts for overhead line hardening, we have included an initial estimate for the number of poles that may need to be replaced with modern equivalents at key locations to avoid cascade failures. Through FY25-27 we will carry out more detailed site/asset analysis, and further refine our forecasts into site specific and risk-based investments.

6.6 Gas strategy to enable change for a renewable and resilient energy future

In response to global decarbonisation and a reshaping of New Zealand's energy landscape, we have developed our Volume to Value Strategy that positions our gas business as a valuable contributor to the economy, while we also support a more renewable and resilient energy future. We believe that to ensure safe, reliable, resilient, and cost-effective energy for Kiwis, we need to focus on renewable gas alternatives and optimise the investment and asset management of our network.

We believe that renewable gas is at the core of the overall energy solution – that is essential for a sustainable energy future.

By understanding the capability of our assets to transport renewable gas alternatives safely and reliably, and strategically investing to enhance our assets, we will ensure that we are positioned to participate in a renewable energy future. The ability to transport renewable alternatives that meet our customers' needs today and into the future will ensure the value of our assets and viability of our business. Below we discuss the main strategies relevant to gas asset management and planning functions.

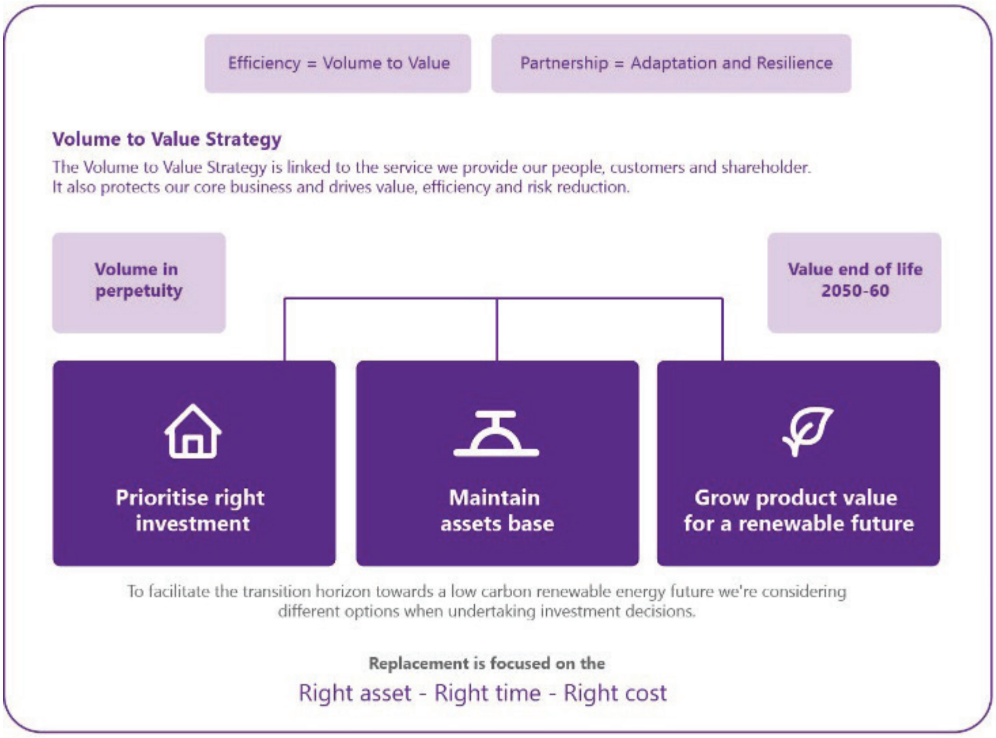


Figure 26 – Powerco Volume to Value Strategy.

Gas decision-making framework

To support the Volume to Value Strategy, we have refreshed our decision-making framework to prioritise intervention decisions with a focus on ensuring a sustainable and resilient future. These reflect our overall corporate strategic direction with a view to maintain and grow the resilience of our gas networks. This is shown in Table 11. We have prioritised assessment of critical assets at special crossings and regulator stations, and our approach for these is described further below.

Table 11 – Gas decision-making framework.

Criteria	Definition
Safety	Keep the public, our staff, and our contractors safe from harm.
Delivery	Ensure our networks have the capacity and resilience to meet the quality of supply expected by our customers.
Reliability	Safe containment of gas, and operational reliability to deliver gas to our customers at the right quality.
Efficiency	Continuously seek out and deliver cost efficiencies. Focusing on our Volume to Value Strategy by prioritising the right investment, maintaining our asset base, and expanding into a renewable future state.
Partnership	Be a responsible, sustainable and resilient future energy-focused partner of choice for our customers and our other stakeholders.

Strategy for particular areas of vulnerability

Our modelling focused on the low and moderate SSP 1-1.9 and SSP 2-4.5 climate change scenarios that increase the hazard risk, with implications in some regions, but are not as significant as an SSP 3-8.5 worst case scenario. Using the low to moderate scenarios, we wanted to understand what a future that anticipates more frequent, severe flooding and other events looks like, in balance with understanding cost and impacts on our customers and communities. The actual outcome will depend on several factors, including the assets' location within the surrounding topography, catchment, and future growth in that region.

We have modelled our gas network to specifically identify regulator stations and special crossing assets vulnerable to inland flooding and sea level rise (coastal inundation) across our network. Regulator stations step pressures down to lower distribution pressures, which are safer, cheaper, and more reliable to reticulate throughout the network. They are integral to the supply of gas to our customers, and we are looking to maintain the operation of these stations as inundation of a station prohibits its ability to regulate gas pressures effectively.

Special crossings are designed to provide above or below ground passage for a pipeline to ensure that the asset is kept safe at points of our network that are exposed to external factors, such as a river (bridge), road (national significance) or rail crossings. Our climate analysis focused on above ground bridge crossings on state highways that span rivers. These are generally bridges that span large distances, making them more prone to flooding and damage from slash. This was illustrated during Cyclone Gabrielle in 2023, when the pipeline attached to the Ngaruroro River bridge crossing was damaged, almost to failure, in flooding caused by slash from forestry works up stream. The total number of assets identified as vulnerable are identified in Table 12. For more detailed information about specific regional risk and overview maps, refer to Appendix 5.

Table 12 – Total number of gas assets vulnerable to inland flooding and coastal inundation.

	Hazard			
Asset type	Inland flooding	Coastal inundation	Exposed to both hazards	**Total**
Regulator stations	29	9	8	46 (24%)
Special crossings	2	3	5	10 (3%)

Gas strategy for special crossings

Special crossings that are identified, through vulnerability assessment, as being at risk of flooding, will be prioritised for optionality assessment, with the aim of reducing exposure to slash in a major storm event.

The special crossing decision-making framework (refer Table 13) helps guide the optionality phase and outlines how the scoping process can consider prioritising bridge crossings for optionality. This ensures the appropriate level of consideration is given to understanding any resilience work required for the relocation of pipe on bridge crossings, re-design of existing brackets, drilling pipe underground, holding spares, or if additional isolation points are required.

Table 13 – Special crossings decision-making framework supported by the Gas Networks Emergency Response Plan standard 394S012.

Metric	Number of customers	Customer type	Priority for optionality
Non-strategic pipe	<500	Residential	Low
Strategic pipeline	>500	Residential and commercial	Medium

Metric	Number of customers	Customer type	Priority for optionality
Highway	>500	Critical supply loss to large commercial/industrial customer (including hospitals, rest homes and schools)	High

Gas strategy for regulator stations

Assess and manage the risk of vulnerable stations identified in flood-prone areas based on the number of customers they feed and performance.

Where district regulator stations (DRS) and pressure regulator stations (PRS) have been identified as vulnerable to flooding or sea level rise by 2050, we will consider the following mitigations as part of our asset management planning process:

- Assessment of need, based on the number of customers supplied. If isolation results in a loss of ≤500 customers, the need may be considered low.
- In cases of high loss (>500 residential or large commercial/industrial), a loss impact and cost to relight study will be undertaken to understand the commercial benefit.

Evaluate and validate different options when undertaking investment decisions, while considering alternative solutions.

We will evaluate different options in the planning stages, and validate the most economical solution before the asset replacement/maintenance assessment stage, to ensure we are selecting a cost-efficient solution for the remaining life. This will also:

- Consider relocating a vulnerable station at end of life or when performance identifies upgrade or renewal.
- Below ground stations (Cocons) will not be installed in in flood-prone areas in alignment with our district/pressure regulator station design standard GDS-DRS-01.
- Where appropriate, consider raised stations to decrease the impact on station assets. Decisions about which stations are of higher importance to the network and should be protected can be prioritised, based on variables such as age, the number/type of customers supplied, and flow rate.

Our intention is that by using these strategies, alongside our climate change scenarios, the climate-related risk assessment work undertaken will enable us to identify our priority physical risks, and associated investments required over the short, medium, and long-term timeframes.

Regional analysis of risks and prioritising investment

7. Regional analysis of risks and prioritising investment

Early outcomes of the vulnerability analysis, with a geo-spatial overview of the physical hazards challenges for our networks, is provided in Appendix 5. These sections include some case studies and more detailed views of the types of vulnerabilites identified. The information is provided in three groupings:

1. Electricity-only regions
2. Electricity and gas regions
3. Gas-only regions

High-level outputs of the vulnerability work are covered in the gas and electricity 2023 AMPs. These are generally aligned with the impacts and identified vulnerabilities we have observed during recent severe weather events. Figure 27 provides a summary of key items of resilience-related investment identified in our 2024 AMPs.

We intend to carry out more detailed site analysis in FY25/26, and in line with improving our understanding of resilience value (as described in Section 6.5 and 6.6), we will use this to help define specific programmes of work, as required.

Flooding

- $16m for strengthening 50 critical subtransmission and spur 11kV river crossings at risk of damage from river flooding.
- $10m zone substation relocation out of flood zones (high-risk sites).
- $14m for rebuilding 5% of the underground network exposed to river flooding and storm surge.
- $3m for additional spares and site improvements to improve response to

Storms

- $14m for storm-hardening 2% of network that is understrength for extreme wind speeds.
- $8m for line relocations related to 10% of the network with fall-in risk from trees/forestry.

Slips

- $14m for relocating 1% of overhead network within active and slip-prone areas.

Community hubs

- $13m for establishing 40-60 off-grid community hubs for hard-to-serve areas.

$2m per year for strengthening our special crossings and stations in flood-prone areas

Figure 27 – Summary of climate resilience investment in AMP 24 (electricity and gas).

Next steps

8. Next steps

Our next steps for embedding and advancing our Climate Adaptation & Resilience Plan include tasks across the Powerco business.

Table 14 – Powerco team tasks for implementing and advancing the Climate Adaptation & Resilience Plan.

Function	Example tasks
Network Operations	• Expand mapping of customers to "critical infrastructure". • Emergency preparedness plans up-to-date. • Event management platform to communicate restoration progress. • Low voltage visibility to improve event response.
Engineering Services	• Support in decision-support frameworks. • Ongoing intake and updating of GIS hazard information as it becomes available.
Design and Asset Information	• Review of design standards against scenarios. • Incorporate hazards information into design tools.
Network Planning and Operational Technology	• Desktop assessment of critical customers. • Assess grid exit point impacts. • Network impacts outage scenario modelling. • Further scope investment plans for network strengthening or hazard mitigation. • Publish and train planning and design teams on GIS hazard views. • Review critical spares and depots based on scenario analysis. • Augment Copperleaf to be able to quantify resilience benefit. • Apply climate scenario wind impacts to network via Neara.
Customer	• Engage with councils and other lifelines utilities, further identify critical customer database and customer expectations. • Engage with customers/community regarding value of resilience.
Business Strategy	• Significant event definition. • Establish prudent restoration times for different services. • Test resilience measures and targets. • Continue developing distributed energy storage and generation solutions.

Appendices

Appendix 1 – Glossary of terms

AMP means Asset Management Plan.
Capital expenditure (Capex) means the expenditure used to create new assets or increase the service performance or service potential of existing assets beyond the original design service performance or service potential. Capex increases the value of the asset stock and is capitalised in accounting terms.
CBD means central business district.
Cocon means below ground regulator station.
CP means cathodic protection.
DRS means district regulator station.
ERP means Emissions Reduction Plan.
FSA means formal safety assessment. This is how Powerco assesses general network risks through a regular five-yearly process.
GDB means gas distribution business.
HVP means Hutt Valley and Porirua region, which is one of our network areas.
ICP means customer installation control point in billing and reference systems.
IP means intermediate pressure (700-2000kPa).
ISO 55000 refers to the International Organization for Standardization publication 55 000. It is a suite of three documents.
KPI means key performance indicator.
LP means low pressure (0-7kPa).
MAOP means maximum allowable operating pressure.
MBIE means Ministry of Business, Innovation and Employment.
MCS means monitoring and control system.
MED means major event day.
MP means medium pressure (7-700kPa).
M&S means main and service pipe.
OMS means Outage Management System, which is used for call operations and the coordination of outage restoration efforts.
Operational expenditure (Opex) means the expenditure, including maintenance and inspection, required to survey and maintain the assets to achieve their original design lives and service potentials. It also includes the expenses related to our third-party prevention programme.
PELOS means planning emergency levels of service.
PRS means pressure regulator station.
SAIDI means system average interruption duration index. This is the average length of time of interruptions of supply that a customer experiences in the period under consideration.
SAIFI means system average interruption frequency index. This is the average number of interruptions of supply that a customer experiences in the period under consideration.
SPX means special crossing, designed to provide passage for a pipeline across a river, road or railway.
TPK means Te Puni Kāpuni (Issues Register), our tool for identifying projects and prioritising their need.
VAL means line and service valve.
WACC means weighted average cost of capital. This is regulated by the Commerce Commission.

Appendix 2 – Design standards related to climate risks

Table 1: Powerco design standards related to climate risks

Climate risk and impacts	Relevant Powerco asset standards
Increased winds/gales: • **Design to withstand extreme winds.** • **Cut vegetation regularly to safe distance to reduce risk from up-rooting.** • **Invest in storm and hurricane forecasting tools.** • **Consider placing cables underground.** • **Redundancy**	• Electricity design follows AS/NZS1170 2022 Wind Standard – Reflected in 393S008 Overhead Design. • Vibration standards for high wind areas. • Increase design strength based on wind speed and feeder class (393S008) (393S009). • Vegetation Management Strategy, Refer 2023 Electricity AMP, Chapter 21, Page 335. • If cannot meet design wind standards as per 393S008, alternative design is explored, such as underground design.
Rainfall: • **Design for resilience to pluvial flooding.** • **Assessment of site drainage requirements.** • **Impact of restricted access to sites/lines because of flooding.**	• 350S006 Zone Substation Design and Construction Requirements. • Gas Operations Standard GDS-DRS-01 District/Pressure Regulator Station Part 2 Design – Location and Structures.
Increased flooding: • **Flood risk assessment and planning. Site ground installations outside of potentially affected zones.** • **Location assessment equipment, structure and gas asset positioning.**	• 350S006 Zone Substation Design and Construction Requirements. • Gas Operations Standard GDS-DRS-01 District/Pressure Regulator Station Part 2 Design – Location and Structures. • Gas Operation Standard GDS-MSS-01 Mains and Service Part 2 Design.
Flood defence: • **Ensure flood defence systems and coastal management plans are adequate.** • **Consideration of site access during flooding events.**	• 350S006 Zone Substation Design and Construction Requirements.

Climate risk and impacts	Relevant Powerco asset standards
Landslides/ground movement: • **The potential for ground movement and landslides should be taken into account when assessing pipeline routes and asset sites for installing grid infrastructure.**	• Seismic strengthening of zone substations – see Electricity AMP 2023, Section 4, Network investment. • Gas Operation Standard GDS-MSS-01 Mains and Service Part 2 Design. • Gas Operations Standard GDS-DRS-01 District/Pressure Regulator Station Part 2 Design – Location and Structures.
Increased river erosion: • **Shoreline management plans/coastal erosion assessment.** • **Pipe crossing position and depth of cover.**	• Reflected in 393S008 Overhead Electricity Design Pollution Standard with corrosion zones. • Gas Operation Standard GDS-MSS-01 Mains and Service Part 2 Design.
Temperature: • **Design standards that maintain equipment rating over its lifetime performance in the face of all potential ranges of temperature rise.** • **Manage vegetation under power lines to ensure adequate clearance is maintained.** • **Assess changing demand profile (milder winters, increased summer cooling) over equipment lifetime.**	• Overhead Electricity Line Design Standard 393S008 – maximum conductor temperatures. • Vegetation Management Strategy, Refer 2023 Electricity AMP, Chapter 21, Page 335. • 393S042 Powerco Clearance Parameters Standard.
Wildfires: • **Management of vegetation around electricity infrastructure to ensure adequate clearance.**	• Vegetation Management Strategy, Refer 2023 Electricity AMP, Chapter 21, Page 335.
Reducing frost, snow, ice cover: • **Design equipment for ice loading.**	• Design follows AS/NZS1170 2022 standard for temperature, and snow loading (designs that are in alpine regions).
Increased lightning: • **Design of electrical equipment to withstand lightning impulses, including shielding and surge suppression devices.** • **Redundancy**	• 393S019A High Voltage Surge Arrestors – Selection and Installation Design (Lightning area expanded to whole networks and surge arrestors made standard on all transformers).

Appendix 3 – Our regulatory and policy context

Powerco is a regulated electricity and gas distributor. This operating environment, alongside national and local policy, standards, and guidelines, provides important context for our resilience and adaptation planning.

Regulation and policy are quickly changing, and we have noted here key existing regulatory settings and regulatory and policy reviews, which we will monitor and continue to engage with. In particular, the regulatory and policy focus is growing to direct improved climate resilience for critical infrastructure and for communities.

Regulated essential infrastructure

Powerco is a regulated distributor under the Commerce Act 1986. Under Part 4 of the Commerce Act, Powerco's revenue and expenditure are set by the Commerce Commission as part of monopoly regulation. We are also subject to significant information disclosure requirements, publicly publishing our investment plans, technical and financial performance, and prices. The regulatory regime allows us to recover the value of our asset base using a regulated cost of capital (WACC) set by the Commission, and a forecast of our expenditure. Every five years, the Commission reviews its forecasts and resets our allowable revenue. This process is designed to ensure the costs paid by customers for us to manage and operate our network is efficient, given we are a monopoly and an essential service.

We are also a lifeline utility providing an essential service. The Civil Defence and Emergency Management Act 2002 (CDEM) provides the framework for the emergency management system. We have a duty to maintain operations 24/7, including in the case of a major event, such as a flood. As a lifeline utility, we work with other lifeline utilities in regional groups to plan and respond to events at a regional level. Lifeline groups have a primary interest in responding to events, and they are also a key network for resilience planning. An outline of the lifeline groups on our network is provided in Section 3.3.

Current regulation and policy guiding adaptation and resilience

The regulatory and policy environment is complex, particularly when the investment, planning, and climate response aspects combine to inform climate resilience and adaptation. The current regulatory context crosses three policy areas relevant for adaptation and resilience, as described here.

1. Investment in our energy networks

The market regulation described above sets processes (including forecasting and asset management planning), regulatory checks and disclosure requirements for how we determine our investment. Our Board makes investment decisions based on both regulatory controls and commercial considerations.

The Commerce Commission decision on Powerco's FY26-30 investment (revenue) is in progress and will be finalised in late 2024, following a consultation process on the draft decision.

There are also some specific regulations and standards that guide investment priorities in our maintenance and upgrade activities, for example the tree regulations and design standards (see Appendix 2).

2. Environmental and local government planning

The Resource Management Act 1991 (RMA) and regional and district plans guide the location and environmental controls for maintaining our current assets and building upgrades or new assets. Regional and district plans may also identify flood hazard areas or other natural hazard zones or controls. Powerco's network crosses 29 council areas and the requirements vary across the multiple regional and district plans. Many regional and district plans are under review.

Some councils have, or are in the process of developing, adaptation/resilience plans or climate change strategies. These generally have a longer-term outlook. With the various reviews and retreat inquiry under way, there is expectation for more local adaptation plans to emerge.

RMA national policy statements (NPS) have been set by government and direct council plans and decisions on certain topics. The NPS for urban development requires certain growth regions (includes Wellington and Bay of Plenty) to prepare a Future Development Strategy to plan for 30 years of growth in population and infrastructure. A proposed NPS is in the consultation phase. This would set a framework for council decisions on natural hazard risk.

3. Direction for New Zealand's climate response

The Climate Change Response (Zero Carbon) Amendment Act 2019 amended the Climate Change Response Act 2002 to introduce a requirement for a National Adaptation Plan (NAP) to be in place. The first NAP was released in August 2022 and the next NAP is due in August 2028. This long-term adaptation strategy sets out how Aotearoa New Zealand will build resilience for an uncertain future and identifies long-term adaptation goals and actions that the government will focus on in the current NAP period. Some relevant actions identified in the current NAP are:

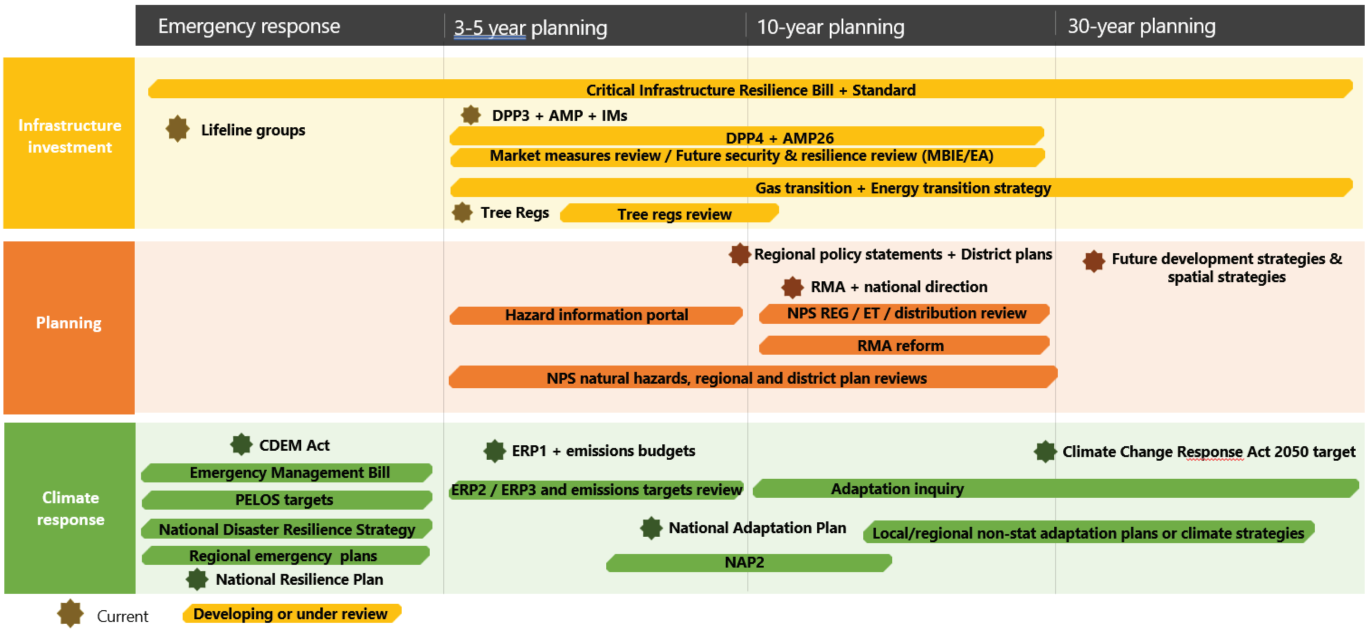
- Scope a resilience standard or code for infrastructure to encourage risk reduction and resilience planning in existing and new assets.
- Integrate adaptation into Treasury decisions on infrastructure to ensure that decision-making on new assets and across major renewal or upgrade programmes considers climate risks.
- Develop guidance to support asset owners to evaluate, understand and manage the impacts and risks of climate change on their physical assets and the services they provide.
- Develop and implement the Waka Kotahi Climate Adaptation Plan to enable climate-resilient transport networks and journeys, connecting people, products and places for a thriving Aotearoa.
- Develop a national hazard information portal.

An Emissions Reduction Plan (ERP) for each emissions budget period is also a requirement under the Climate Change Response Act. This has some overlap in government direction under the Act but is less focused on actions relevant for adaptation and resilience. The current ERP was released in 2022 and ERP2 is due for release in late 2024.

A changing government policy and project context

There are current and planned reviews across many areas of regulation and policy. Figure 28 illustrates the complexity of both the current, and changing, policy and regulatory context. In 2024, with a recent change of government, policy direction is uncertain, and new policy is expected to emerge during the next two years.

Figure 28 – Current and changing regulatory and policy context for adaptation and resilience.



A number of reviews commenced before the 2023 election, and there is some uncertainty about the timing for progress under the current government term.

- **DPMC critical infrastructure resilience review:** The purpose of this review is to establish a framework to improve the performance and consistency of New Zealand infrastructure resilience. In particular, to look at mechanisms for funding and investment to focus on preparedness and knowledge. Public consultation was completed in 2023 and a Bill and/or standards may be introduced in 2024.

- **Emergency Management Bill:** Replaces the Civil Defence Emergency Act 2002 and introduces new roles and responsibilities across the sector. The Bill is currently before Select Committee. It intends to enhance the resilience and accountability of critical infrastructure, and modernise the legislative design, including establishing a more responsive regulatory framework for setting standards. The Bill would require critical infrastructure entities to develop, or contribute to the development of, sector-specific plans for responding to and recovering from emergencies. It also introduces a requirement for critical infrastructure entities to establish and publicly state their planning emergency levels of service (PELOS).

- **Electricity Networks Aotearoa Cyclone Gabrielle review:** This review commissioned by ENA reports on the appropriateness of the electricity distribution sector risk reduction, readiness and response to Cyclone Gabrielle. The report was released in July 2023. The report noted key aspects for consideration, including out of zone vegetation, substation flooding (in the Hawke's Bay, stop banks designed for 1/100y + 0.5m flood event), and line failure because of high winds/slips. The need for the establishment of community hubs in some locations was highlighted. The report supports work under way by the ENA to consider development of industry resilience measures.

- **Energy Strategy and Gas Transition Plan:** This was proposed under the Emissions Reduction Plan 2022. In 2023 a Gas Transition Plan issues paper was released, but the future of a Gas Transition Plan is currently unclear. A draft Energy Strategy was planned for consultation in mid-2024, but its future is also unclear. There are some workstreams continuing to progress separately, including Electricity Authority (EA) work on the future system operation.

- **Select Committee inquiry into climate adaptation:** This commenced in 2023 with a reformed inquiry then established in May 2024. The inquiry will look into a number of aspects, including: current approaches to community-led retreat and adaptation funding, its strengths, risks and costs; lessons learned from severe weather events; the role of the private sector in managing climate risk; alignment and integration with existing legislation and regulatory framework and potential economic or other incentives needed to support adaptation actions (both before and after extreme events); funding sources, access to them and principles and criteria for cost sharing; and targets or indicators for assessing progress to more resilient communities and infrastructure. In combination with other policy direction for enhanced focus on adaptation planning, this inquiry is expected to support the development of more adaptation plans at a local or regional level.

- **Central government funding available to support community resilience:** In May 2022, the Government committed $16 million over four years for community-based renewable energy projects. This was expanded in May 2023, with an additional $30 million committed through until 2027. The Community Renewable Energy Fund[1] comprises workstreams that complement each other and take a holistic approach to driving energy sector innovation through collaboration between suppliers, electricity distribution businesses, the wider community, funding partners and central and local government agencies. Workstreams within the fund included up to 40 solar energy systems on community buildings in regions affected by Cyclone Gabrielle and other severe weather events, and other community-level energy resilience projects.

[1] Community Renewable Energy Fund | Ministry of Business, Innovation & Employment (mbie.govt.nz)

Appendix 4 – Network vulnerability example and criticality ranking table

To better understand vulnerabilities to community energy supplies, particularly in the event of long duration outages. We use the following ranking methodology, as referenced in Section 5.3.

Figure 29 – Example of basic ranking system that can be used to assess vulnerability of supply.

	Group weighting	Scale	Definition	Score
Access risk	2	High	Hilly route prone to slips, only one road, bridge crossings.	3
		Medium	Single road but on flat land, easy to get around. Multiple access routes but likely to be compromised in an extreme weather event.	2
		Low	Multiple routes for access.	1
Alternative supply	2	None	No alternative supply (spur).	3
		Part	Alternative supply for part of the route.	2
		Full	Full alternative supply.	1
Distance from substation	1	0	>10km	1
		2	2-10km	2
		10	<=2km	3
Substation security	1	N	No alternative 33kV supply to substation.	3
		N-1 SW	Switched alternative supply.	2
		N-1	Full alternative supply.	1
Historical performance	2	0	Fewer than two outages a year.	1
		2	2-9 outages a year.	2
		9	9+ outages a year.	3

Table 15 – Example criticality table (392S034 Powerco Asset Criticality Definition).

Metric	Asset type	Loss of important customers	Priority for optionality
Major	Subtransmission Zone substation transformer	51	
	HV distribution Zone substation switchgear	>5,000 customers Kinleith or significant customer Radio equipment for core communications	

Metric	Asset type	Loss of important customers	Priority for optionality
Significant	Subtransmission Zone substation transformer	52, 53	
	HV distribution Zone substation switchgear	>2,000 and <5,000 customers Key commercial customers	
Moderate	Subtransmission Zone substation transformer	54, 55	
	HV distribution Zone substation switchgear	>500 and <2,000 customers Critical customers	
Minor	HV distribution Zone substation switchgear	>50 and <500 customers Notable customers	
	Low voltage	All assets in a CBD	
Insignificant	HV distribution Zone substation switchgear	<50 customers Residential	
	Low voltage	All assets not in a CBD	

Note – These are deterministic measures that have been used to help prioritise areas of network that, in terms of resilience, would benefit the most from network hardening approaches. The next step will be moving to a network modelling-based approach that will allow us to take a more supply-centric view. This would take into account the types of customers and services impacted by specific outages on the network, including the duration of the outage and the cost of the outage (VoLL).

Appendix 5 – Regional risk overview and maps

Tauranga – Electricity

Region overview

The Tauranga area covers Tauranga city and the northern parts of the western Bay of Plenty district. Mt Maunganui is considered in a separate area plan. The Tauranga area of supply comprises two different terrains or environments. Tauranga city includes industrial, commercial, and residential land use, while the northern rural landscape tends to consist of rolling country, predominantly used for rural and lifestyle dwellings.

The region has a temperate, coastal climate with mild winters and warm humid summers. Peak demand is in winter, but increased summer activities, including greater use of air conditioning, could see this change to a summer peak in future.

The popularity of this area as a place to live, reflecting the good climate, terrain, and coastal setting, is the single biggest reason for its development and is reflected in the high demand growth rates.

Tauranga is a major city and is the economic hub of the area. The recent upgrade of major transport links and continued land development signals confidence in population growth, commerce, and industry. Primary production, including horticulture, is also a significant economic activity, with many kiwifruit orchards in the Aongatete and Katikati areas.

The area is supplied by the Tauranga and Kaitimako GXPs. Tauranga GXP is a grid offtake at both 11kV and 33kV.

The Tauranga GXP supplies 11 zone substations: Bethlehem, Tauranga 11kV (TP), Waihi Road, Hamilton Street, Sulphur Point, Otūmoetai, Matua, Ōmokoroa, Aongatete, Katikati and Kauri Point. The Kaitimako GXP supplies the Welcome Bay substation and the Pyes Pā substation.

The region uses a 33kV subtransmission voltage. Twin dedicated circuits feed each of the critical inner-city substations of Hamilton Street and Waihi Road.

Twin 33kV high-capacity circuits link Tauranga GXP with a major subtransmission interconnection point at the Greerton switching station. From this, two circuits supply the northern substations (Ōmokoroa, Aongatete and Katikati) via dual circuits and Kauri Point on a single circuit from Katikati.

Otūmoetai is now supplied from twin radial subtransmission circuits from Greerton, with a single 33kV radial circuit from Otūmoetai supplying Matua.

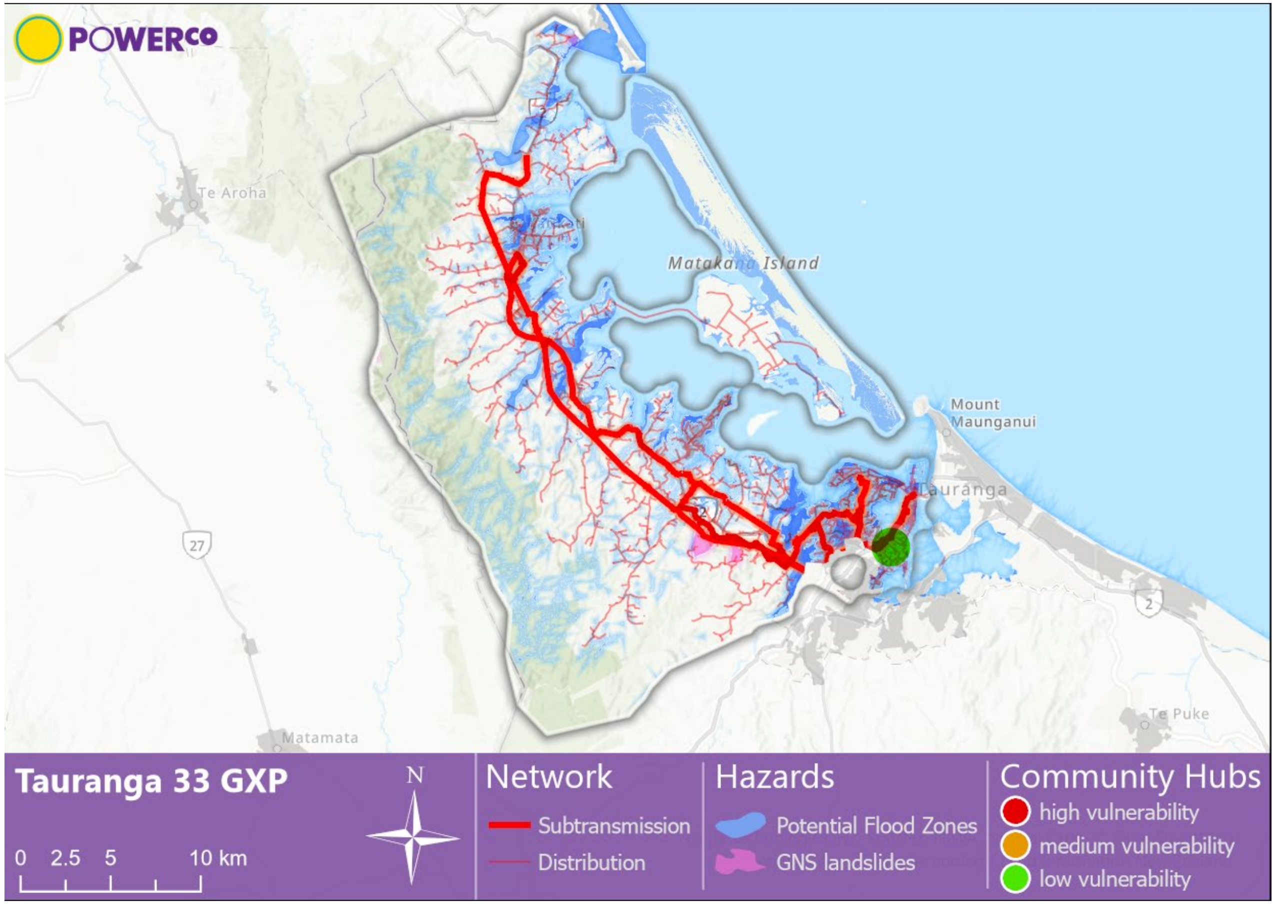
The Bethlehem/Otūmoetai ring and the twin Ōmokoroa circuits share poles for several spans out of Greerton, which raises common types of failure risks and protection issues. A project is underway that will install a third subtransmission circuit from Greerton to Ōmokoroa and will reduce the number of poles shared between the Bethlehem/Otūmoetai ring.

Trustpower's Kaimai generation scheme feeds into the Greerton switching station.

The subtransmission and distribution networks in the Tauranga area are mainly overhead, although there are also large areas of underground cable, particularly in the inner city or newer subdivisions. Environmental and urban constraints require most of our new circuits to be underground.

Table 1 – Tauranga inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	218 (9%)	1 (1)	0



Tauranga 33kV GXP overview

The Tauranga 33kV network supports the Tauranga CBD and surrounding commercial and residential areas, as well as the significant populations around the harbour from Ōmokoroa to Katikati, Athenree and Waihi Beach, as well as Matakana Island, which we have difficulty accessing during poor weather. Local generation backup is planned for the island.

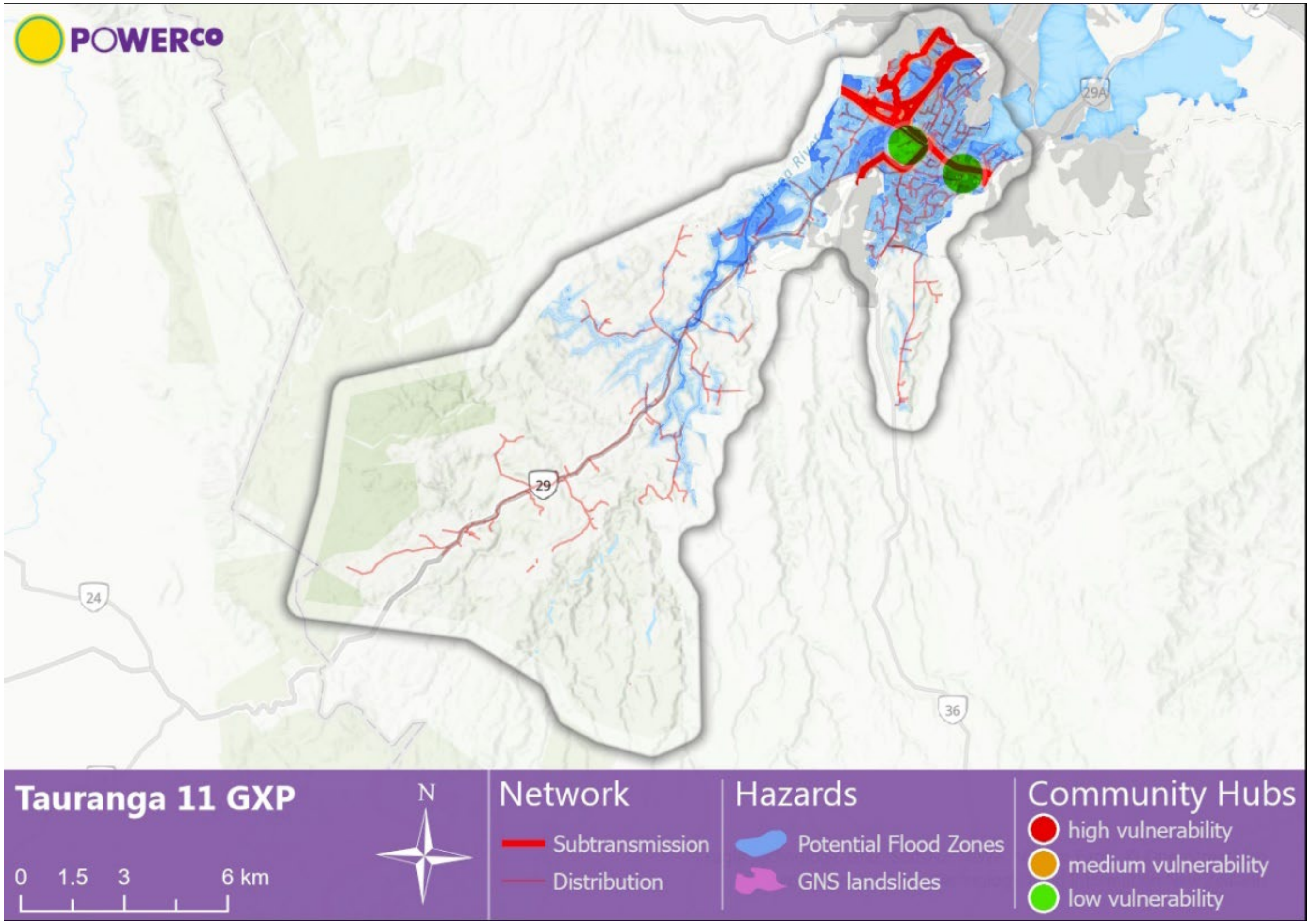
The key hazards in this area are sea level rise risks along the coastline, and inland flooding risks related to our river crossings and ground-mounted assets in overland flood paths from the Kaimai Ranges, including through most of the urban areas.

Significant services include Tauranga Hospital, Port of Tauranga (Sulphur Point), Chorus interchange, and significant council wastewater and water supplies. Various local medical centres and emergency services are also supplied from the Tauranga 33kV GXP.

Tauranga City Council is carrying out work to improve sea defences to the CBD area.

We have identified hub areas across the Bay of Plenty region. At this stage, most of the identified community emergency hubs are within the wider Tauranga urban area, as well as numerous aged care facilities.

Given the robust network, as well as the strong transport links, we do not expect our ability to supply the community emergency hubs in this area to be a major concern. We are working with local Civil Defence National Emergency Management Agency (NEMA) on understanding other community areas not currently identified.



Tauranga 11kV GXP overview

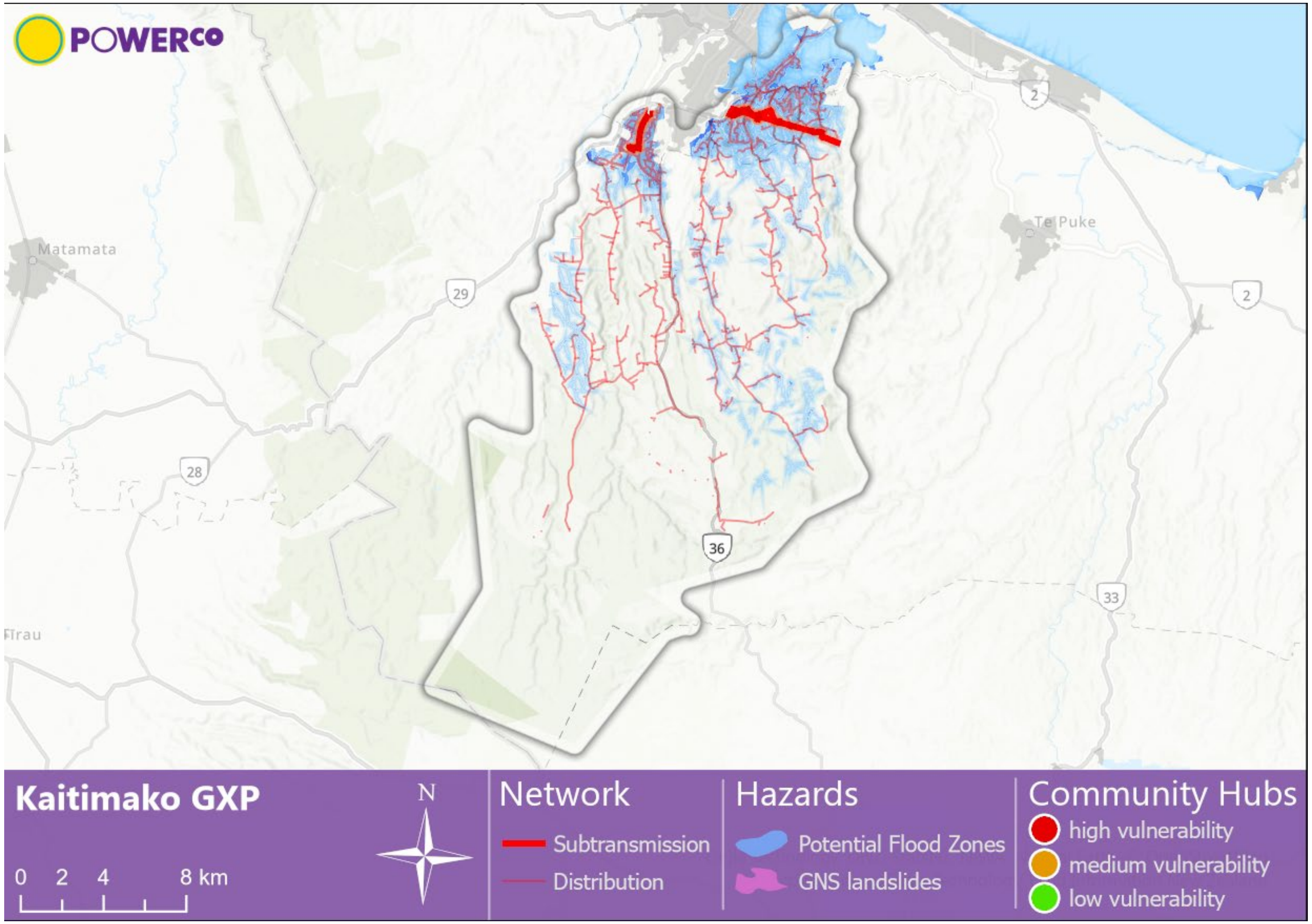
The majority of our Tauranga 11kV network supplies the urban areas along Cameron Road. The more significant feeders extend out along Kaimai Drive.

Similar to our Tauranga 33kV network, there are a mix of inland flood risks within some of the valley and river areas, which could impact some of the underground networks and river crossings in the area.

Significant services include Tauranga Hospital, Kaimai Generation and local medical centres, Chorus interchange, significant council wastewater and water supplies, and emergency services.

Tauranga Hospital, in particular, has a number of alternative supply routes given the criticality of the site.

There are two community emergency hubs that have been identified for this region. Both appear to have good electricity supply reliability.



Kaitimako GXP overview

The region supplied by Kaitimako GXP is predominantly overhead network, so is relatively robust to localised flooding, which is the predominant hazard in this area. However, the long feeders can be exposed to outages during storms.

Significant services include Tauranga City Council Oropi water treatment plant, including the Ohauiti and Waikite and Kaitimako reservoirs, as well as inlet and wastewater pumping stations throughout the city. It appears emergency services are expected to largely come from the Tauranga and Mt Maunganui urban areas.

No community emergency hubs have been identified in this region, although there are a number of aged care facilities in the region. We expect further work with local Civil Defence NEMA to identify other sites.

Mt Maunganui – Electricity

Region overview

The Mt Maunganui area covers the urban parts of Mt Maunganui, the developing area of Papamoa, and the Wairakei coastal strip. It also encompasses Te Puke and surrounding rural areas down to Pongakawa and the inland foothills. In recent years, we have constructed a dual 33kV circuit from Wairakei to Te Matai, which links the two areas.

The Mt Maunganui area shares many of the features of the neighbouring Tauranga area, including terrain, climate, and land use. The region includes a long coastal strip and some rugged inland terrain. The coastal area contains severely deteriorated network equipment, which has impacted reliability and performance. The inland area is more rugged and presents difficulties for access and maintenance.

The Mt Maunganui CBD is the economic hub, with expansion along the coast to accommodate population growth driven by the attractive lifestyle and climate. In rural areas, horticulture dominates. For example, there are many kiwifruit orchards around Te Puke that use the local cool stores and packhouses for their product. The Port of Tauranga is also a significant economic driver.

The area is supplied by the Mt Maunganui and Te Matai GXPs. The Mt Maunganui GXP supplies five zone substations – Papamoa, Matapihi, Omanu, Te Maunga and Triton. The Te Matai GXP also supplies five zone substations – Wairakei, Te Puke, Atuaroa Avenue, Paengaroa and Pongakawa. The region uses a 33kV subtransmission voltage.

Subtransmission and distribution in the Mt Maunganui area are predominantly through overhead lines, especially in rural areas. All new intensive subdivision is supplied through underground networks.

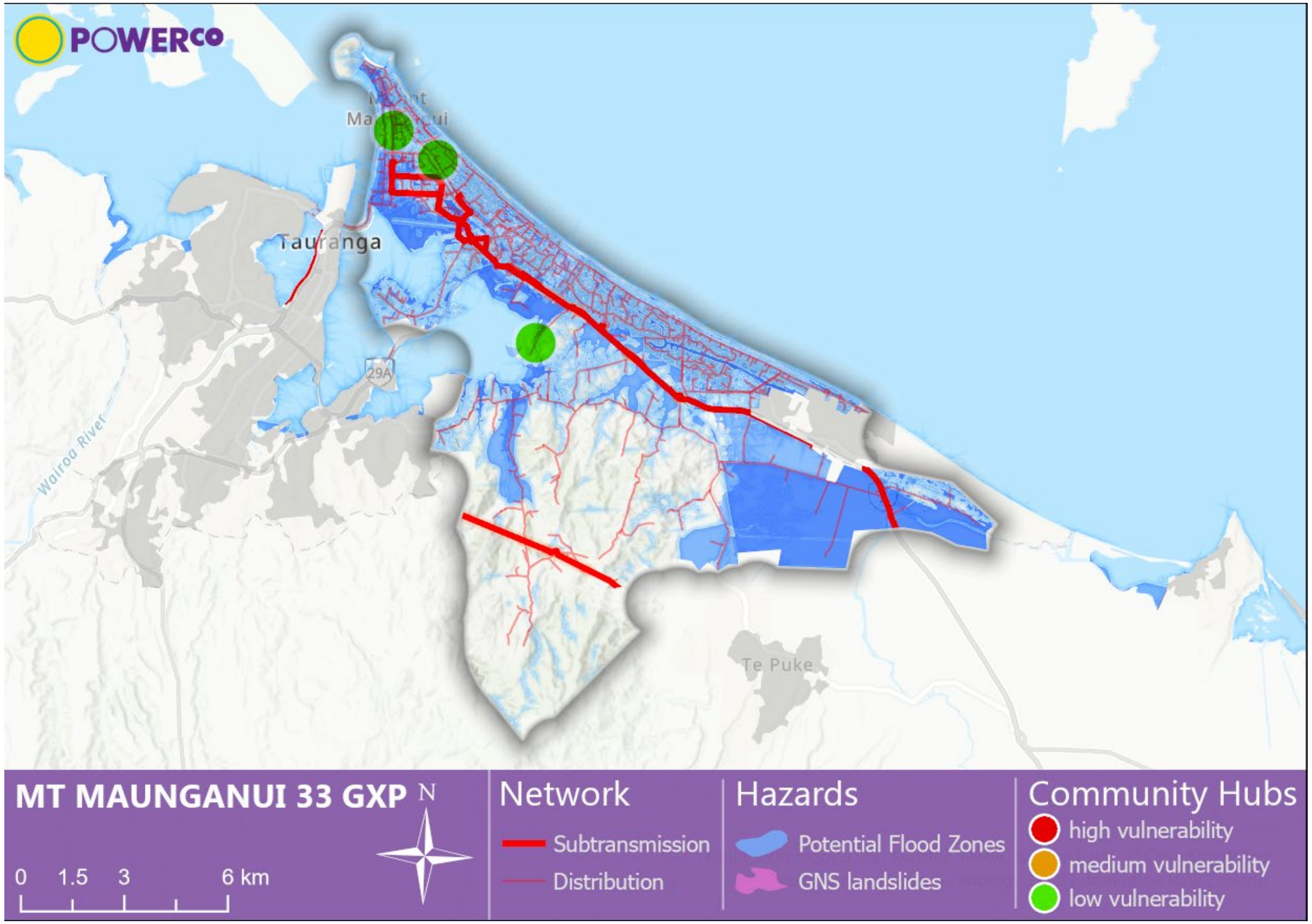
The subtransmission network from Mt Maunganui GXP is predominantly twin circuit architecture. Two dedicated circuits directly feed each of the Triton, Matapihi (adjacent to Mt Maunganui GXP), Omanu and Te Maunga substations. Twin circuits from Te Maunga continue to Papamoa substation as the tie point between the two GXPs.

The 33kV subtransmission from the Te Matai GXP has a meshed architecture. Dual circuits supply the Te Puke substation. Atuaroa is an urban substation, installed to offload Te Puke, and is normally supplied through a single 33kV circuit out of Te Matai. Its alternative supply comes from the Kaitimako to Te Matai line. Paengaroa is supplied by a single circuit from Te Matai. Paengaroa, in turn, supplies Pongakawa through a single circuit.

An old transmission grid line links Te Matai GXP and Kaitimako GXP (Tauranga area) at 33kV, with connections to Atuaroa Avenue and Welcome Bay substations. This provides limited backup to Atuaroa Avenue and Te Matai itself.

Table 2 – Mt Maunganui inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	34 (5%)	0	0



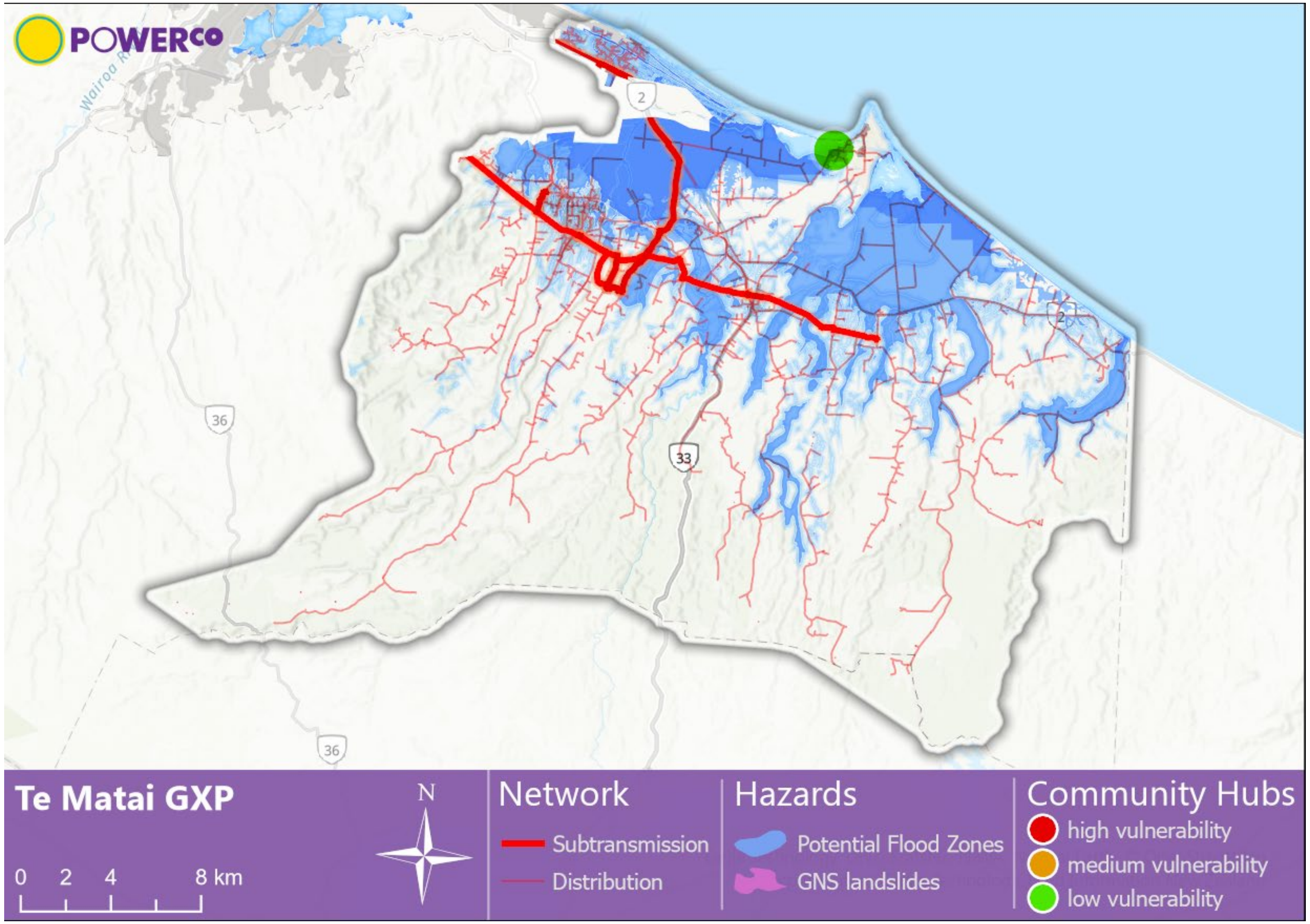
Mt Maunganui 33kV GXP overview

With many low-lying areas, the commercial and residential areas around Mt Maunganui are quite exposed to sea level rise risks. Long-term sea level rise forecast data from Tauranga City Council shows exposure all along the coastline out to Papamoa. Note that the current data available is for SSP 5-8.5.

Significant services include Tauranga Airport, Port of Tauranga, local freight, various council pumping stations, including the Te Maunga Waste Water Treatment Plant, as well as various medical centres and emergency services. For this reason, we have significant supply diversity across the urban network to allow for significant transfers of power should any substations be lost.

There is a significant spur heading towards our Pongakawa substation in the east, as well as to our Kauri Point substation in the north. There is also a major pinch point through Tauranga GXP and Greerton switching station for much of the region. We are working with Transpower on diversification of supply for the wider Western Bay of Plenty area. This is currently subject to a “bulk supply” review.

This region contains the majority of community emergency hubs identified by Civil Defence NEMA. Because of robust supplies, there should be options for resupply should there be damage to the area network.



Te Matai GXP overview

Similar to the Mt Maunganui area, the Te Matai supply area is dominated by various inland flooding risks, as well as exposure to long-term sea level rise.

Significant services include a large number of council water and wastewater pumping stations, and the Waiāri Water Supply Scheme. Emergency services for the area, including Coastguard NZ, are also potentially affected.

There is a significant spur heading towards our Pongakawa substation in the east. We are exploring potential generation connection as well as longer term allowance for an alternative 33kV supply to the area.

There was limited information available regarding community emergency hub sites in this region, including a number of aged care facilities.

Coromandel – Electricity

Region overview

The Coromandel area covers the Coromandel Peninsula and a northern section of the Hauraki Plains. The main towns in the area are Thames, Coromandel, Whitianga, Tairua, and Ngātea.

The economy is largely based on tourism, with some agriculture and forestry. The population is highly seasonal, and the annual demand profile is peaky.

The region is characterised by rugged, bush-covered terrain, with minimal sealed road access for heavy vehicles. This makes access to lines for construction, maintenance, and faults difficult and costly. Sensitive landscape and heritage areas also restrict options for upgrading and building new lines.

Seasonal weather extremes and cyclones can impact the quality of supply. The demand for electricity peaks in the summer when the thermal ratings of overhead lines are limited by the higher ambient temperatures.

The subtransmission circuits in the Coromandel area are supplied from the Kopu GXP, just south of Thames. The area uses a 66kV subtransmission voltage, which is unique across our networks.

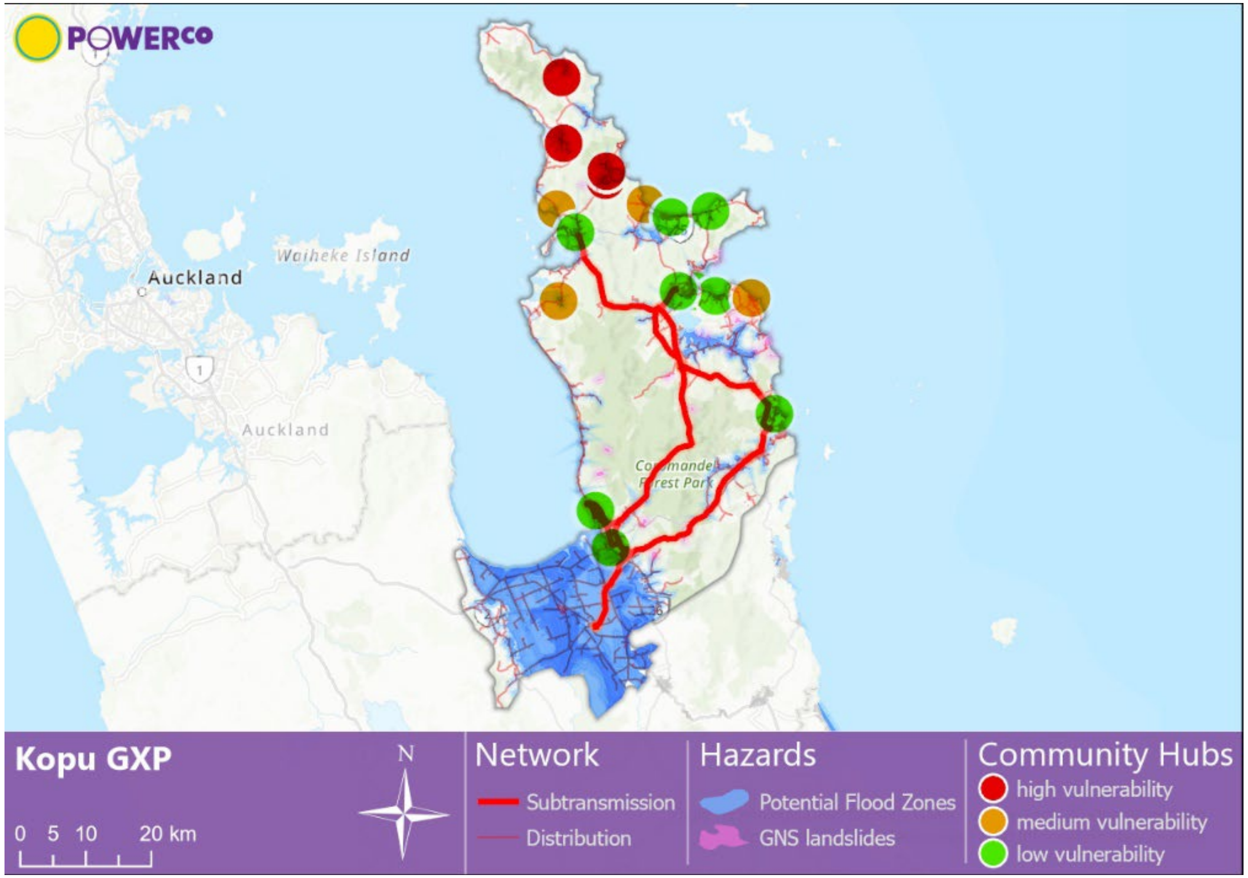
The subtransmission is dominated by a large overhead ring circuit, serving Tairua and Whitianga, with a teed radial line feeding Coromandel. A further interconnected ring serves the Thames substation. These ring circuits have been operating in a closed loop after protection upgrades were made.

Matatoki substation is directly adjacent to the Kopu GXP. Kerepehi substation is fed from a single radial circuit.

Our subtransmission and distribution networks in the Coromandel area are predominantly overhead, reflecting the area's rural nature and rugged terrain. Some of the original transmission circuits are very old, but we have been working through a programme of upgrading and renewing the circuits during the past decade.

Table 3 – Coromandel inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	83 (10%)	(3)	(1)



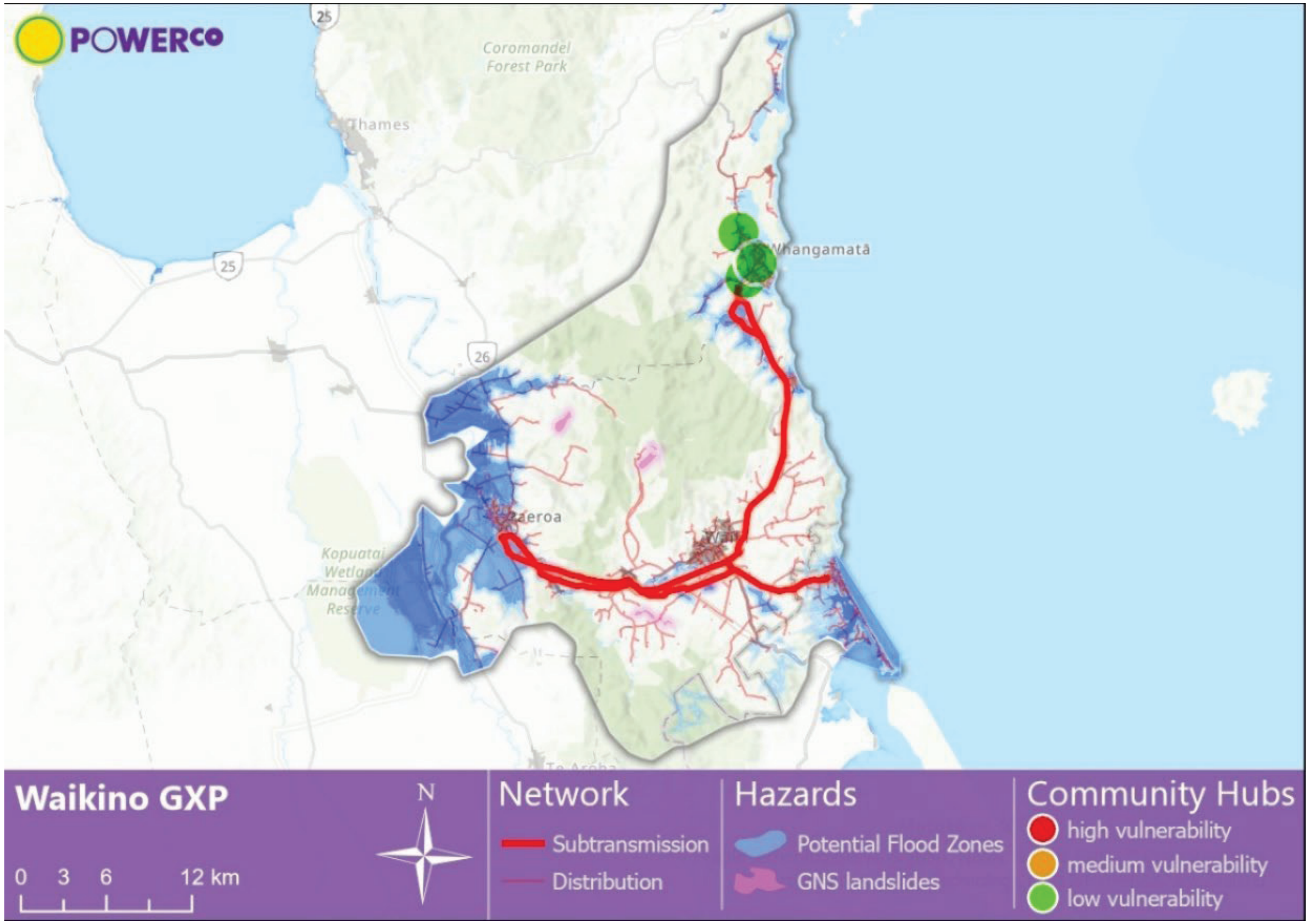
Kopu GXP overview

The Thames-Coromandel region is supplied by a single Kopu 66kV GXP. This area can be characterised by:

The Coromandel peninsula network stretches a significant distance through geological and vegetation hazards, with significant accessibility challenges to remote communities. Much of the inner Coromandel area is heavily forested with steep terrain that is prone to slips, requiring helicopter access. Our Kopu-Tairua line partially follows SH25a, which suffered a significant slip in 2023. There is also extensive coastline, significant portions of which are already affected by sea level rise and coastal erosion processes. Thames-Coromandel District Council (TCDC) has developed adaptation plans, which we are working through to understand network adaptations.

The Hauraki plains are a significant area stretching south from the Firth of Thames, in a flood plain between the Waihou and Piako rivers. Since 1908, swamp land has been drained, and through pumping, canals, and flood gates, has been turned in to productive farmland. We note Waikato Regional Council and Hauraki District Council are working through adaptation review for this area. We operate four area substations and five industrial substations in this area. Significant services in the area include Thames Hospital, the Pauanui and Kerepehi water treatment plants, wastewater treatment plants and council pumping stations, and emergency services throughout the region.

Our analysis shows increased risk in the remote coastal areas to the north of the Coromandel peninsula, given the long spur networks and the high-risk coastal and hill roads to access these locations. We are working with community groups on potential options to improve energy resilience.



Waikino GXP overview

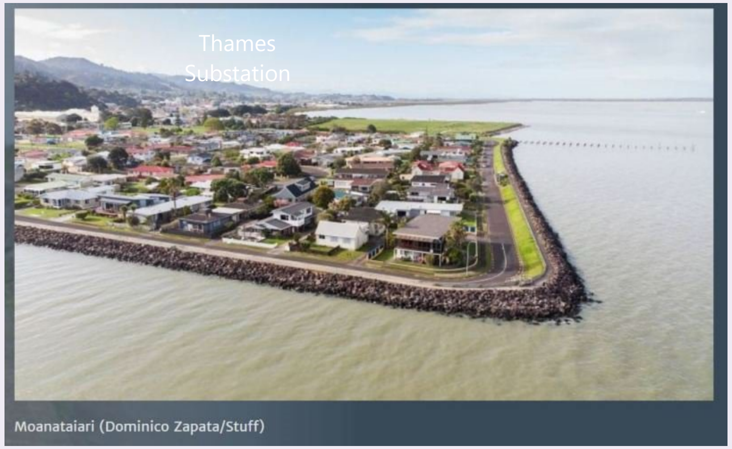
The Waikino supply area is spread between the lower Hauraki flood plains to the east of Paeroa, the coastal area around Whangamatā, and down to the top of the Bay of Plenty. It has similar risks to the Coromandel peninsula further north – sea level rise, flooding and slips.

Significant services include Hauraki District Council, Thames-Coromandel and Western Bay of Plenty water and sewage treatment plants and pumping stations, and emergency services and medical centres.

Most of the community emergency hubs are focused around the Whangamatā area. We have relatively stable local network supply support through our Whangamatā battery energy storage system (BESS).

Figure 29 – Waikato Regional Council has invested in significant flood protections for areas such as Paeroa. These measures protected the community during Cyclone Gabrielle, 2023.

Coordinating with local government on coastal adaptation



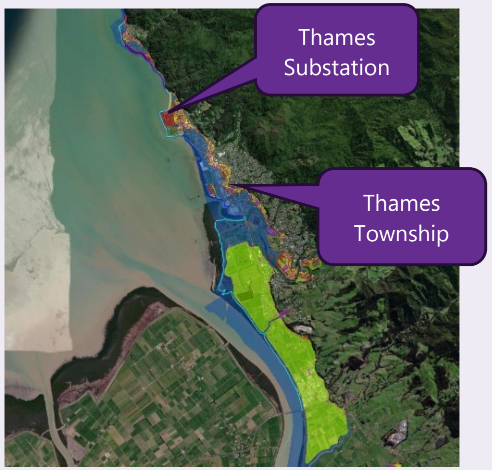


Figure 30 – We work with local councils to understand how the regional adaptation plans may influence the long-term location of our network supplies. For example, Thames substation, located in Moanataiari, has been identified as at risk of inundation because of sea level rise towards the end of the century (coloured areas). Discussions have started with the community on potential long-term managed retreat. While the Thames substation has mitigation against floods by having a raised floor, aligned with Thames-Coromandel District Council we may need to relocate the substation to within the area that is intended to be reinforced with sea walls.

Improving resilience through investment in backup supply

Figure 31 – Left, for areas that have increased vulnerability to network outages, in some instances our Whangamatā BESS can be used for local energy support. The BESS has been operating since 2020 and can supply power to 1,400 customers in the event of network failure. This allows the township to operate islanded for short durations.
Figure 32 - Right, in the Coromandel, we are also installing backup generation that has the ability to support 3,000 homes and businesses during network outages.

Waikato – Electricity

Region overview

The Waikato area extends from the Hauraki Plains north of Morrinsville and Tahuna, through the rural land of eastern Waikato, and to rural areas south of Putāruru.

The Kaimai Range runs the length of its eastern boundary. The supply area covers parts of the Matamata-Piako and south Waikato districts.

The terrain is flat to rolling pasture land, sprinkled with towns and settlements.

The environment is generally favourable to network construction, maintenance and operations. However, peat lowland areas can provide challenges for structural foundations and the thermal rating of cables.

The climate is typical of the Waikato region, with mild winters and warm humid summers. Because of its inland location, the region is relatively sheltered from extreme weather and coastal influence.

The key element of the region's economy is primary production, with most of the region being high-production dairy country. In addition, several important industrial and food processing facilities are located within the area. These have been instrumental in driving recent demand and network developments.

The significant population centres are Morrinsville, Te Aroha, Matamata and Putāruru. Population growth is modest to static, although associated economic activity brings modest demand growth. The industrial park at Waharoa has had considerable growth in primary and supporting industries. Tīrau is subject to tourism activity, and the dairy plant is the largest single load.

The area is supplied by the Waihou, Piako, Hinuera and Arapuni GXPs.

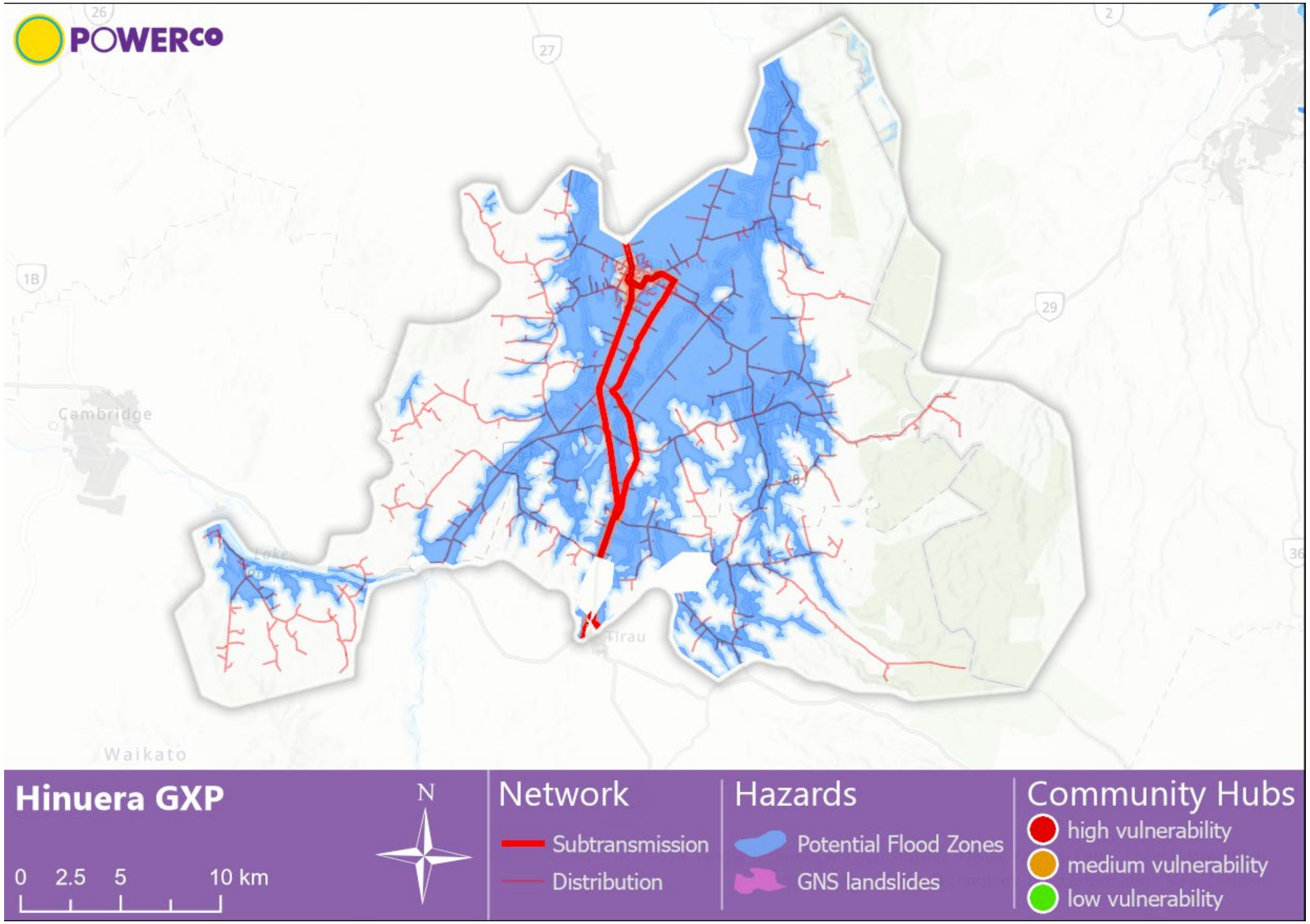
- Waihou GXP supplies six zone substations – Mikkelsen Road, Tahuna, Waitoa, Inghams, Farmer Road and Walton.
- Piako GXP supplies four zone substations – Piako, Morrinsville, Tatua and Waharoa.
- Hinuera GXP supplies three zone substations – Lake Road, Browne Street and Tower Road.
- The new Arapuni GXP supplies two zone substations – Putāruru and Tīrau.

Almost all subtransmission in the region is at 33kV, with a single 110kV subtransmission circuit supplying Putāruru zone substation from the Arapuni GXP.

The Waikato subtransmission network is best described as interconnected radial, with a mix of overhead lines and underground cables. With the completion of recent network reinforcement projects, some of the Waikato zone substations have been upgraded to have two dedicated circuits. The remaining substations rely on switched 33kV backfeeds from different GXPs, so it is not possible to have parallel operation of supply lines.

Table 4 – Waikato inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	124 (10%)	(8)	0

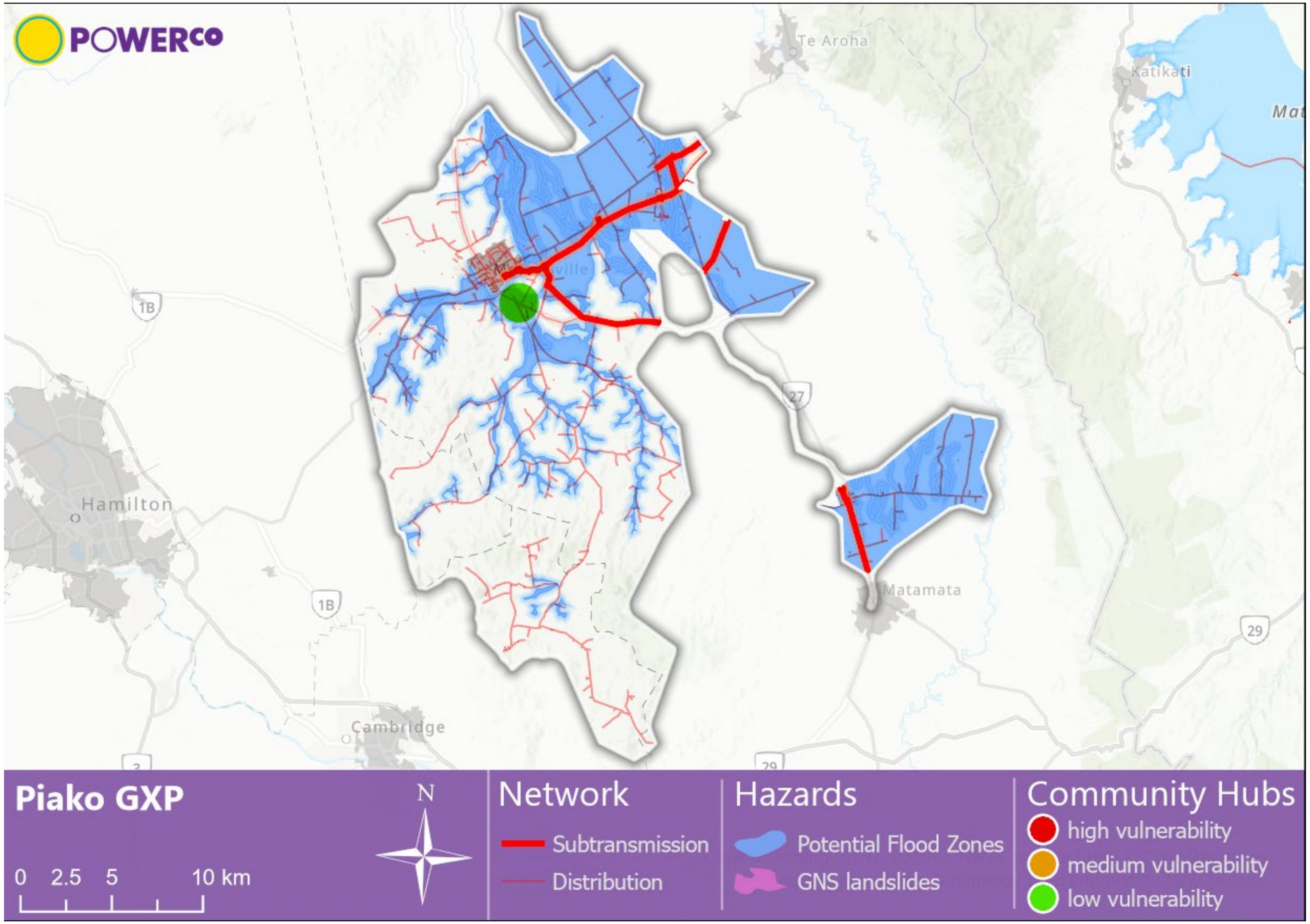


Hinuera GXP overview

The predominant hazard in the Hinuera supply area is flood-prone soil, which can result in low-level flooding in the rural areas around Matamata township during heavy rain. The rural network is largely overhead, so is not vulnerable to flooding damage, although there may be disruption to transport links when flooding occurs.

Significant services include the Te Poi and Tawari Street water treatment plants, Matamata Wastewater Treatment Plant, Pohlen Hospital, and emergency services supporting Matamata and the surrounding area.

There were no community emergency hubs identified for this area.

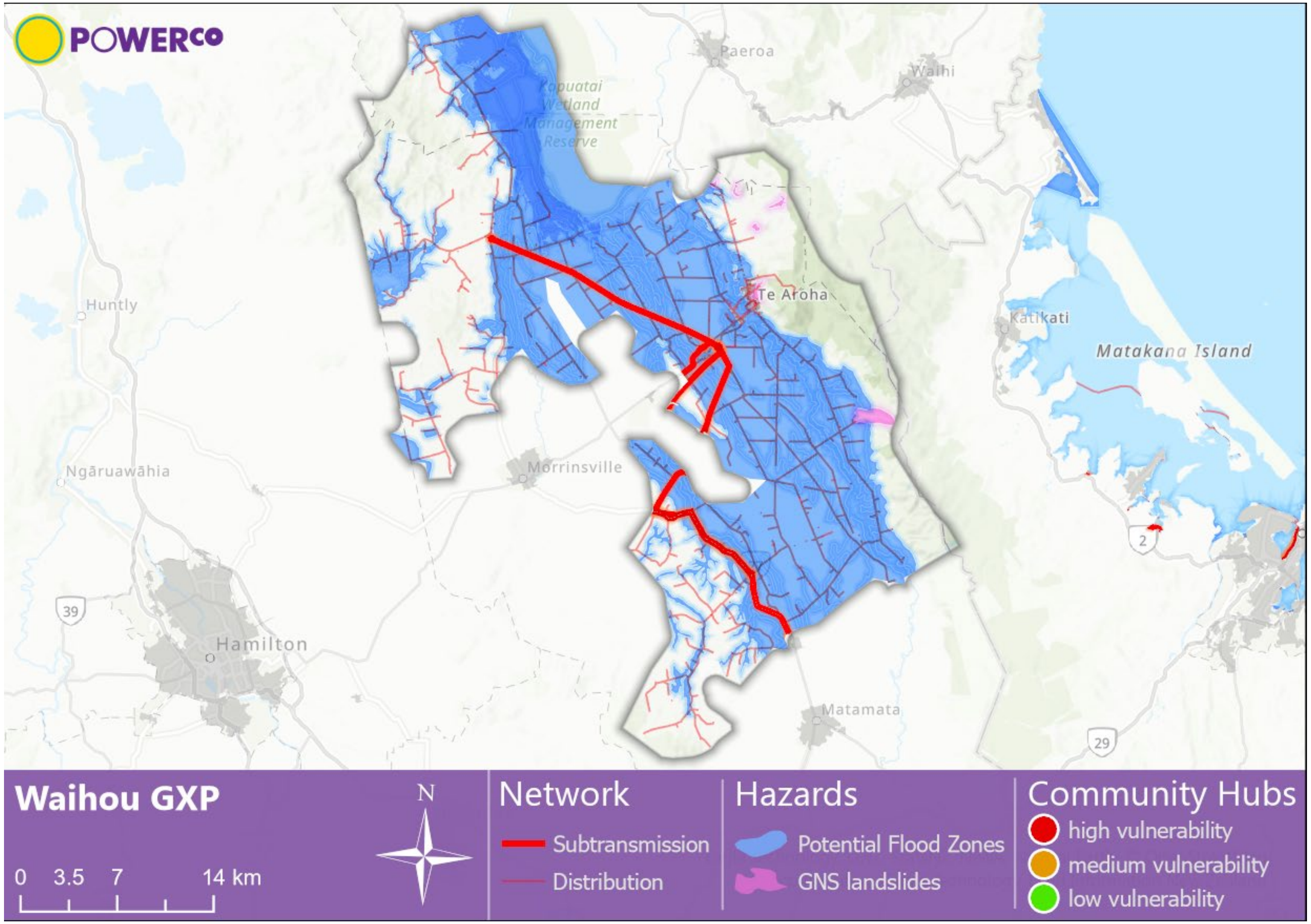


Piako GXP overview

Similar to Hinuera, the flat areas of the Piako supply area surrounding Morrinsville township can be prone to flooding. The council has been making improvements to the stormwater system within the township after historical flooding events. The network in this area is predominantly overhead, so there are fewer issues from flooding, and it has a significant amount of interconnection with the Waihou supply area.

Significant services include local council pumping stations, which according to Waikato Regional Council generally have backup generation, Morrinsville water and wastewater treatment plants, and local emergency services.

The identified community emergency hubs aren't expected to have supply vulnerability, although there are a number of aged care facilities.

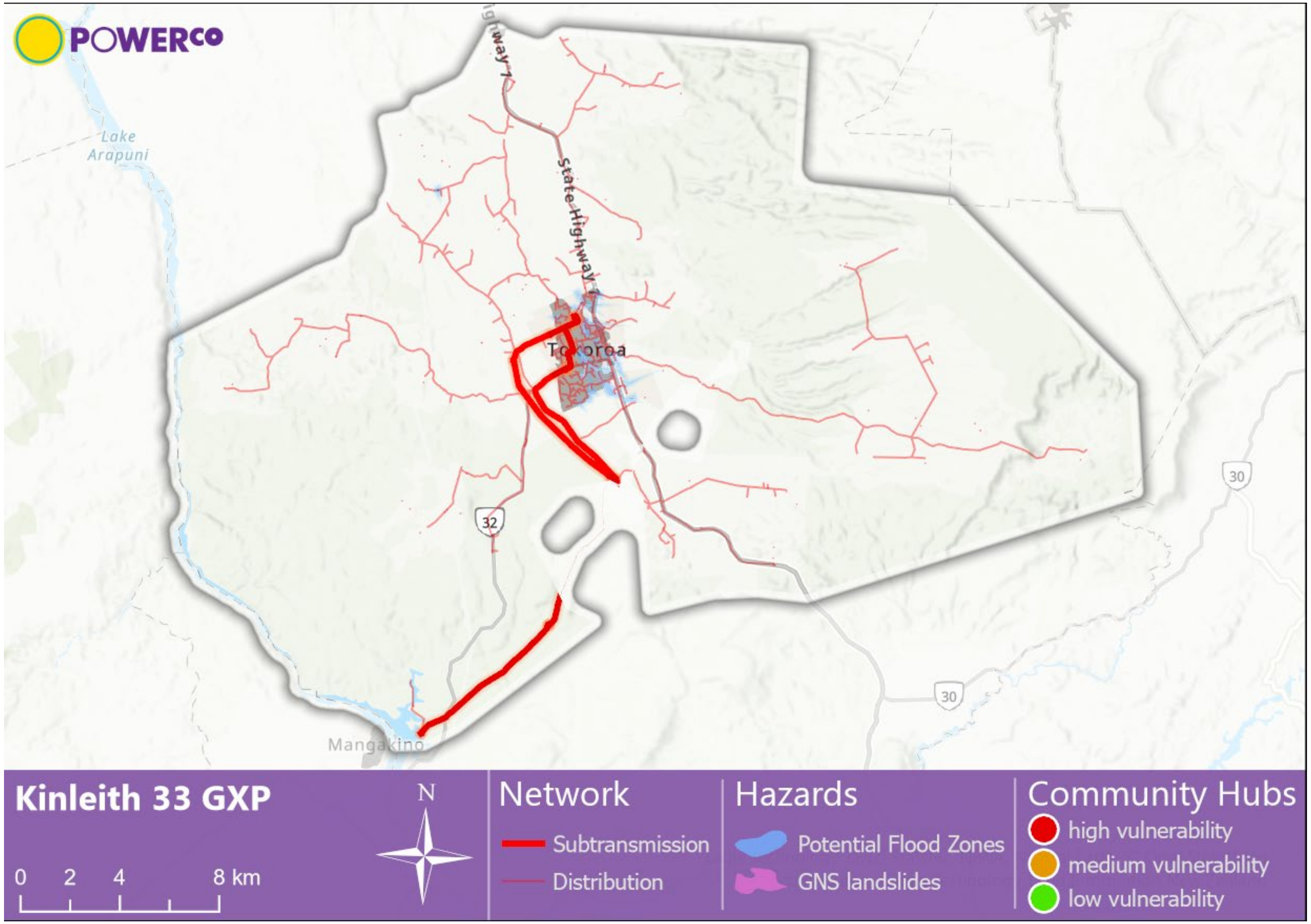


Waihou GXP overview

The Waihou supply area is dominated by low lying land from the Firth of Thames inland. There are large areas of flood-prone soil. The Waikato Regional Council manages flood protection schemes via stopbanks and pumping stations around the Waihou River through to Te Aroha.

Significant services in the area are the Waihou and Te Aroha wastewater treatment plants, water treatment plants, Te Aroha Community Hospital, and emergency services supporting Tahuna and Te Aroha.

We do not have any information about community emergency hubs in the area.

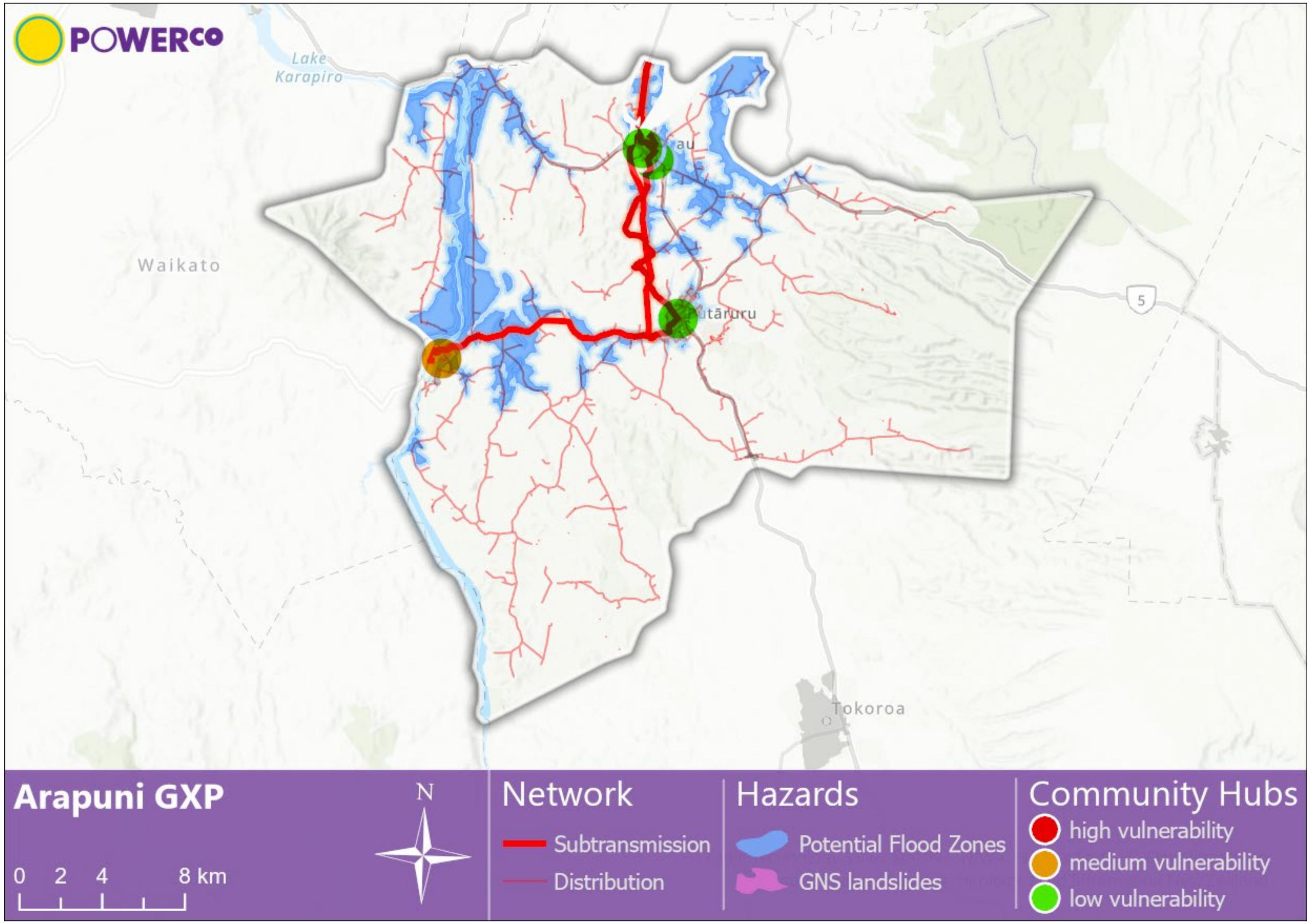


Kinleith 33kV GXP overview

The Kinleith area predominantly supplies the Oji Fibre Solutions Kinleith pulp and paper mill, the nearby township of Tokoroa, and the surrounding area. This region does not appear on the hazard layers we have looked at, although it has experienced historical flooding. The township is supplied by two zone substations with 33kV interconnection.

Significant services include Tokoroa Hospital, water and wastewater plants, pumping stations for the township, and emergency services for Tokoroa and surrounds.

There were no community hub sites identified, and we will work with local communities to identify if there is support we can provide.



Arapuni GXP overview

The Arapuni supply area covers Tīrau down to Putāruru. A significant area is at risk of flood from the Waihou River. We have recently constructed a new grid connection – the Arapuni-Putāruru 110kV line – that will help provide capacity and alternative supply to the region.

Significant services in the area include the Waihou and Te Aroha wastewater treatment plants, water treatment plants, Te Aroha Community Hospital, and emergency services supporting Putāruru and Tīrau.

Community emergency hubs within the Tīrau and Putāruru urban areas have stable support, while those in the more remote areas along the Waihou River are more exposed.

Whanganui – Electricity

Region overview

The Whanganui area covers the city of Whanganui and its surrounding settlements, which form the Whanganui district.

Whanganui city lies on the north-western bank of the Te Awa o Whanganui – the Whanganui River.

Waverley, a small South Taranaki town, is also part of the Whanganui area.

Much of the land outside the city is rugged, hilly terrain surrounding the river valley. A large proportion of this is within the Whanganui National Park. This means that access to these areas, especially following major weather incidents, is difficult, and can result in lengthy outages for remote customers.

The Whanganui district has a temperate climate, with sunshine hours slightly higher than the national average at 2,100 hours per annum. The area receives about 900mm of annual rainfall, and the Whanganui River is prone to flooding in heavy rain.

The Whanganui area can also be hit by occasional storms off the Tasman Sea. High winds cause the most disruption, as they can fell trees and throw debris onto lines, which leads to widespread and prolonged outages.

The district's economy is driven by agriculture, forestry, and fishing. Whanganui City is the main service centre for the rural district and is a self-sustaining commercial entity.

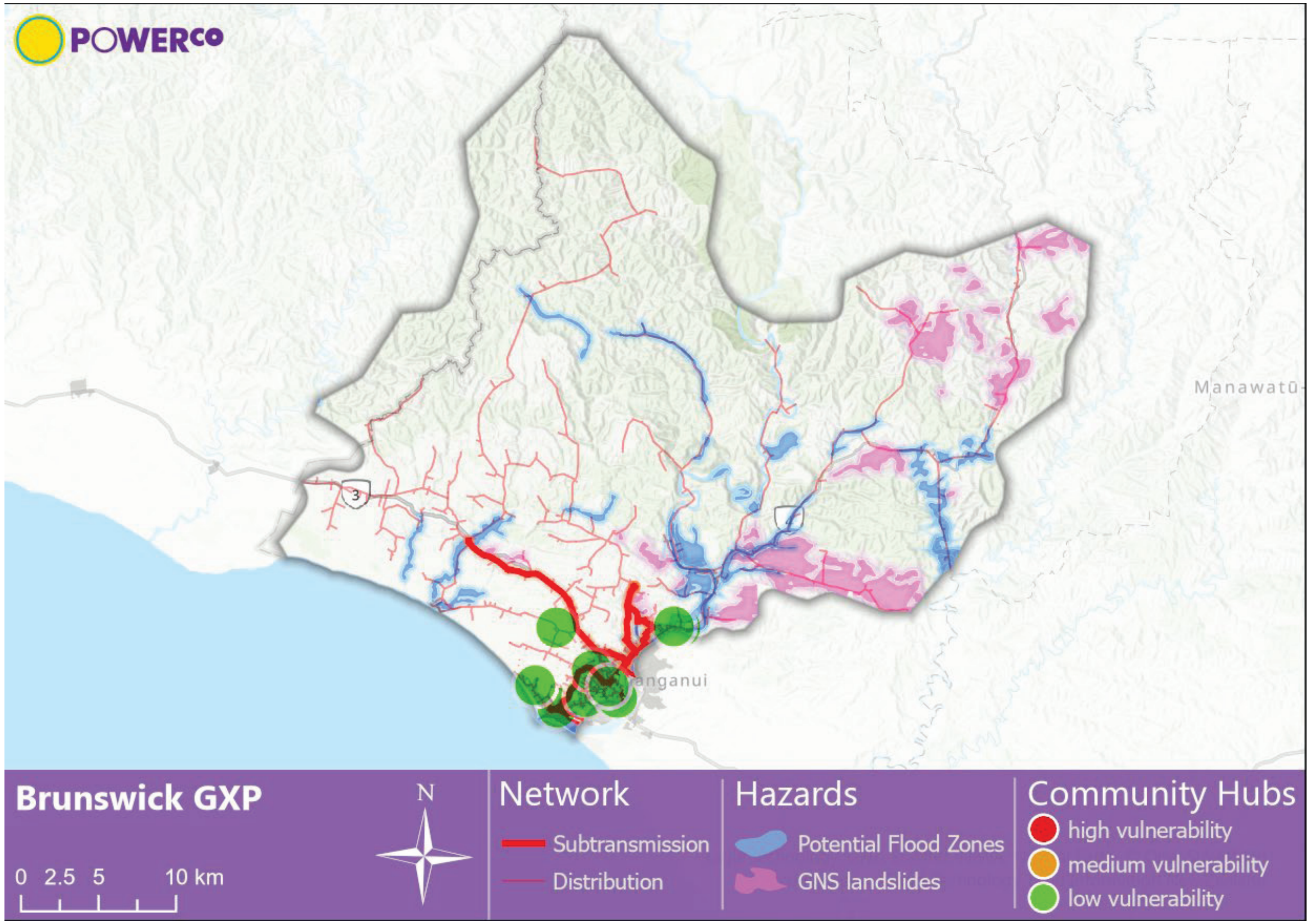
There are several industrial and commercial customers of significance within Whanganui city. However, none are of sufficient size to warrant a dedicated substation.

The area connects to the grid through three Transpower GXPs – Wanganui and Brunswick GXPs supply Whanganui city and its surrounding areas, Waverley GXP supplies the town of Waverley.
There are nine zone substations in the Whanganui area, five of which – Blink Bonnie, Taupō Quay, Beach Road, Hatricks Wharf and Wanganui East – are supplied from the Wanganui GXP. Peat Street, Roberts Avenue, Kai Iwi, and Castlecliff are supplied from the Brunswick GXP. Waverley GXP directly supplies the Waverley township and surrounding areas via 11kV distribution feeders.
Whanganui has a unique, somewhat meshed, subtransmission architecture. Most substations in the city are supplied from single radial lines, often more than two substations per 33kV feeder, but with some alternative switched 33kV capacity.
Because of this architecture, it is problematic to provide the breakless or quick switching required to comply with our security criteria. However, from a purely risk-of-supply perspective, the architecture is quite robust and cost-effective.
The subtransmission and distribution networks are mainly overhead, even in urban areas.

A planned renewal project will refurbish conductors and the river crossing towers between Wanganui GXP and Taupō Quay substations in the near term.

Table 5 – Whanganui inland and coastal flooding – exposed assets.

	Ground-mounted transformers	Zone substations	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	169 (35%)	1 (2)	0



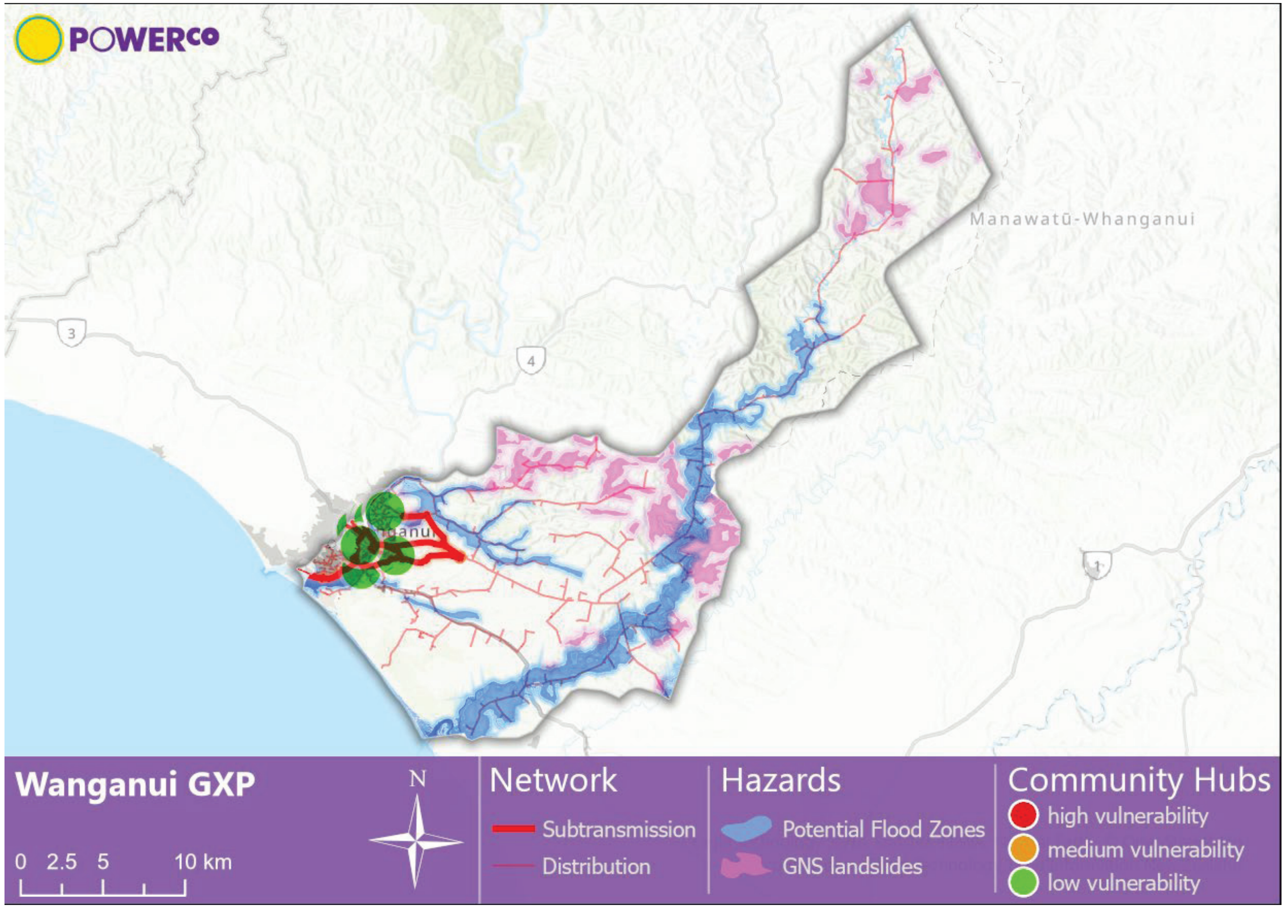
Brunswick GXP overview

Similar to Wanganui GXP, the Brunswick GXP supply area is quite robust within the city areas, with significant network interconnection. Most substations are able to be supplied from either GXP with significant interconnection through both the overhead and underground networks. We have a notable spur supplying Kai Iwi that has had some disruption in the past. In 2022, we set up this site for connection to our mobile substation if the site needs to be bypassed. Much of the rural areas to the north-east are quite exposed to slips.

Significant services include a notable number of Whanganui District Council wastewater pumping stations, Kai Iwi water supply, Koatanui repeater station, and emergency services, including Coastguard NZ.

The city area is serviced by a large number of community emergency hubs with good supply reliability. We do not have information on any sites that may support the areas further inland, which are at greater risk of having road access cut.

Figure 34 – Supply to Whanganui from Brunswick GXP travels through an area of active slips. We are reviewing this line for potential land movement.



Wanganui GXP overview

Whanganui city is supplied from both sides of the Whanganui River – Brunswick GXP from the north and Wanganui GXP from the east. The primary hazard for the area is flooding from Whanganui River, with Anzac Parade flooding as recently as 2015. Land is prone to slips along Brunswick Road, and there is coastal inundation risk in some of the suburbs closer to the west (Castlecliff).

Significant services include a notable number of wastewater pumping stations, a water treatment plant, Whanganui Base and Belverdale hospitals, and emergency services supporting Whanganui city.

The city area is serviced by a large number of community emergency hubs with good supply reliability. We do not have information on any sites that may support the areas further inland, which are at greater risk of having road access cut.

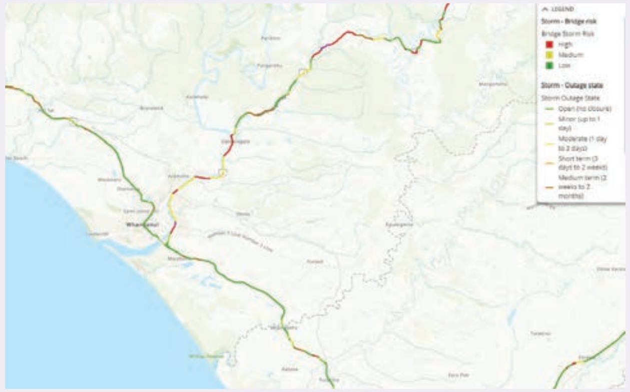
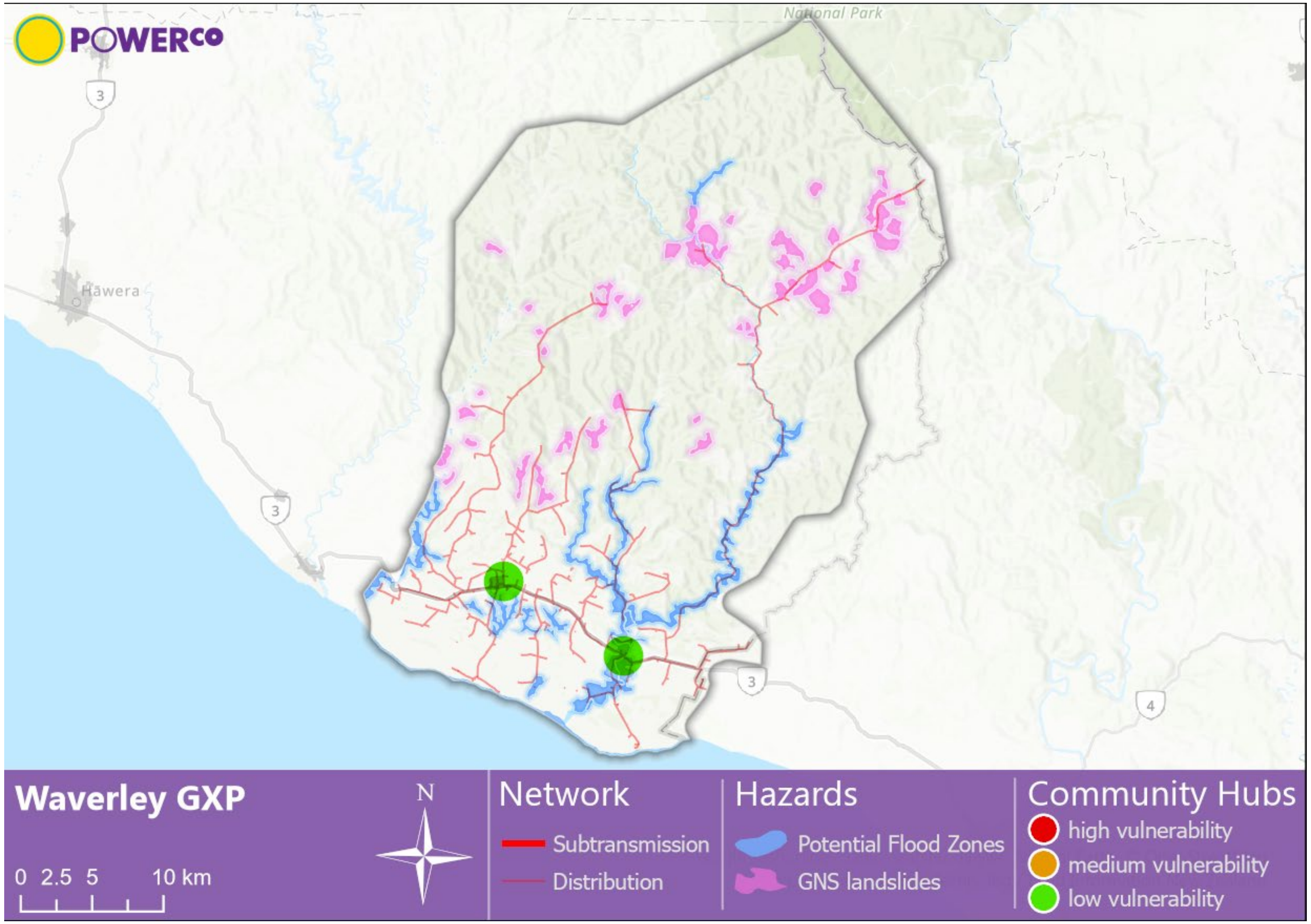


Figure 35 – NZTA mapping showing risks of significant outages to SH4, heading inland from Whanganui.



Waverley GXP overview

The Waverley supply area largely comprises the network between Whenuakura and Waitōtara rivers, supplying Waverley, Waitōtara and the rural areas that stretch inland.

Given the rugged terrain, the main hazards are the continual erosion of the coastline (communities are set back 100m from the coast because of this), flood-prone areas around the river systems, and ongoing land movement further inland.

Significant services include water supply and wastewater for Wai-inu Beach and Waverley, and emergency services supporting the townships and surrounds.

The only identified community emergency hubs are located within the township areas, with good access and electricity network supply. We will work with community groups to understand vulnerability for areas further inland.

Substation upgrades to improve resilience to the Whanganui supply

Figure 36 – During the 2015 Whanganui flood, large parts of the city were inundated when the Whanganui stopbanks were breached. On the eastern river bank, Anzac Parade was flooded, top left, and is subject to a climate adaptation review by Horizons Regional Council. During the same event, Peat Street substation also flooded, bottom left, because of stormwater not being able to discharge to the river.

We have been working to improve drainage in the area, and carried out major upgrade work, right, to secure supply to the eastern side of Whanganui city. The new switchroom has a raised floor (1.2m) to accommodate future flooding risk. Further work may be needed to reinforce the existing 11kV switchroom, which is still vulnerable to flooding via overland flood paths.

Rangitīkei – Electricity

Region overview

The Rangitīkei area covers towns in the district, including Bulls and Marton, and follows the state highway up to Hunterville and Mangaweka. It also includes the towns of Waiouru, Taihape and Raetihi, and the surrounding rural areas.

The terrain is varied, with rolling countryside in Rangitīkei, and more rugged, mountainous terrain in the Ruapehu district, where the Central Plateau and mountains of the Tongariro National Park dominate.

The climate ranges from temperate in the Rangitīkei area to sub-alpine in the Ruapehu district. Snow can settle in places more than 400m above sea level, such as Raetihi, Waiouru and Taihape. Extreme weather occurs frequently and has a widespread impact on the network, making it difficult to access faults.

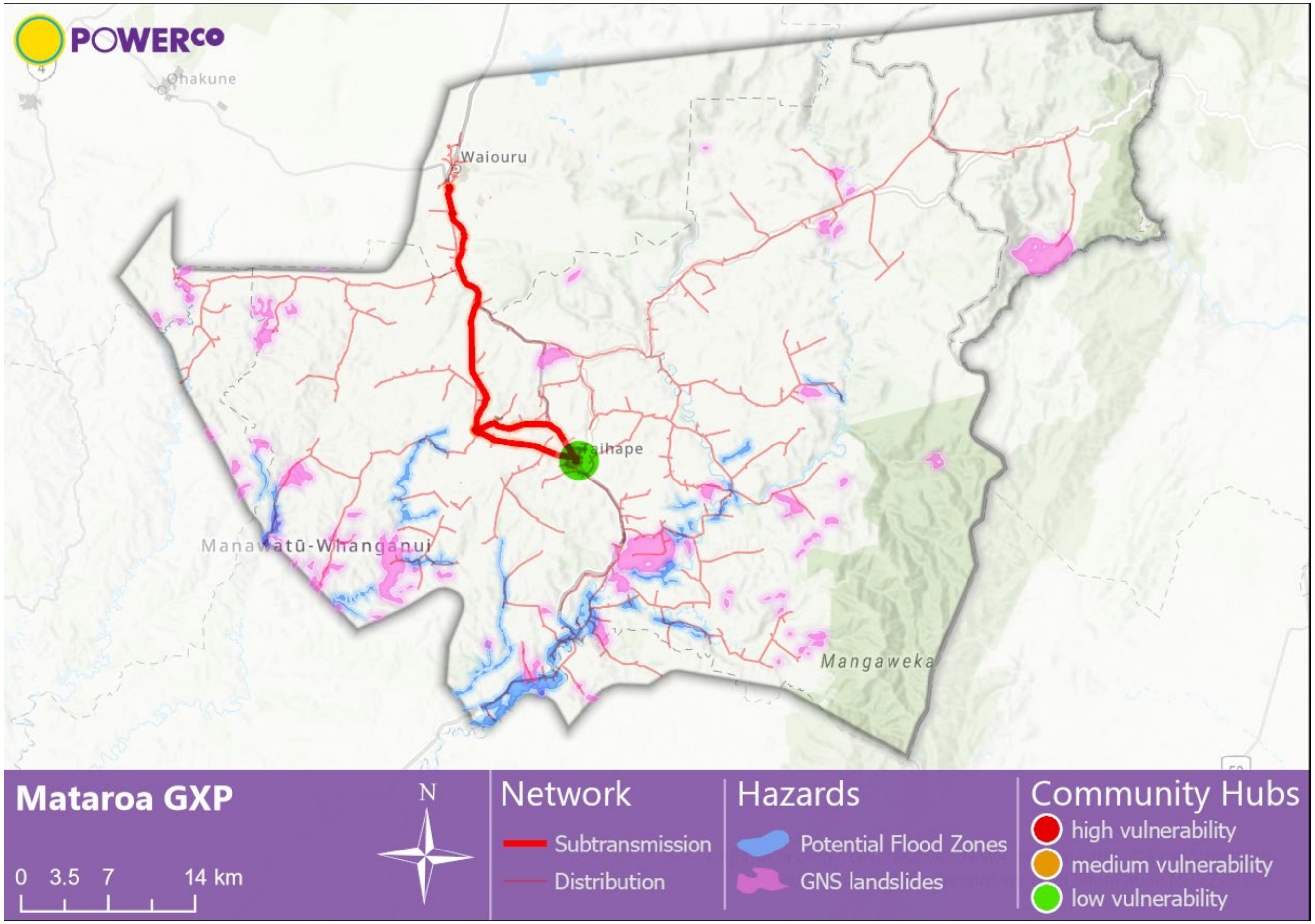
Primary production and downstream processing are the most prominent industries in the Rangitīkei economy. In the Ruapehu district, tourism and primary production drive the economy. Ohakune, with its proximity to the world heritage area of the Tongariro National Park, attracts many visitors for outdoor activities, such as skiing.

Taihape, Marton and Bulls are the significant urban centres. Waiouru is dominated by a large armed forces camp. The Rangitīkei area is connected to the grid through Marton, Mataroa and Ohakune GXPs. Mataroa and Ohakune GXPs have a single offtake transformer. From Mataroa GXP, two 33kV lines supply Taihape substation, while a single 33kV overhead line serves Waiouru. Ohakune is a shared GXP and supplies directly at 11kV.

Marton GXP supplies Pukepapa, Arahina, Rātā and Bulls substations through radial 33kV overhead lines. The Pukepapa substation is directly beside Marton GXP. The Arahina substation supplies the Marton township, and Rātā is sub-fed from Arahina through a single 33kV line and services the upper Rangitīkei area around Hunterville. There is little or no interconnection at 33kV. The subtransmission and distribution circuits are almost exclusively overhead, with long lines and sparse connections reflecting the highly rural nature of the area. Between Pukepapa and Rātā, there is a 22kV distribution tie that serves as a backup for Rātā. Isolating and restoring the network after a fault can be challenging and often time-consuming.

Table 6 – Rangitīkei inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	44 (18%)	0	0



Mataroa GXP overview

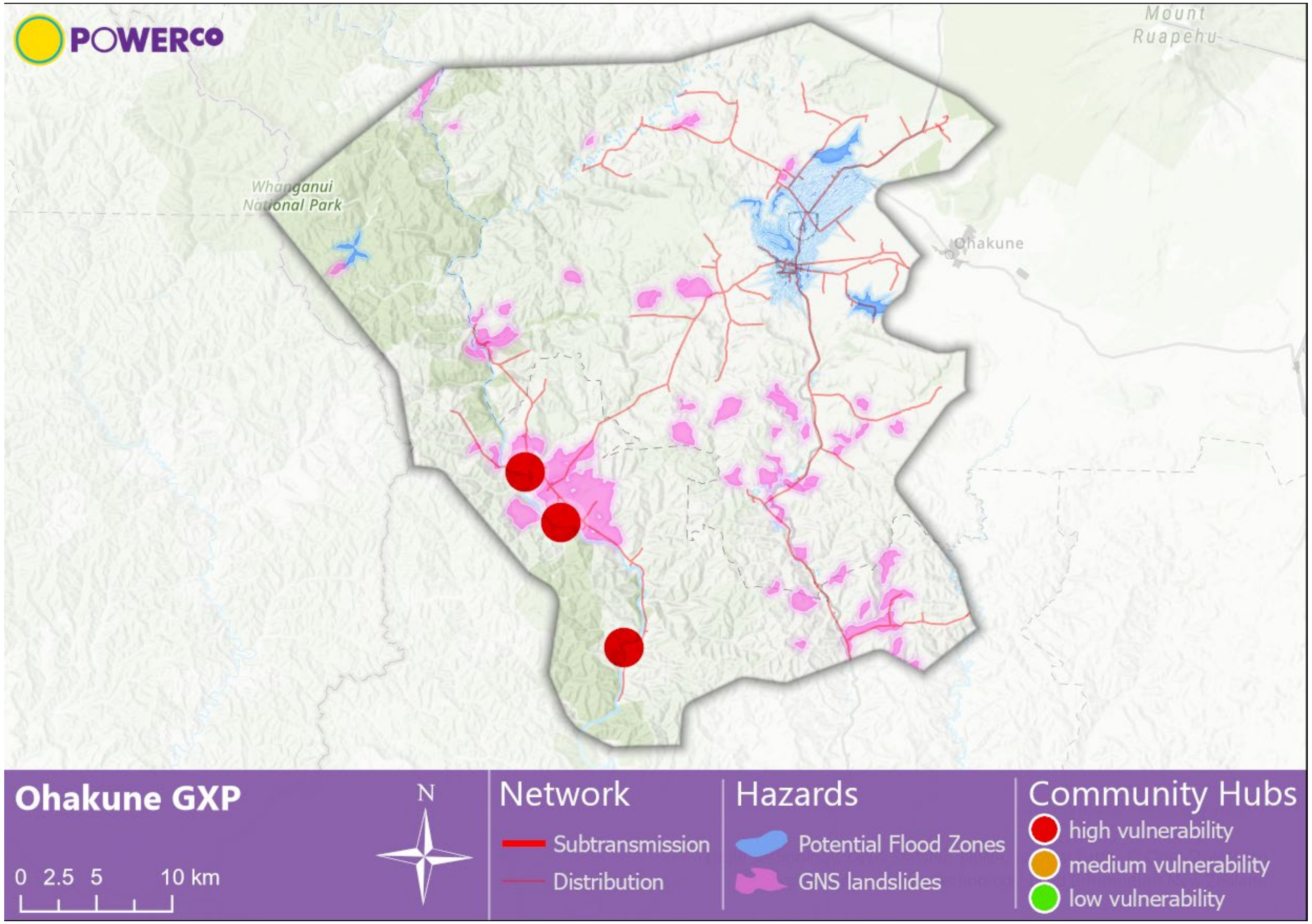
Mataroa supplies a largely rural area, with many rural properties and long network length. Significant areas are Taihape township in the south, and Waiouru (military base) in the north, at the end of a long spur. Our supply to Waiouru includes several river crossings.

Snowstorms have traditionally caused significant network damage, most recently in 2015 when there were significant outages. We have been carrying out work to convert this region to fluorine conductor to lessen snow loadings. We have also been replacing key poles to reduce the risk of cascade failure.

Significant areas of network from Waiouru and Taihape pass through active slips, putting our supply at risk. We are reviewing options for line realignment.

Significant services include water and wastewater treatment plants supporting Mangaweka, Taihape, and NZDF Waiouru, the Taihape communications repeater at Papakai Road, and emergency services supporting the townships and surrounding areas.

The community emergency hub areas appear to have good supply. However, there is no transmission redundancy, which could lead to extended outages should there be upstream supply issues from Transpower.

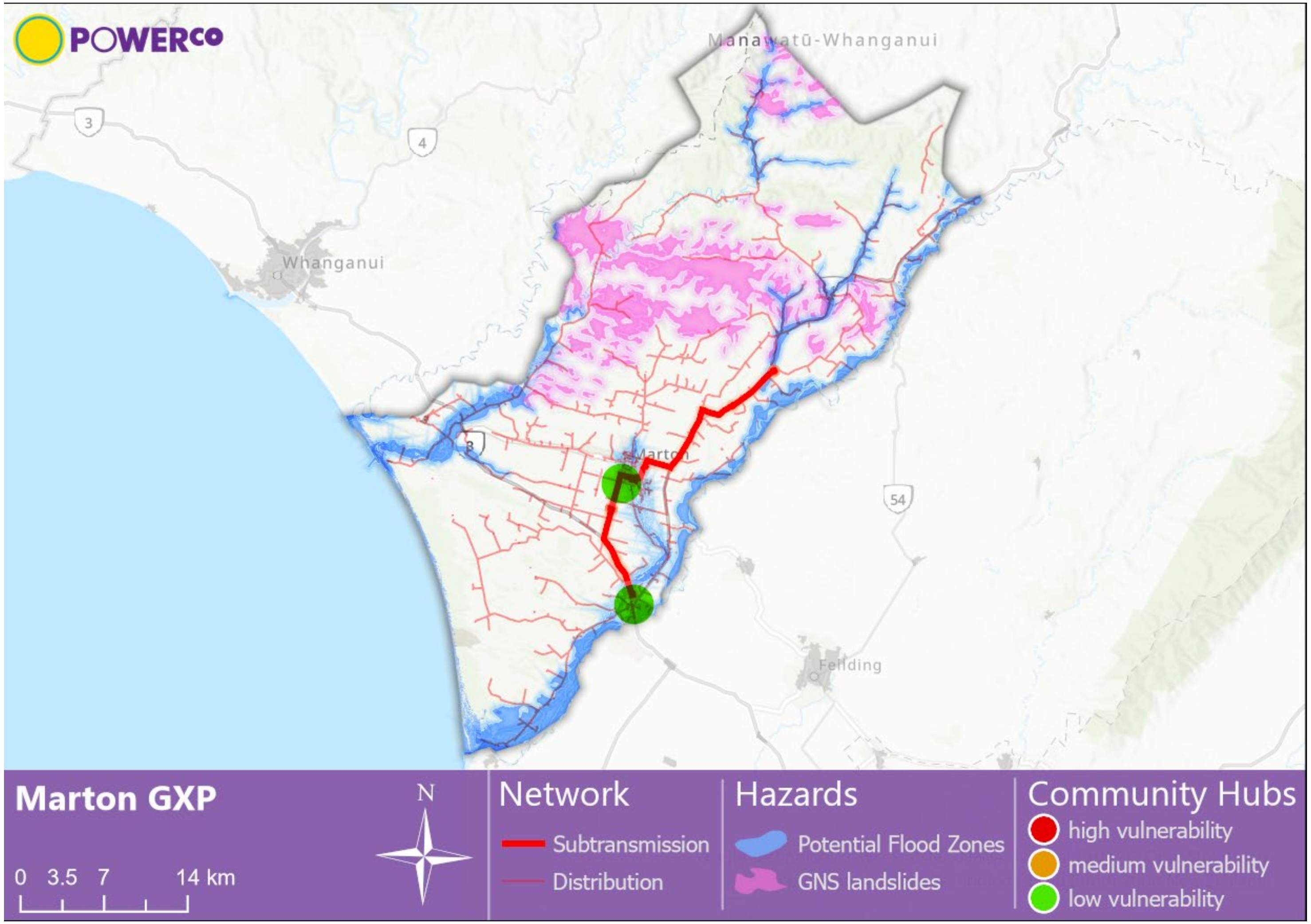


Ohakune GXP overview

The Ohakune supply area covers the rural areas around Ohakune township (serviced by The Lines Company). The area has similar challenges to Taihape, given the snow and ice storms that can affect the Central Plateau. The other key hazard is the large amount of slip-prone land through which much of the network traverses.

Significant services to the area include the Raetihi Water Treatment Plant, wastewater pumping stations, and area emergency services that are primarily based around Raetihi.

There are multiple community emergency hub sites closer to the Whanganui National Park that are particularly at risk of extended outages. We will work with these groups to see what opportunities there may be for improving resilience.



Marton GXP overview

The Marton supply area covers Marton, Bulls, Turakina and Rātana townships, and the surrounding areas broadly between the Whangaehu and Rangitīkei rivers, and inland from the coast. The predominant hazards are the river systems and the large amount of slip-prone land to the north of Marton.

Bulls substation used to be supplied on a large subtransmission spur, but we have interconnected this to the Bunnythorpe GXP network as an alternative supply.

Significant services in the area include the Rātana, Bulls and Marton water and wastewater treatment plants, and emergency services supporting the region and surrounds.

The region's community emergency hubs are well supported via network supply. There may be additional sites for those outside the urban areas and we are looking to better understand how we could support improving resilience.

Proactive investment needed to ensure hardening

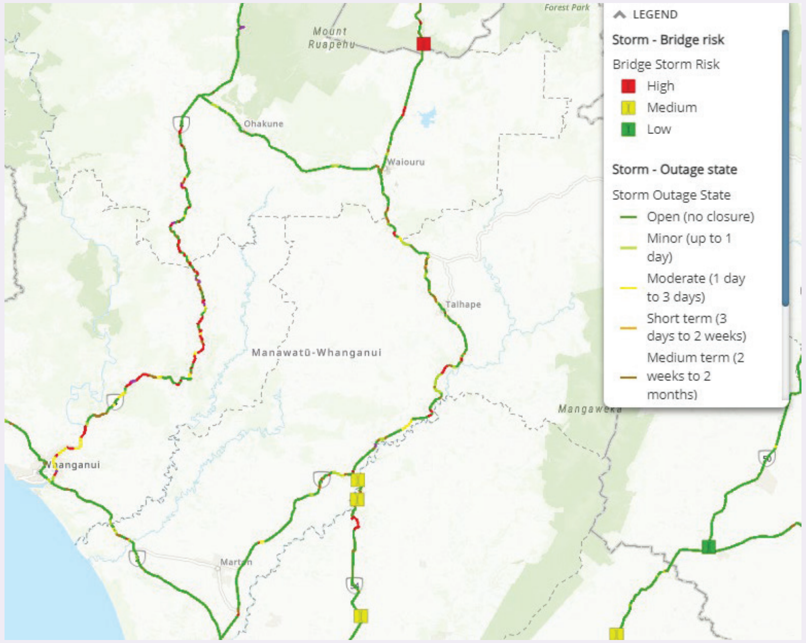


Figure 37 – Left, an example of ground cracking/movement as a slope slips in to the Mangaweka gorge. This puts at risk our main 11kV supply to Mangaweka, which supplies 600 ICPs. We have needed to relocate this line multiple times in the past few years to manage the risk of failure, and we are now considering long-term options for realignment.

Figure 38 – Right, the largely inland rural areas are mainly affected by road disruption because of slips and flooding, which could leave areas with disrupted travel links for several months.

Wairarapa – Electricity

Region overview

The Wairarapa area covers the central and southern parts of the Wairarapa district. Masterton is the major urban centre, with a population of approximately 23,500. Other significant towns are Greytown, Featherston, Carterton and Martinborough.

The Tararua Range runs along the western boundary of the Wairarapa area. Adjacent is a low-lying, flat, and rolling area where the main urban centres are located. To the east, the terrain is generally hilly through to the coast.

The Wairarapa area has a dry, warm climate. Strong winds off the Tararua Range can occur in spring and summer. Weather can be extreme in coastal areas. The area also receives heavy rain from the south and east, which can cause flooding.

Forestry, cropping, sheep, beef, and dairy farming are the backbone of the economy. The area around Martinborough, in the south, is notable for its vineyards and wine, as are the outskirts of Masterton and Carterton. Deer farming is growing in importance.

Lifestyle sections are also becoming popular in the area, particularly as it is just a commute, albeit long, from Wellington.

Increased wind generation and irrigation could significantly impact the electricity system. The Wairarapa area is connected to the grid at two Transpower GXPs – Greytown and Masterton. The region uses a 33kV subtransmission voltage.

The Masterton GXP supplies eight zone substations – Norfolk, Akura, Chapel,
Te Ore Ore, Awatoitoi, Tīnui, Clareville and Gladstone. The 33kV network has a meshed or ring architecture in Masterton. The Greytown GXP supplies five zone substations – Kempton, Featherston, Martinborough, Tuhitarata and Hau Nui. Similarly, a ring connects Martinborough and Featherston with Greytown (Transpower GXP).

Rural substations are generally supplied by single radial lines of quite a small capacity. Downstream of the zone substations, the distribution networks operate at 11kV.

The subtransmission and distribution networks are almost entirely overhead. Access is reasonable except in the backcountry and eastern coastal hills.

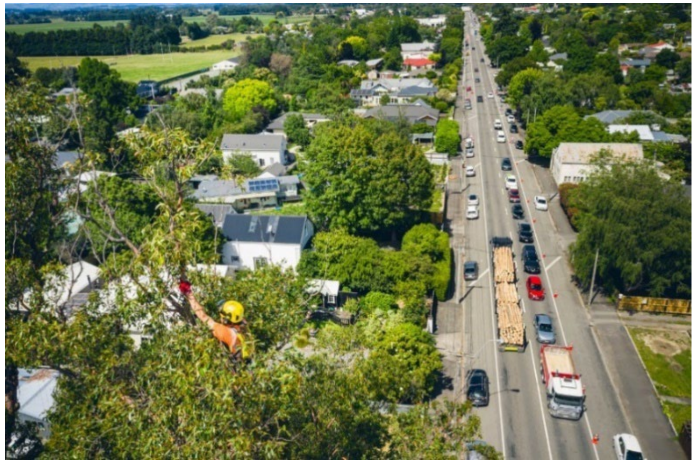
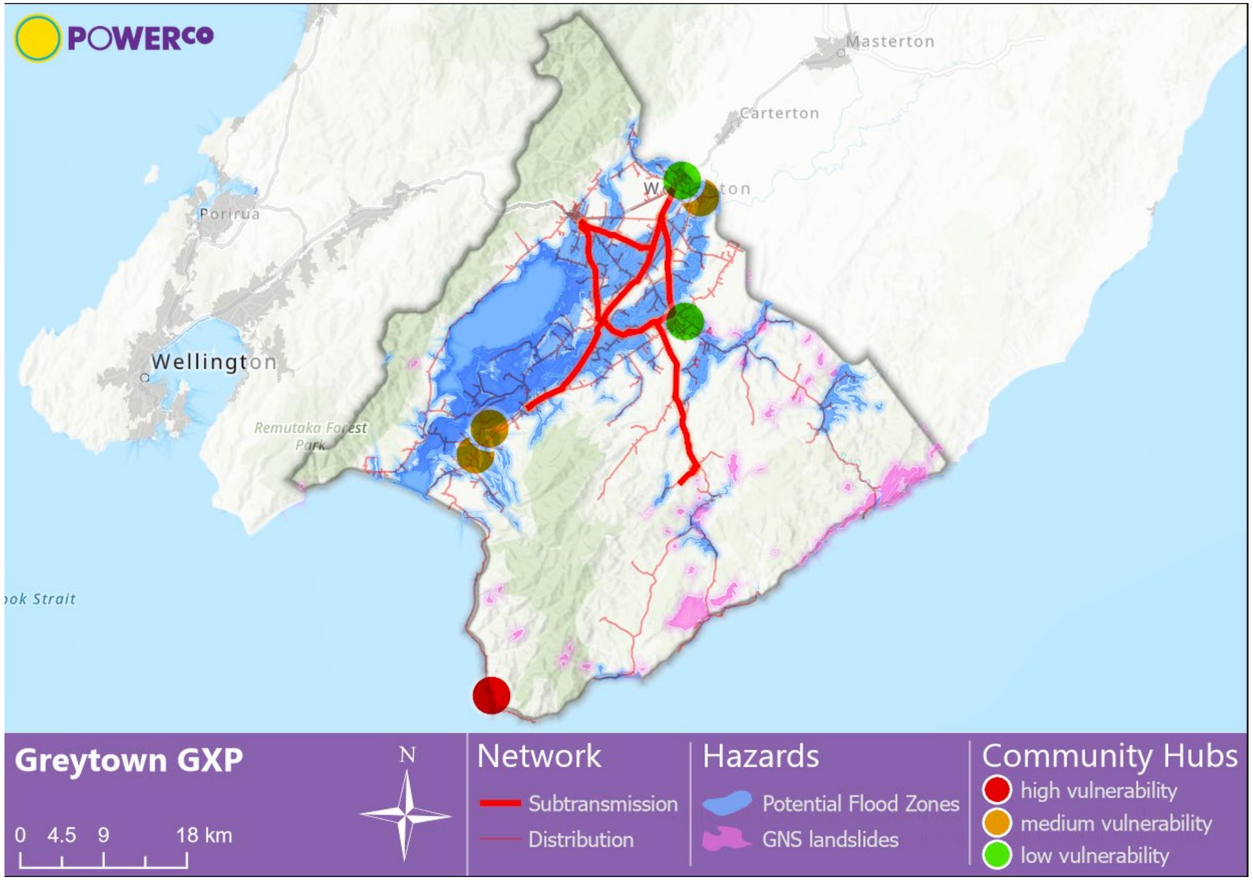


Table 7 – Wairarapa inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	81 (12%)	1 (3)	0



Greytown GXP overview

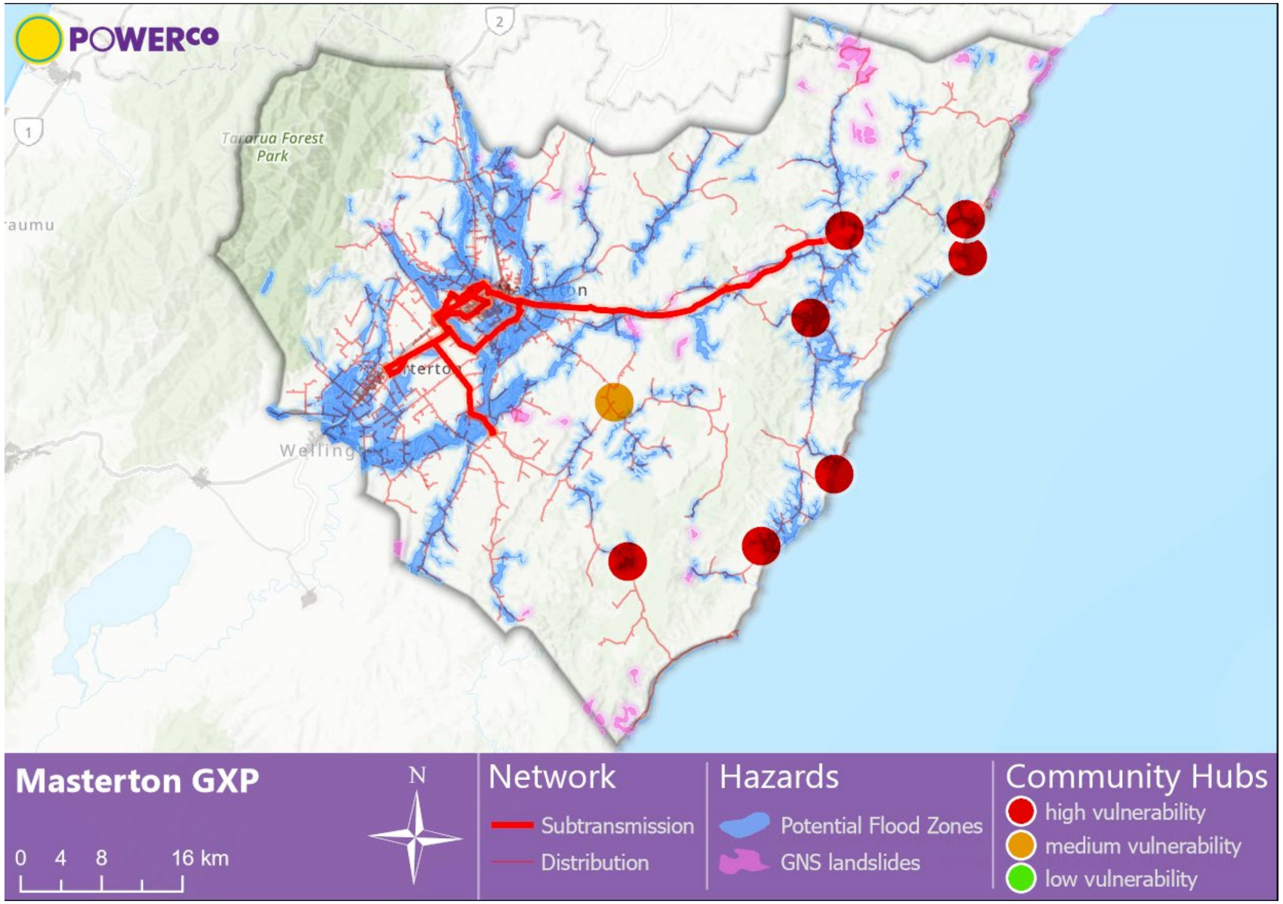
The subtransmission network out of Greytown GXP is dominated by flood plain between the Pāhautea, Tauherenīkau, Waiohine and Ruamāhanga river systems, as well as the low-lying area around Lake Wairarapa. Given the terrain, these rivers have changed course in the past. As we operate ringed network between our urban areas of Featherston and Martinborough, we expect there to already be a reasonable amount of robustness to single points of failure. However, this entire region is dependent on 110kV supply from Transpower travelling over the Remutaka overpass. In recent years, Transpower has been upgrading sections of the northern route to improve supply via the Mt Bruce direction.

Other network risk relates to coastal erosion, which is showing up in landslip risk maps. We have needed to relocate the feeder out to Cape Palliser multiple times because of land movement, and sections of the coastal road have washed into the sea.

Our Hau Nui substation is supplied off a lengthy spur network with some long spans across valleys.

Significant services in the area include Featherston, Greytown and Martinborough water and wastewater treatment plants, the connection to the Hau Nui wind farm, and emergency services supporting the area.

Because of the proximity to the Hikurangi subduction zone, there are a large number of fault lines that run through the Wairarapa area. Therefore, the seismic and tsunami risk is significant – as identified by the September 2023 New Zealand Lifelines Council report.



Masterton GXP overview

Masterton GXP supplies Carterton, Masterton and Tīnui townships. The hill country towards Tīnui is slip-prone, so there is some risk to lines during heavy storms or seismic events. We intend to keep closer watch on poles in known slip areas.

Our network outside of the urban areas is largely overhead. Other than at low-lying river crossings, the network should not be impacted during flooding events. If transport links are disrupted, there could be difficulties gaining access to carry out network repairs.

There are significant areas at risk of flooding, although the majority of our underground networks are within the urban areas, which are covered by flood protections from Greater Wellington Regional Council.

In discussion with the Wairarapa lifelines groups, the main concern is the potential disruption getting support services over the Remutaka overpass during national or regional emergency situations.

Significant services include Carterton, Masterton, Tīnui and Castlepoint water and wastewater treatment plants, Wairarapa Hospital, and regional emergency services.

In terms of community vulnerability, this is one of the more challenging areas to service out to the eastern coast, with long network lengths, easily disrupted transport links, and numerous slip, flooding and vegetation risks. We have been building community generation solutions to help support these areas during major network outages.

Community generation to help provide energy support during major supply disruptions

Figure 39 – Left, NZTA Waka Kotahi maps showing road risk of SH2, from the west, and towards the north via Mt Bruce. Centre, given the mountainous terrain in the eastern and southern parts of the Wairarapa, we have some areas of significant spur network that can be exposed to long repair times in the event of network disruption, such as the spur line through which the Hau Nui wind farm is connected to the grid. Right, for larger remote communities, such as Riversdale and Castlepoint, we have been installing community generation that will give some level of backup power while network repairs take place.

Taranaki – Electricity

Region overview

The Taranaki area covers the northern, central and some southern parts of the Taranaki region.

The Taranaki area overlaps three territorial authority areas – New Plymouth district, Stratford district and South Taranaki district.

Taranaki's terrain and climate are generally quite favourable to asset construction, access, maintenance, and life expectancy. The exception is the coastal areas, where additional corrosion can affect assets as far as 20km inland.

Severe weather events, such as storms, can significantly impact the network. Tornadoes can also occur, although these are infrequent, and their impact is localised.

Agriculture, oil and gas exploration and production, and some heavy industries are the backbone of the Taranaki economy. Agriculture is dominated by intensive dairying suited to the temperate climate and fertile volcanic soils.

The area is supplied by GXPs at Carrington Street, Huirangi and Stratford.

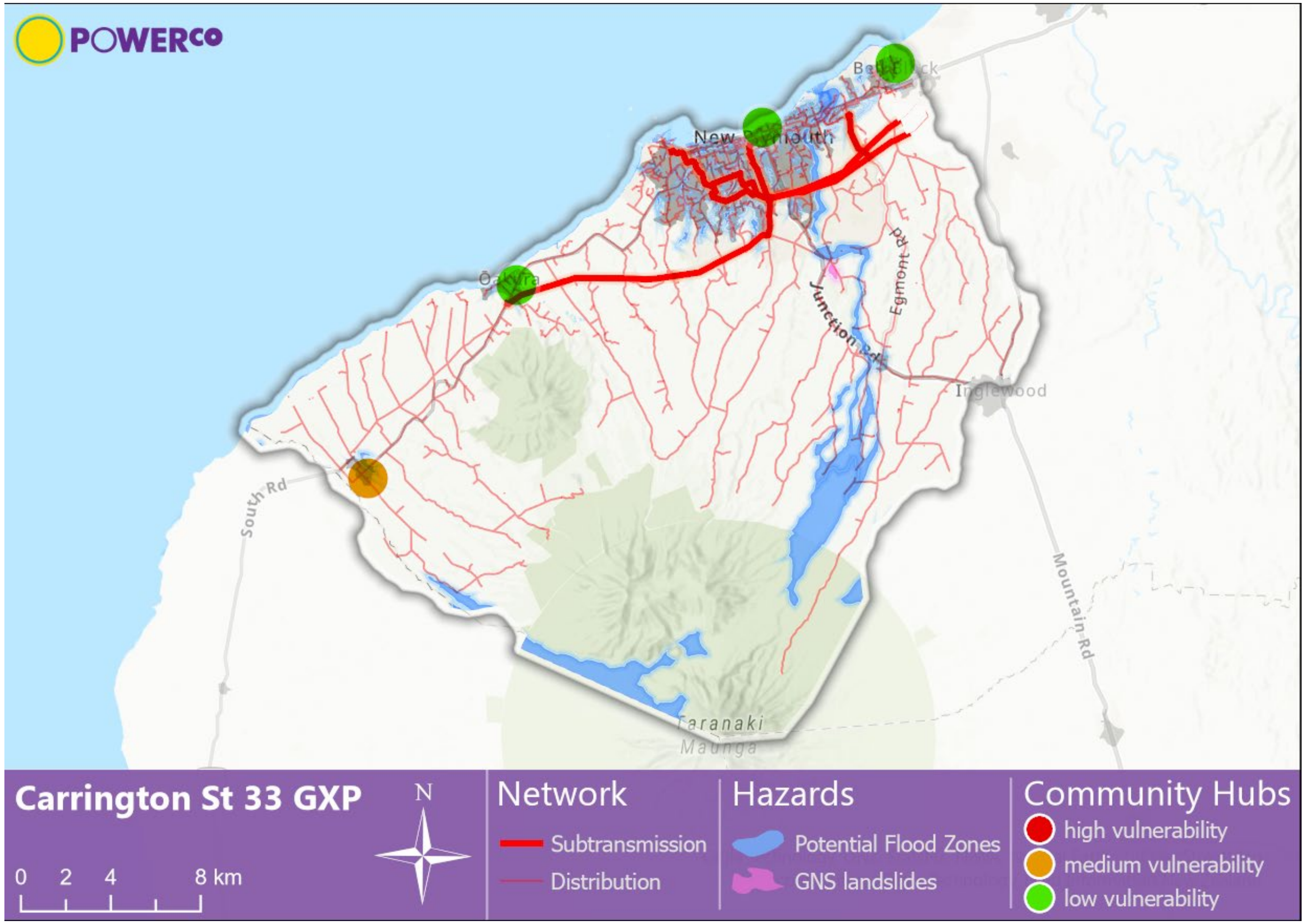
The Carrington Street GXP supplies five zone substations – Brooklands, Moturoa, City, Katere and Ōākura. The Huirangi GXP supplies six zone substations – Bell Block, Waitara East, Waitara West, Mamaku Road, McKee, and Inglewood. The Stratford GXP supplies seven zone substations – Motukawa, Douglas, Cardiff, Cloton Road, Waihapa, Kaponga and Eltham.

The subtransmission and distribution networks in the Taranaki area are mainly overhead.

There are some underground networks in the newer urban areas, particularly New Plymouth city. Subtransmission is mainly meshed or interconnected radial. The notable exception is in New Plymouth, where the five main urban substations are supplied from twin 33kV circuits, and all are dedicated circuits directly from the GXP.

Table 8 – Taranaki inland and coastal flooding – exposed assets.

	Ground-mounted transformers	Zone substations	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	108 (10%)	1	0



Carrington Street 33kV GXP overview

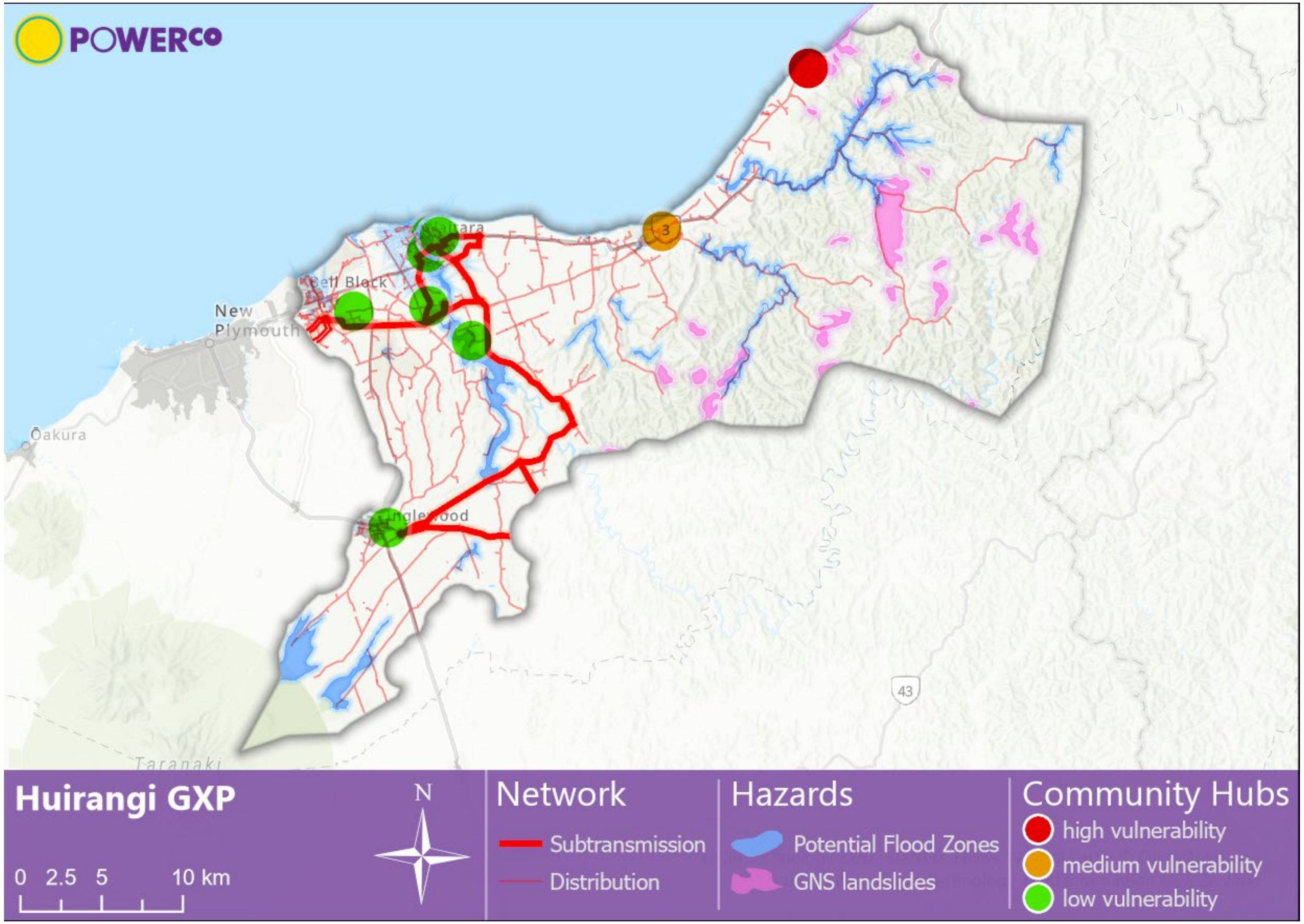
Carrington Street provides supply to much of New Plymouth, as well as Ōākura and Bell Block. The region is characterised by the central volcanic zone, Mt Taranaki, that dominates the geography and from which the majority of the river systems originate from and flow to the coastline. There is some flooding risk, such as has been experienced at Waitara (see study below).

The local network is supplied from Carrington Street and includes 33kV river crossings of two predominant rivers (Waitara and Manganui) in a couple of well set-back areas, but the rural networks around the coastline are relatively well interlinked by network and roading links.

In the case of some modes of eruption or crater lake failure, there is some risk of lahar extending out to the coast. We are working with local authorities on updates to the science regarding this.

Significant services include the Ōākura and New Plymouth water and wastewater treatment plants, pumping stations throughout the area, Taranaki Base Hospital, and emergency services supporting the urban and rural areas, including surf lifesaving.

There are a reasonable number of emergency community hubs within the New Plymouth and Ōākura urban areas. There are also a number of aged care facilities. There are limited sites identified in the more rural areas closer to the mountain.

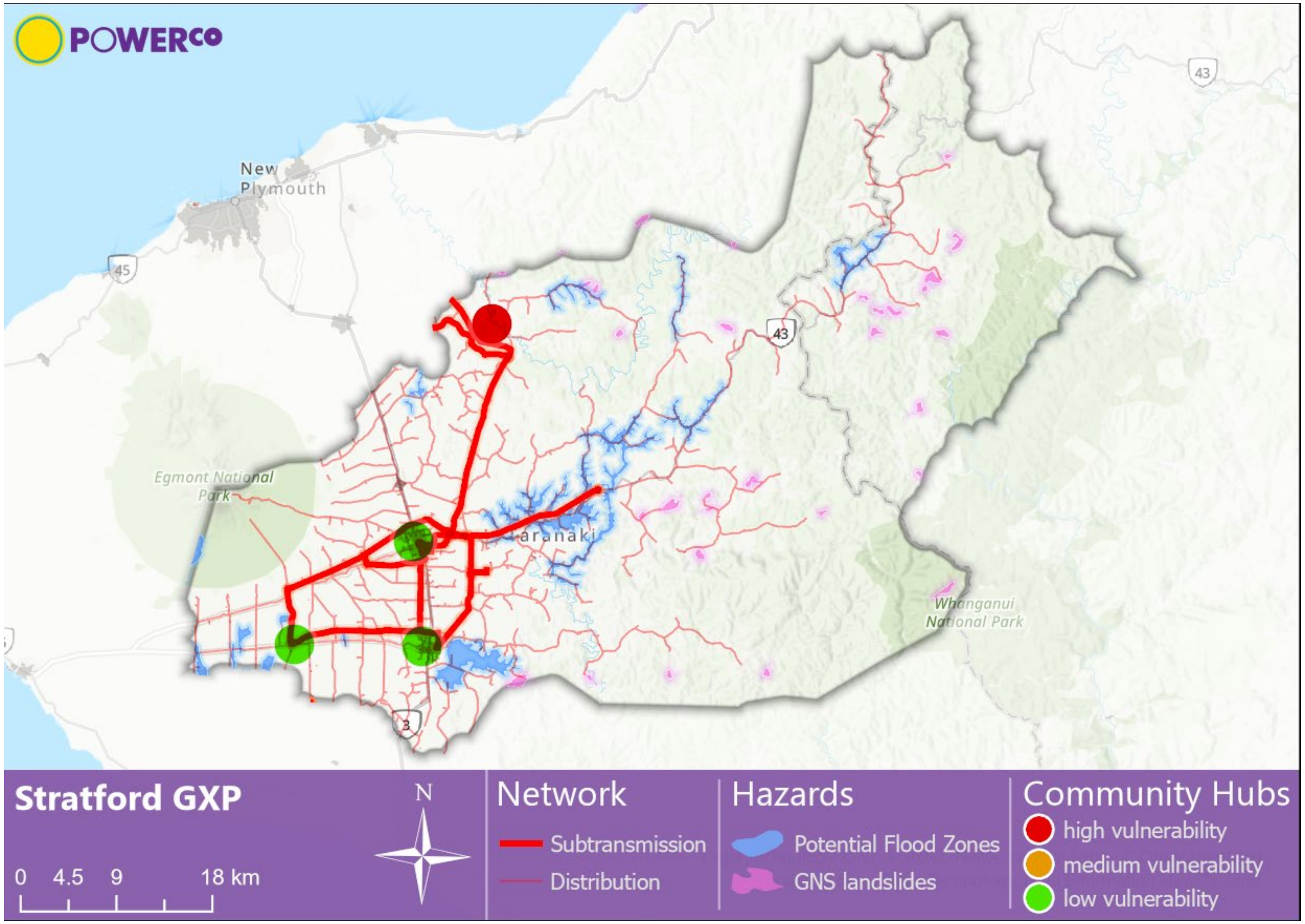


Huirangi GXP overview

The Huirangi network supplies Waitara, Inglewood, Urenui, and the rural surrounds. This network is heavily interlinked with the Carrington supply area from New Plymouth, so supply is reasonably robust and both these areas can support each other. In terms of hazards, there are some areas of flood-prone soil around river systems, as well as substantial areas of land movement in the inner hill country to the east.

Significant services include New Plymouth airport, Waitara, Bell Block, Inglewood and Urenui water and wastewater plants, pumping stations, and emergency services supporting the region.

There are a number of emergency community hub sites in the urban areas where supply appears robust. The long spur lines that supply the eastern rural areas are quite exposed.



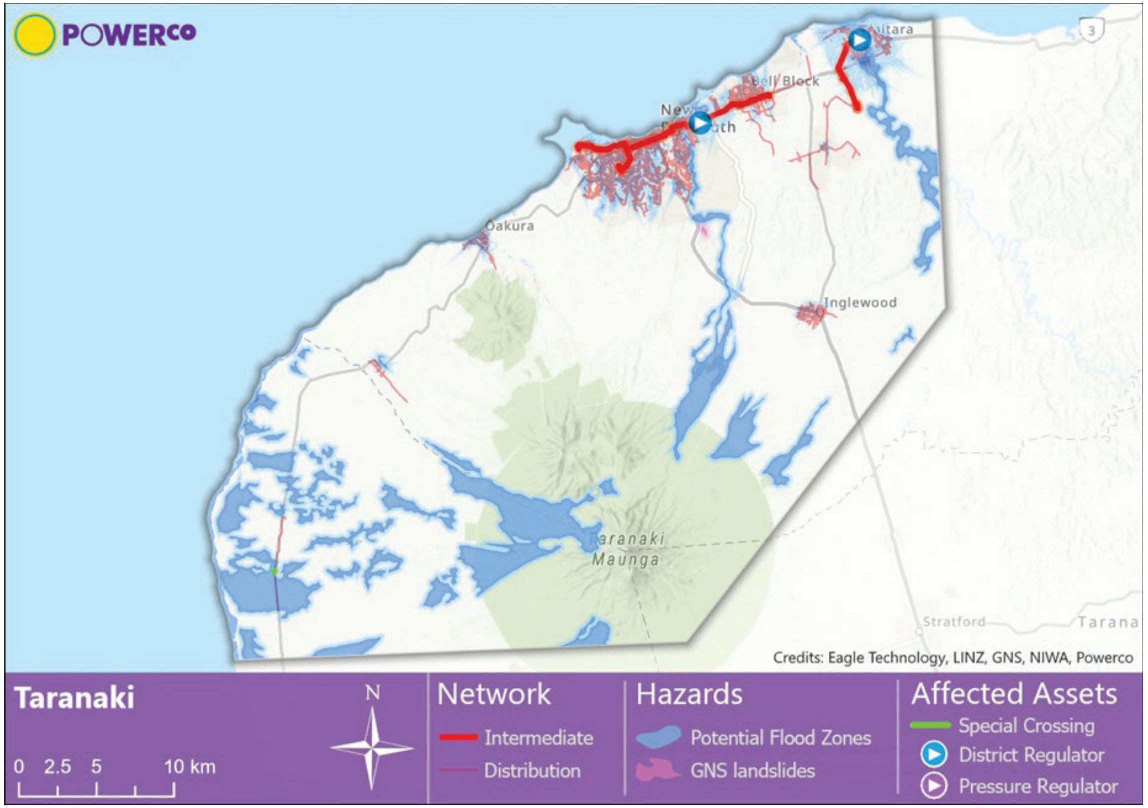
Stratford GXP overview

The Stratford supply area services Stratford, Eltham, Manaia and smaller townships in the district. The southern extent of this GXP tends more to the high-country back roads where access is less robust. This area shares similarities to our other Taranaki networks – relatively strong urban networks and long spur networks supplying large rural areas.

Significant services include the Eltham, Stratford and Manaia water and wastewater plants, pumping stations, Stratford power station connection, and emergency services supporting the townships and the surrounding area.

Within urban areas there are several emergency community hubs, which appear well supported. As with large communities exposed to isolation, we have identified Whangamōmona as being at risk, as it is 60km inland along SH43. We have invested in community generators to support this area during major network outages. This site does not appear on this map as a community hub site.

Taranaki – Gas



Region overview

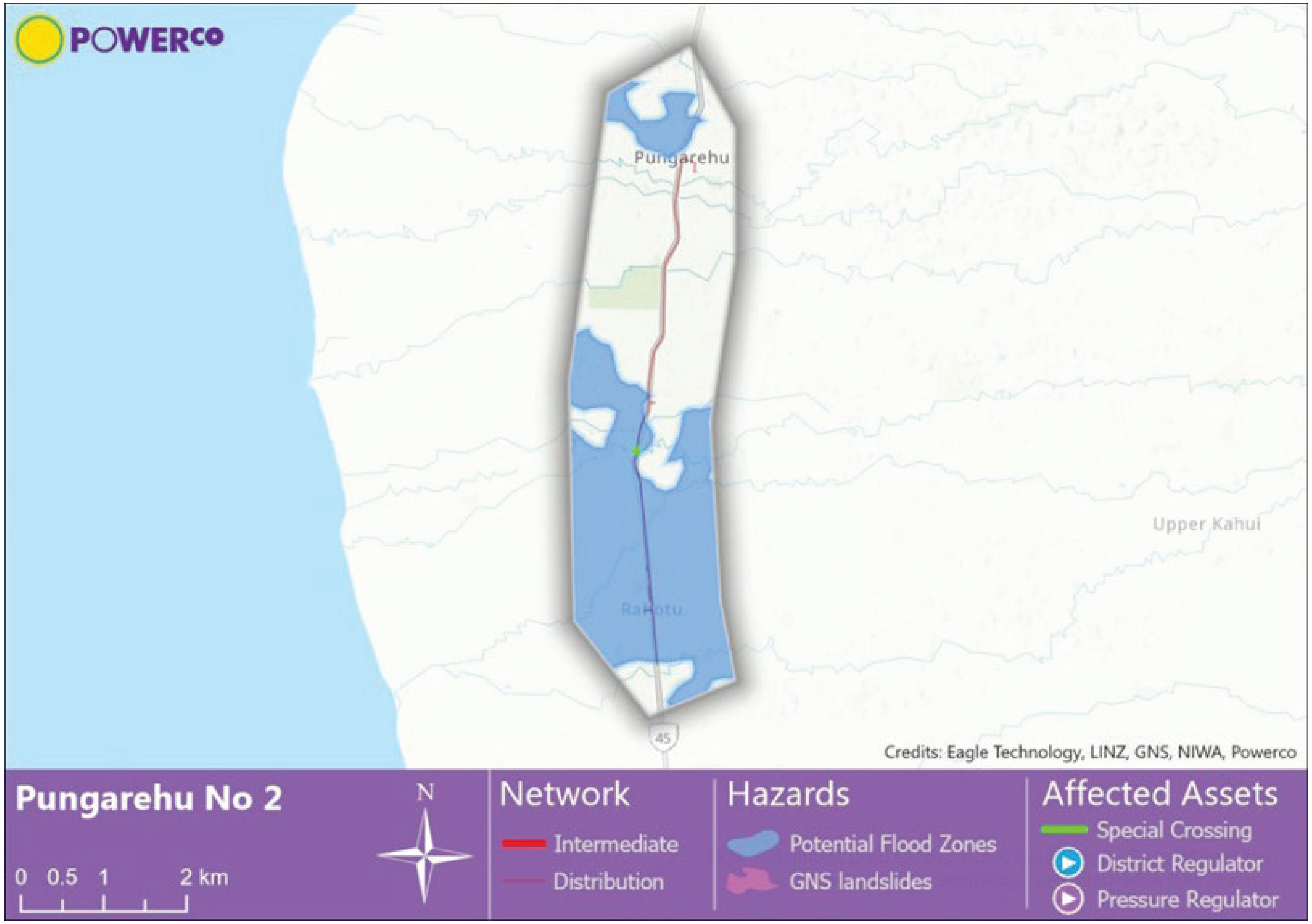
The sparsely populated Taranaki region is projected to be at minimal risk to climate events in the future.

A total of three assets (one special crossing and two regulator stations) are vulnerable to inland flooding and coastal inundation. These assets supply energy to more than 1,100 gas customers.

This map shows inland flooding risk throughout the area. Coastal inundation only affects Waitara.

Table 9 – Taranaki inland and coastal flooding – exposed assets.

	Hazard			
Asset type	Inland flooding	Coastal inundation	Exposed to both hazards	**Total**
Special crossings	1	0	0	1
Regulator stations	1	0	1	2



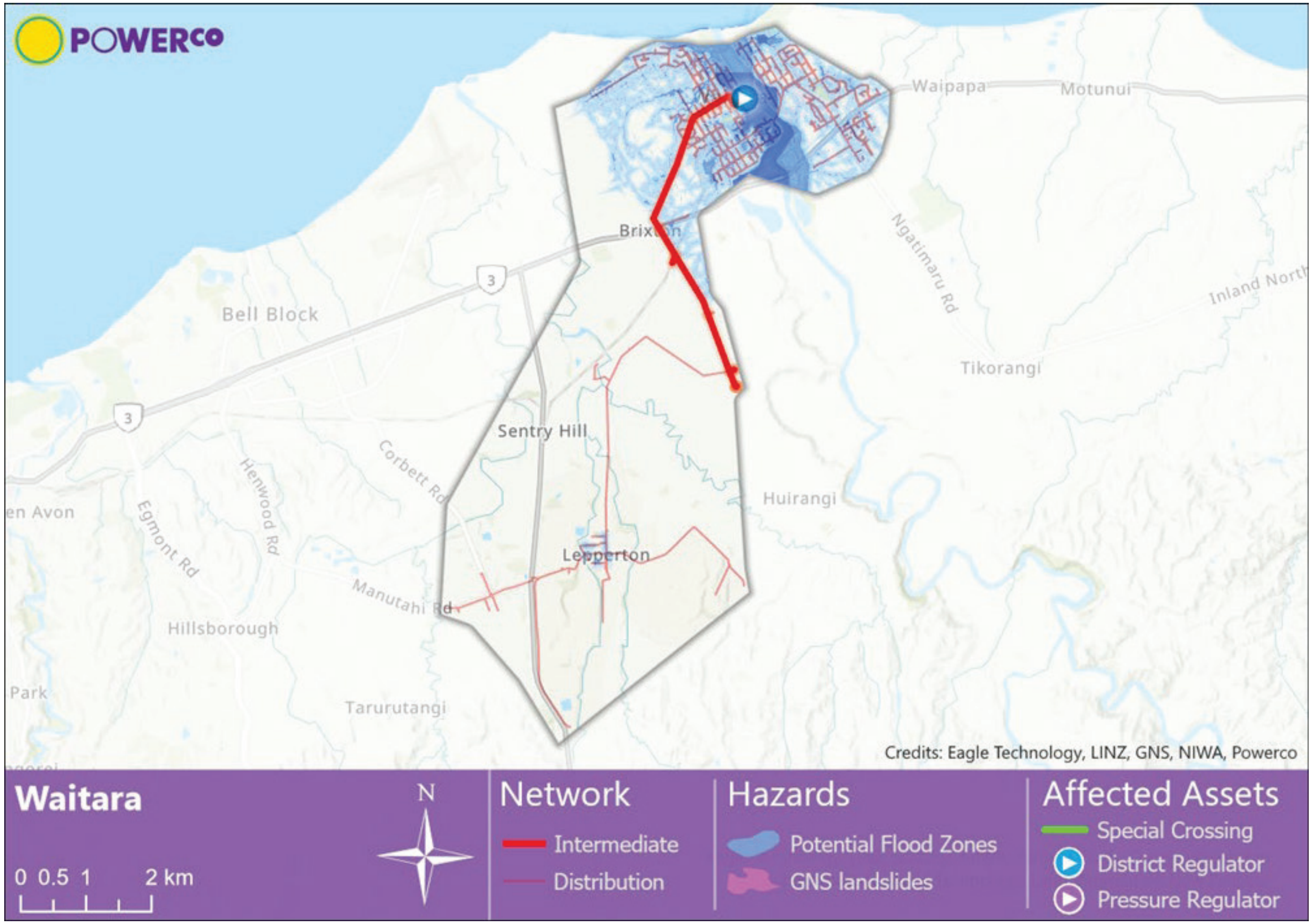
Special crossings – Taranaki

The only affected special crossing in Taranaki is in the small rural Pungarehu No 2 network.

Western Taranaki, located on a flood plain near Mt Taranaki, experiences significant flooding because of the terrain.

This crossing spans the Waitaha Stream, where slash is not a concern, but the bridge is at risk of being washed away during heavy floods.

If lost, 15 residential customers would be affected. Despite its importance, the low number of customers places this crossing low on the priority list for resiliency funding.



Regulator stations – Taranaki

The most affected station in Taranaki is in coastal Waitara, located less than 100m from the river that runs through the town.

Its proximity to the river puts it at risk of best-case coastal inundation and inland flooding, with occurrences between 1-in-60 and 1-in-100 years.

This station (cocon below ground station) is the sole feed to the entire Waitara township, serving more than 1,100 customers, and has experienced multiple floods in the past.

Although it has some flood protection, its history of flooding makes it a candidate for future resiliency reinforcement.

Case study – Waitara township, Taranaki

Waitara township, in North Taranaki, is based around the lower Waitara River as it flows to the Tasman Sea. It is home to 7,550 people (June 2023), and Powerco provides electricity supply to about 3,000 homes and businesses, and gas to about 1,000.

Hazards maps show both the risk of sea level rise and river flooding between 1-in-60 and 1-in-100 years, with some level of vulnerability. Both our gas cocon and electrical substation – critical control points in these networks – are designed for a moderate level of flooding but, in general, are largely dependent on the performance of the 1-in-100 years flood protection scheme for the lower Waitara River, which has been damaged in the past. We intend to work closely with the New Plymouth District Council to understand any future adaptation plans it has for this area, and what opportunities there may be, including possible considerations for how we provide energy to this community.

Figure 40 – The Waitara substation and gas cocon are protected by river stopbanks.

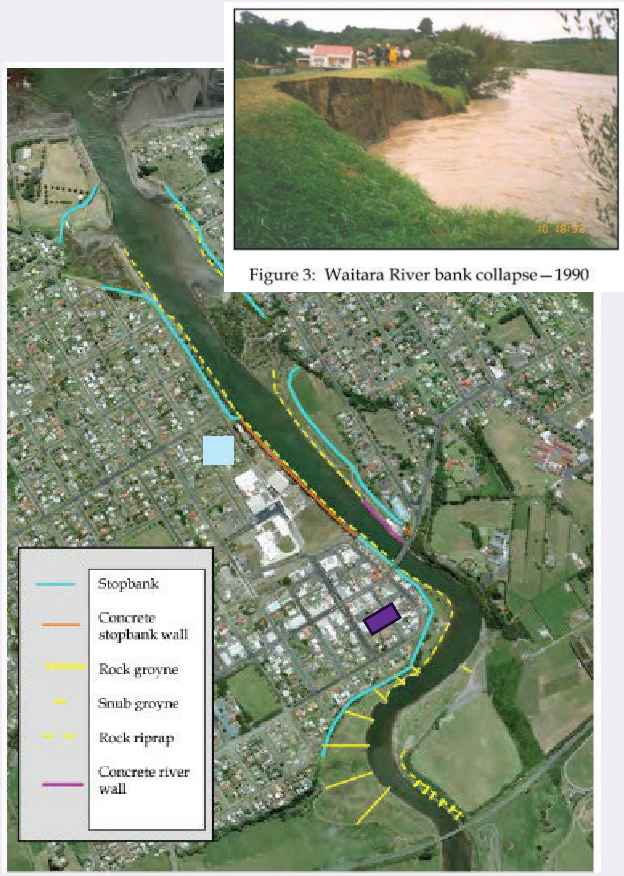


Figure 41 – Waitara River flood protections. Inset, damage that has been sustained by heavy rainfall events in the past.

Egmont – Electricity

Region overview

The Egmont area covers the southern Taranaki region and is part of the South Taranaki District Council area.

The main urban areas are Hāwera, Manaia, Ōpunake and Pātea. Hāwera is the largest of these towns and its population is reasonably stable. Smaller towns in the area rely more on tourism now that their historical function of being rural service centres has been reduced. The terrain is mostly rolling open country, although there are some remote and steep back-country areas with long distribution feeders. There is reasonable access to most parts of the network.

The southern Egmont area is prone to storms off the Tasman Sea, which can severely impact the network. As in northern Taranaki, equipment in coastal areas corrodes quickly.

Agriculture and associated support and processing industries drive the economy, with dairy a long-established and strong sector. There are also large food processing operations, including Fonterra's Whareroa site and Yarrows The Bakers in Manaia. Some oil and gas processing are also present.

The Egmont area is supplied from the Hāwera and Ōpunake GXPs through two independent 33kV subtransmission systems. Ōpunake GXP supplies Pungarehu, Ngāriki and Tasman substations through two 33kV ring circuits. Ngāriki is common to both rings. Hāwera GXP supplies Kāpuni, Manaia, Cambria, Mokoia, and Livingstone substations. A 33kV ring supplies Mokoia and Livingstone. A separate 33kV ring supplies Kāpuni and Manaia, although Manaia has a short section of single circuit teed off the ring.

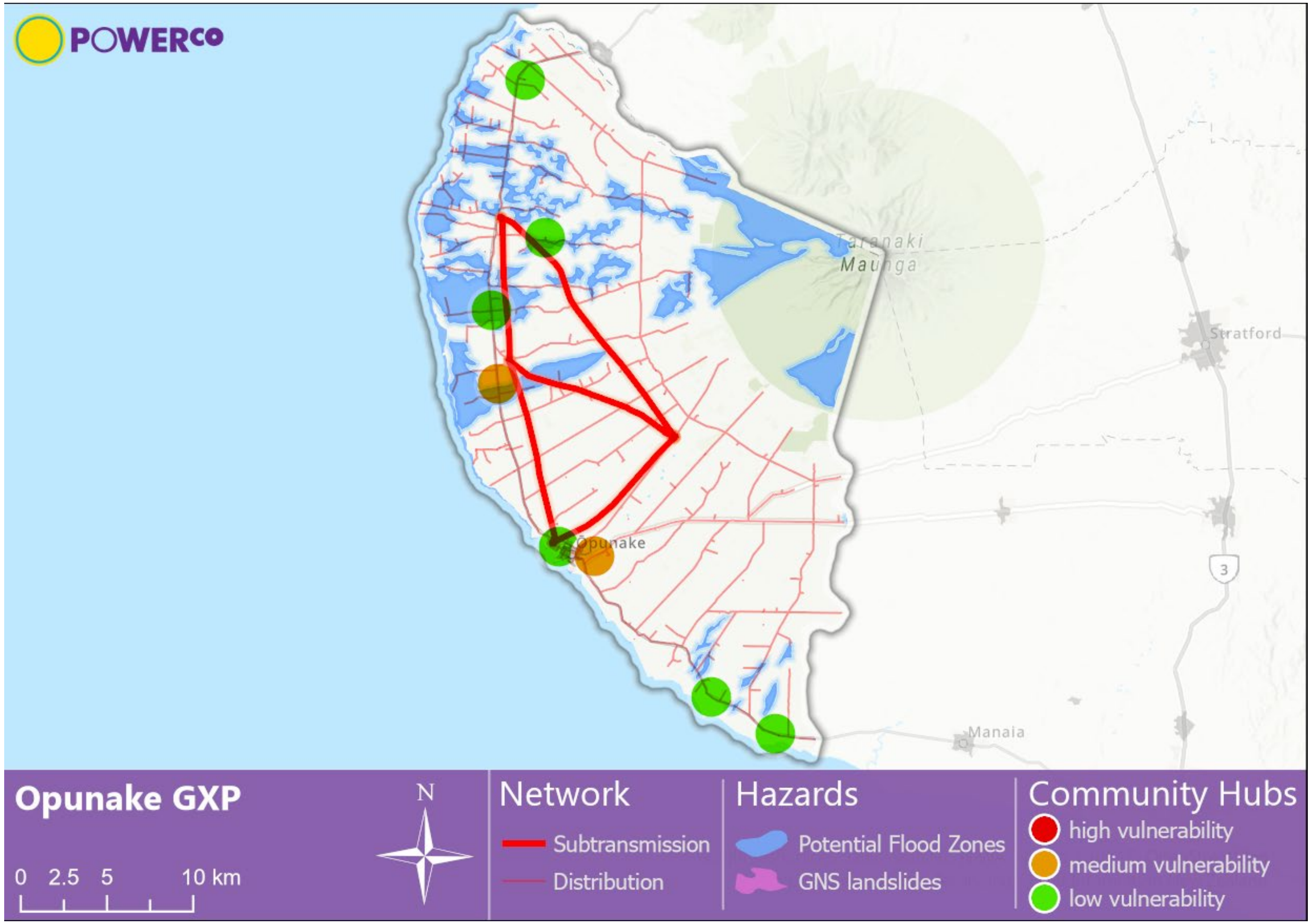
Cambria substation, which is the main substation serving Hāwera township, is supplied by two dedicated 33kV oil-filled cables.

Historically, two different power companies owned the Ōpunake and Hāwera networks. The two subtransmission networks are operated at a 50Hz frequency but with different phase angles, so they cannot be interconnected. The subtransmission and distribution networks are mainly overhead.

The major Fonterra plant at Whareroa is connected directly to the 110kV grid.

Table 10 – Egmont inland and coastal flooding – exposed assets.

	Ground-mounted transformers	Zone substations	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	19 (4%)	0	0

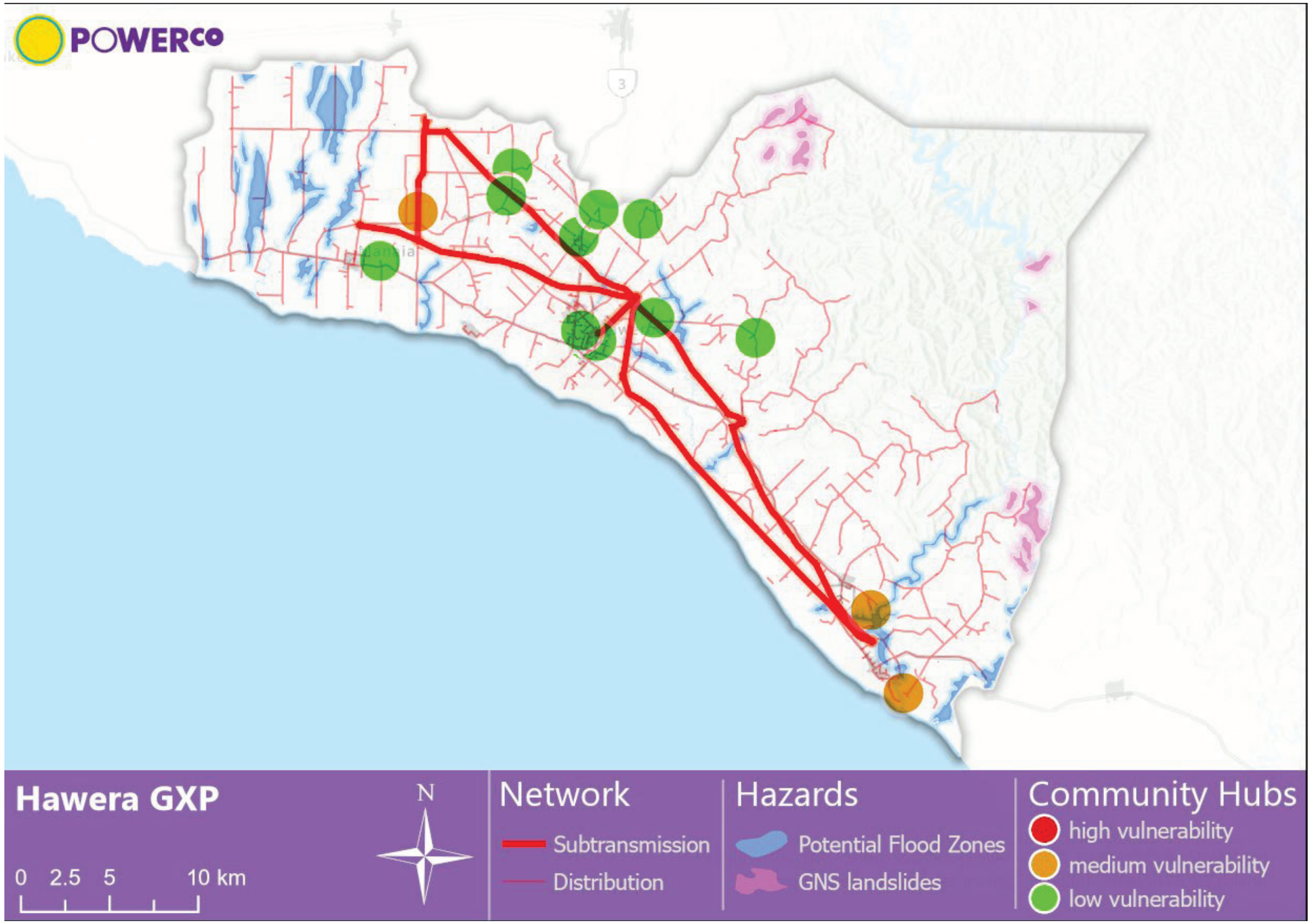


Ōpunake GXP overview

The Ōpunake supply area is largely bounded by the rugged Taranaki coastline and Mt Taranaki. The dominant hazards here are similar to the Taranaki network, with stream and river systems from the mountain prone to flooding during heavy storms. Much of the network is overhead, so the harsh southerlies and vegetation contact are the main cause of network outages in the area. SH45, which connects much of the western coastline, has a large number of stream and river crossings that could impact access to rural areas in the event of disruption.

Significant services in this area are the water treatment plant and wastewater treatment plant, pumping stations supporting Ōpunake township, Ōpunake Hydro, and emergency services.

There are a significant number of community emergency hubs around South Taranaki, although some are more exposed to hazards than others.



Hāwera GXP overview

Hāwera GXP is the primary supply area to Hāwera, Manaia and Pātea townships and the surrounding rural areas.

In addition to coastal erosion processes, there are some areas at risk of flooding, and slip-prone areas further inland from the coast.

Significant services in the region include wastewater pumping stations, wastewater treatment plants at Manaia and Hāwera, and emergency services throughout the region, including Coastguard NZ.

A large number of emergency community hub sites have been identified in the area – some with greater supply vulnerability.

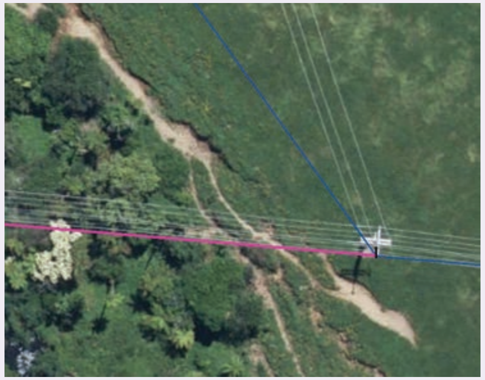
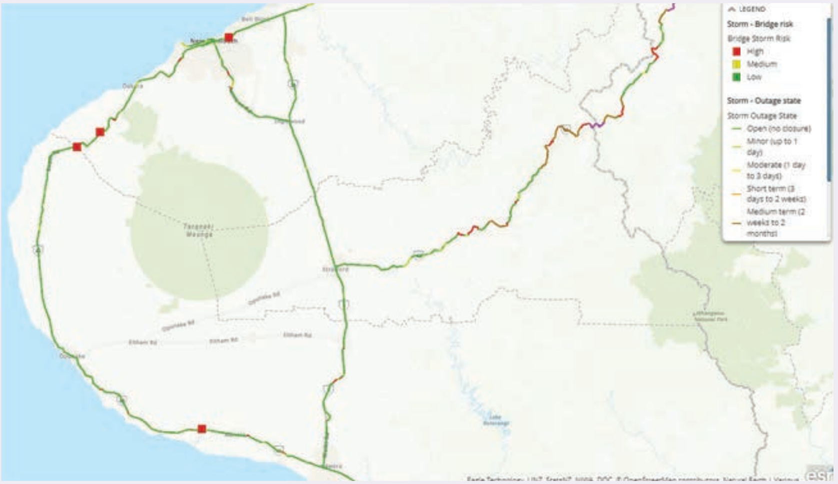
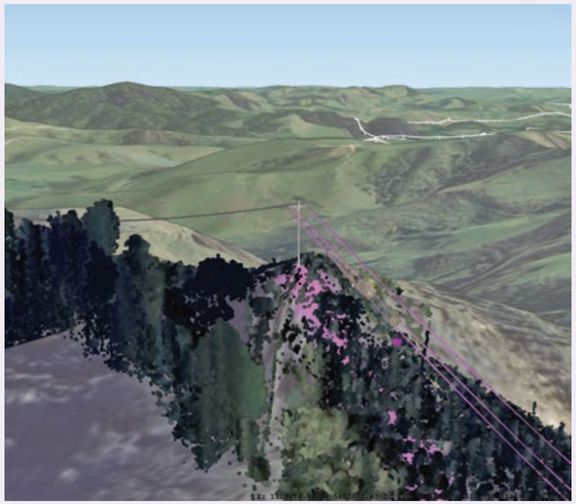


Figure 42 – An example of a slip area beginning to encroach on structure location.

Community generation helps support areas at risk of isolation





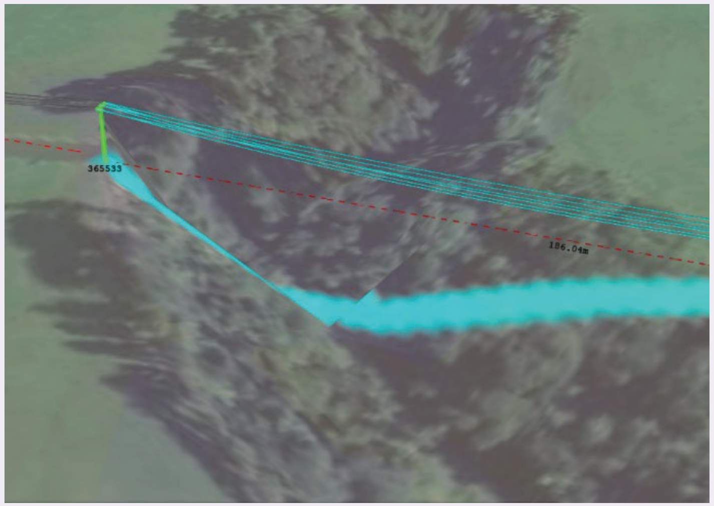


Figure 43 – Bottom left, some areas of our network travel through challenging terrain, such as the hill country east and inland from Mt Taranaki, and through forested areas or large river crossings. Top left, NZTA data shows a number of river crossings that may potentially be damaged, including many high-risk sections inland along SH43 Forgotten Highway.

Top right, our Whangamōmona Village community generator is an example of backup supply being provided to help support communities when road closures may impact our ability to access and repair the network.

Manawatū – Electricity

Region overview

The Manawatū area is dominated by the city of Palmerston North, but also includes Feilding and smaller inland and coastal settlements and surrounding rural areas.

Palmerston North city and surrounding areas to the north and west lie on the Manawatū plains.

The more rugged, hilly terrain is found east of Palmerston North on the Tararua Range and northeast on the Ruahine Range. The Palmerston North area has a temperate but windy climate, with consistent wind in the Tararua and Ruahine ranges.

Wind generation is a major feature in the Manawatū area, with three major wind farms to the east of Palmerston North. Tararua Wind Farm has two generation sources feeding into our network at 33kV and has a significant impact on the protection and operation of the 33kV network.

Access to the area for fault repair and maintenance is good, especially on the Manawatū plains.

Primary production, such as dairying, is significant to the local economy, although less dominant than in other planning areas.

Palmerston North is the economic hub of the area. The city has had steady growth, with areas such as Kelvin Grove, Kairanga and Summerhill popular for residential development. Further development in these locations is signalled in local council planning documents.

Industry and commerce are also strong in the city. The Northeast Industrial area recognises Palmerston North's position as a growing transport and warehouse hub – the city is centrally located with immediate access to major transport links. In recent times, the CBD has had a relatively high growth rate. This is expected to continue given the city's popularity, size, and the considerable distance to the nearest major commercial centres.

Two of New Zealand's major military bases are also in the Manawatū area – the Royal New Zealand Air Force Ohakea base (near Sanson), and the New Zealand Army Linton Military Camp (south of Palmerston North).

The Massey University complex and associated research centres also significantly contribute to the city's vitality.

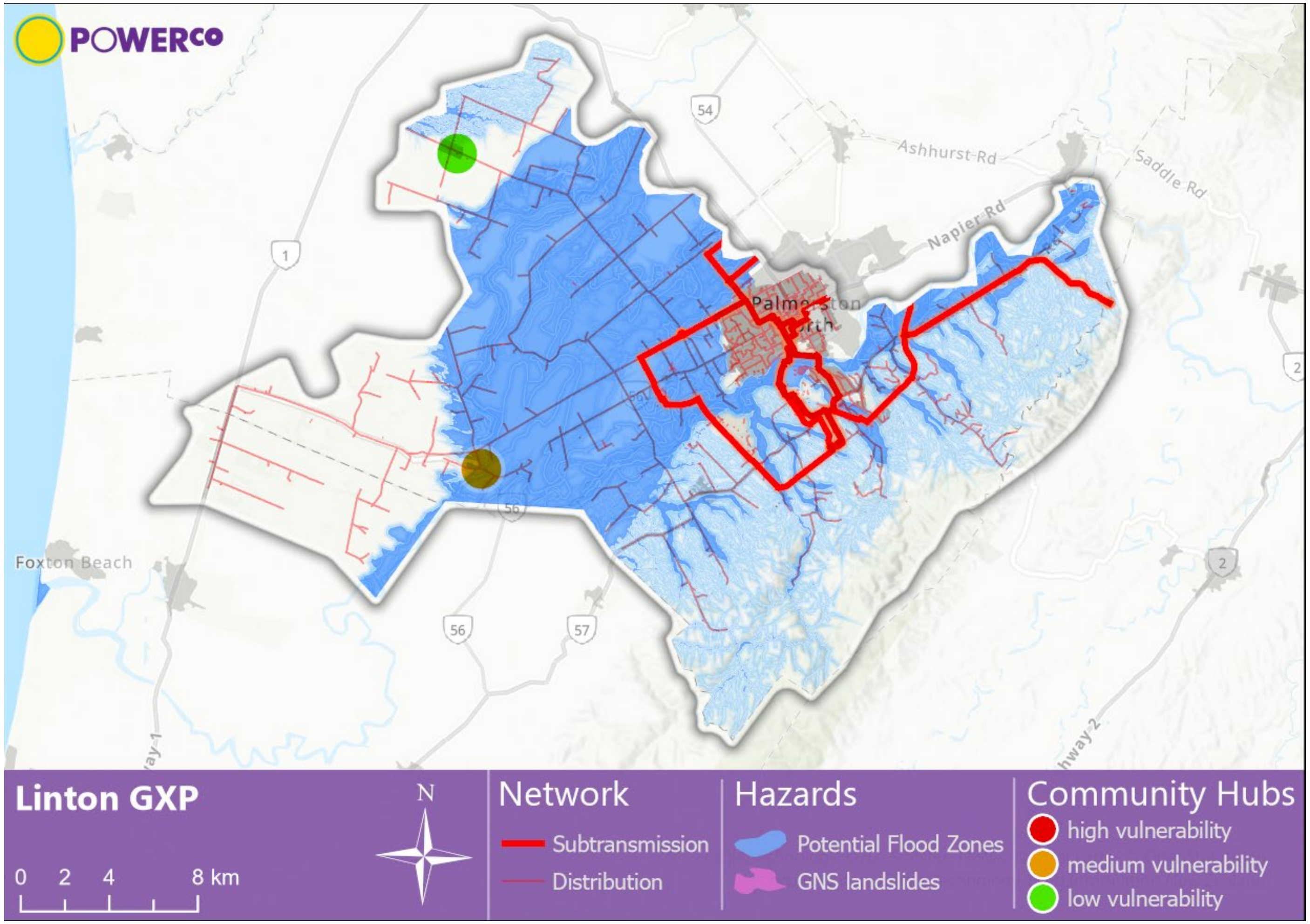
The Manawatū area is connected to the grid through the Bunnythorpe and Linton GXP substations. Bunnythorpe GXP supplies eight zone substations – Keith Street, Kelvin Grove, Main Street, Milson, Feilding, Kimbolton, Sanson and the new Ohakea substation. The Linton GXP supplies four zone substations – Kairanga, Pascal Street, Turitea and Ferguson. Both subtransmission networks supplied by these GXPs have 34MW generation feed from the Tararua Wind Farm.

The subtransmission and distribution networks in rural areas are mainly overhead. Within Palmerston North city there are some overhead lines, but predominantly circuits are underground.

The 33kV subtransmission network is mostly meshed. The two subtransmission networks from each GXP are operated independently but can be interconnected at several points across the city. The city substations generally have full N-1 circuits in either twin circuit or ring circuit configurations. Some ring connections are open because of protection issues, or they cross GXP boundaries. The two rural substations, Kimbolton and Sanson, are on single radial spurs.

Table 11 – Manawatū inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	212 (16%)	1 (2)	0



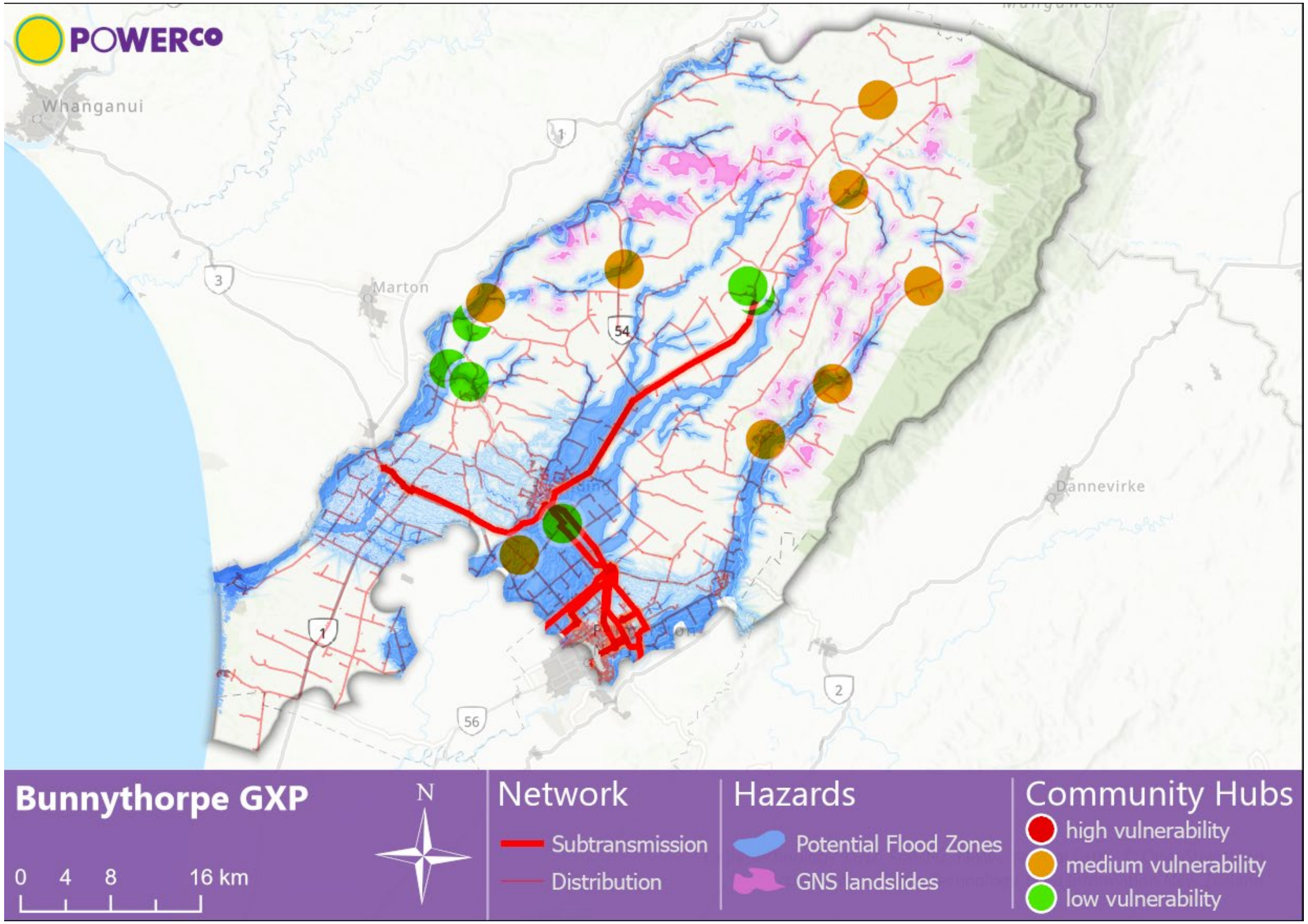
Linton GXP overview

The Linton GXP network supplies Palmerston North from the south end of the Manawatū River. In recent years, we have made significant upgrades to the network to allow most of the urban area to be transferred to Bunnythorpe GXP.

There are large areas of flood-prone soil surrounding the Palmerston North urban areas, including some 1-in-200 years areas around the Manawatū River, as identified by Horizons Regional Council.

Significant services include large numbers of Palmerston North City Council wastewater and stormwater pumping stations, the Turitea Water Treatment Plant, Palmerston North Civil Centre, Manawatū Prison, the connection point for the Tararua wind farm, the NZ Defence Force (NZDF) site in Linton, and emergency services supporting the Palmerston North urban area as well as Longburn and Rongotea.

A smaller number of community emergency hub sites have been identified, and they are predominantly on the north-east side of Palmerston North city.



Bunnythorpe GXP overview

The north of Palmerston North city is supplied from Bunnythorpe GXP, which is a major Transpower substation for the central North Island.

Past reviews by the Manawatū-Whanganui Lifelines groups have highlighted this as a key infrastructure "hotspot" for the region. We have put a significant amount of investment into this area to ensure much of the urban areas are well supported by alternative supply points with large amounts of network interconnection. We plan to replace/upgrade some old oil cables, through which we take supply from Bunnythorpe.

The importance of the area is highlighted by the significant number of services, including Palmerston North Hospital, water and wastewater treatment plants such as Feilding, Himatangi Beach, Sanson and Halcombe, large numbers of Palmerston North City Council and Manawatū District Council pumping stations, connection to the Tararua wind farm, the NZDF Ohakea base, and emergency services that support the urban and rural areas.

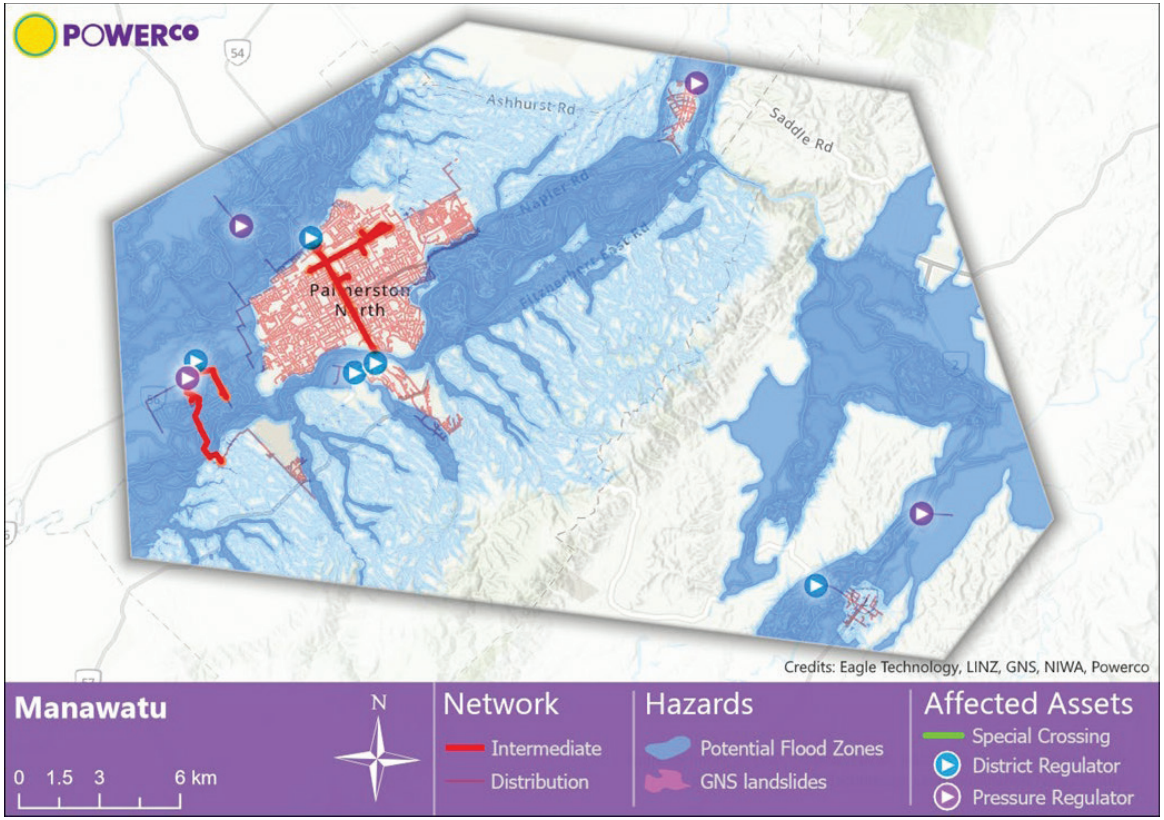
Given the mix of flooding and slip risks in the north-east areas of the network, there are some risks to the emergency community hubs. Mapping from NZTA also shows risks to some of the transport links to the north of the city. There is also a significant number of aged care facilities supplied in the area.

Feilding, Sanson and Bulls subtransmission upgrade

In 2022, we completed building our Ohakea substation, and interconnection between our Bulls and Sanson substations, with both substations now able to be supplied from two different GXPs. This has greatly improved the security of this part of the network. For more information go to: https://www.powerco.co.nz/what-we-do/our-projects/feilding-sanson-and-bulls

Figure 44 – New 33kV cable near Bulls substation, left, and new Ohakea substation, right.

Palmerston North/Manawatū - Gas



Overview

Large portions of the Manawatū region are prone to flooding however, most of these floods have a return interval of between 1-in-20 and less than 1-in-100-years meaning the risk likelihood for flood damage is low.

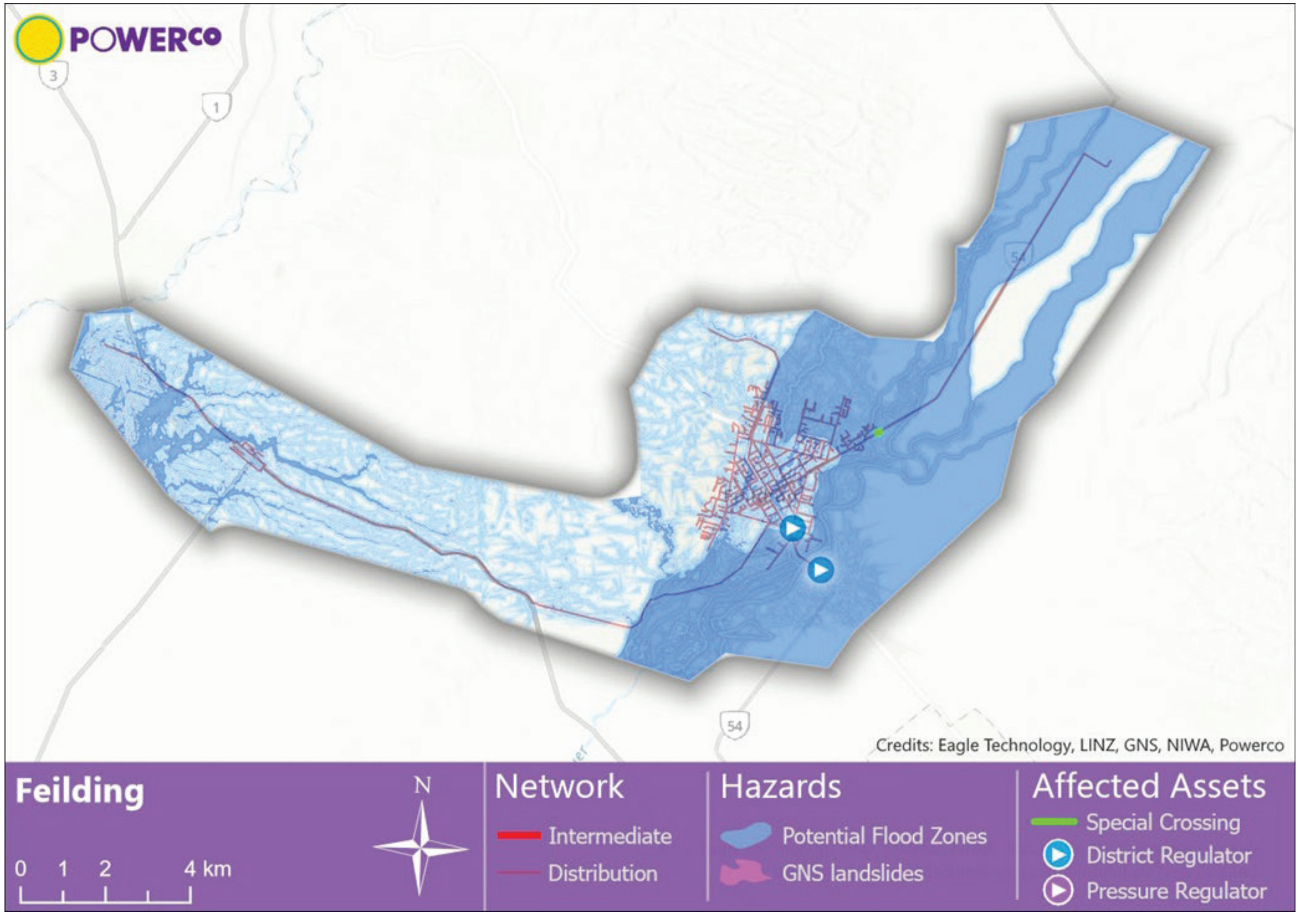
Most affected assets surround Palmerston North due to the large flood plain surrounding the town.

There are no assets of interest affected by coastal inundation in the region.

The only town Powerco distributes gas to within 5.5 km of the sea is Foxton in which there are no special crossings and only two regulator stations. Thus, inland flooding protection solutions will be of higher importance in Manawatū going forward.

Table 12 – Manawatū inland and coastal flooding – exposed assets.

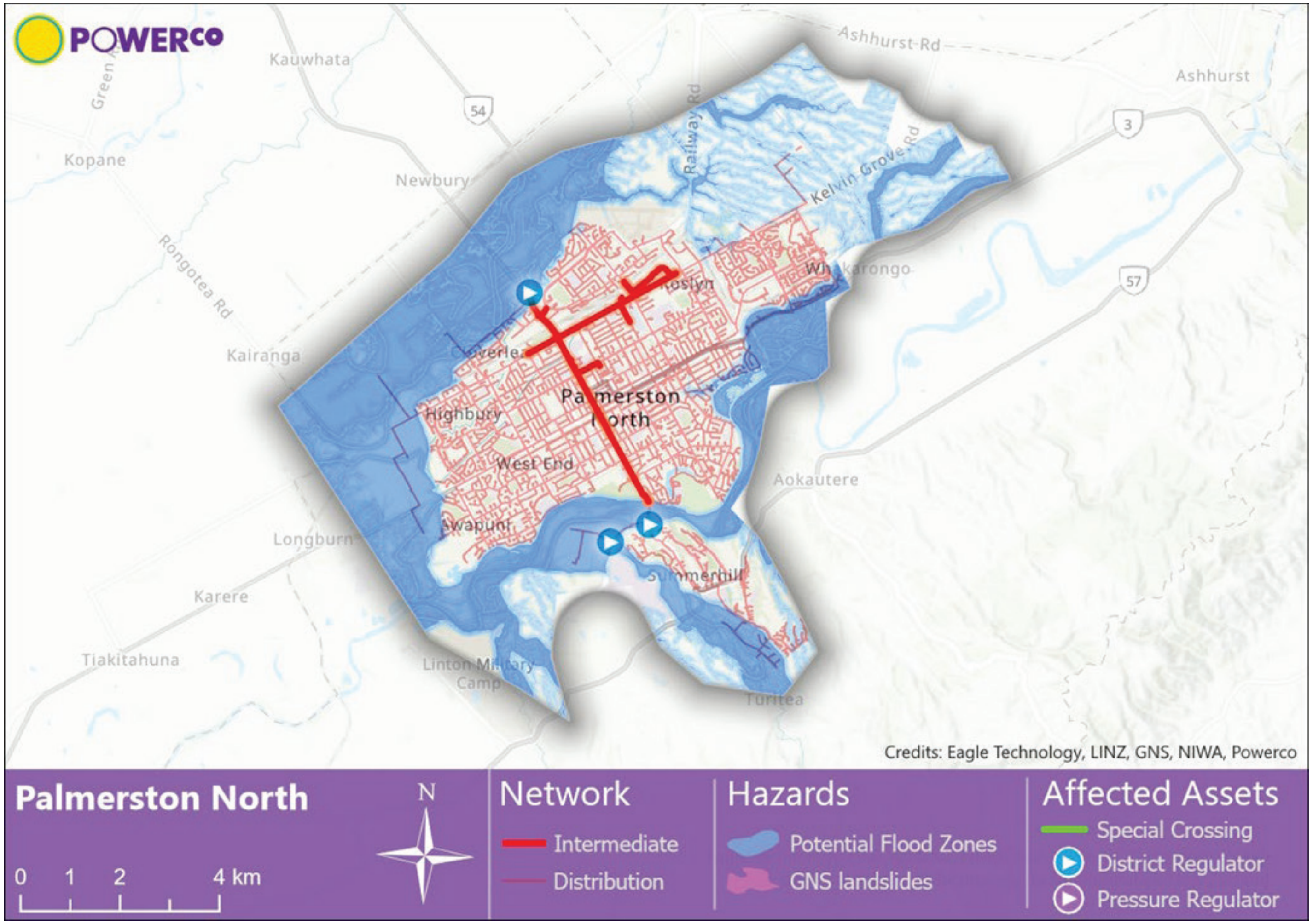
	Hazard			
Asset type	Inland flooding	Coastal inundation	Exposed to both hazards	**Total**
Special crossings	1	0	0	1
Regulator stations	12	0	0	12



Special crossings – Manawatū

The single affected special crossing in the Manawatū region is in north-east Feilding, feeding four rural customers.

Feilding is located in a flood plain where a large 1-in-100-year flood would have a major impact, but would be a rare event. For this reason, this bridge crossing is less of a priority for resilience planning.



Regulator stations – Manawatū

Several regulator stations around the Palmerston North region are at risk of flooding, with the Palmerston North gas gate station of most local significance.

This is vulnerable to a 1-in-60-year flood and supplies all 19,000 customers in Palmerston North.

Tararua – Electricity

Region overview

The Tararua area covers the southern part of the Tararua district, which is in the upper Wairarapa region.

The district has rugged terrain, especially towards the remote coastal areas. Subtransmission and distribution lines are generally long and exposed.

The area generally has a dry, warm climate. Strong winds can occur in spring and summer. The winds gather strength as they come down the Tararua Range and can be very strong, especially in coastal areas.

The area receives heavy rain from the south and east, which can cause flooding.

The Tararua area is connected to the grid at Transpower's Mangamaire GXP. The region uses a 33kV subtransmission voltage.

Mangamaire GXP supplies four zone substations – Mangamutu, Parkville, Alfredton and Pongaroa.

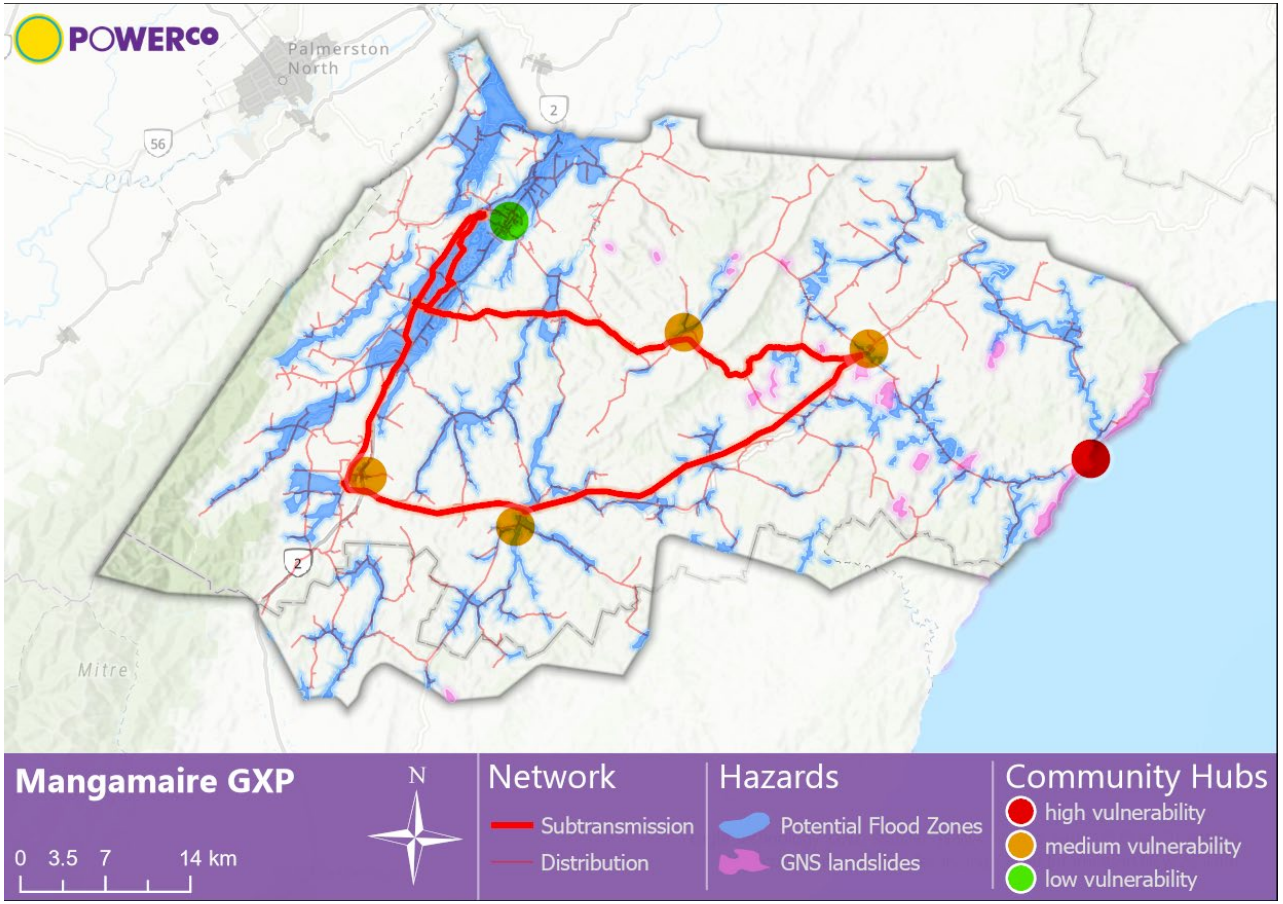
The subtransmission and distribution networks are almost entirely overhead.

Downstream of the zone substations, the distribution networks operate at 11kV.

These 11kV distribution feeders can be long and sparsely loaded. Locating, isolating, and restoring the network after a fault can be challenging and often time-consuming.

Table 13 – Tararua inland and coastal flooding – exposed assets.

	Ground-mounted transformers	**Zone substations**	
	Inland flooding (%)	Inland flooding Medium/high risk (protected)	Coastal inundation
Count	9 (9%)	1 (1)	0



Mangamaire GXP overview

The Mangamaire supply area is challenging. Our network traverses significant distances through rugged terrain out to Pongaroa and there are significant spur networks out to the coast. Hazard maps show significant areas of flood-prone soil around the river networks as well as slip-prone soil in the hill regions. The primary supply is the major ring network, of about 100km, that is generally only accessible via helicopter or 4WD. We have invested recently in better fault monitoring to allow us to find and locate network issues more quickly.

Significant services include water treatment plants at Pahiatua, Waione, and Eketāhuna, and emergency services supporting Pongaroa and Pahiatua.

Due to the challenging terrain, there is significant supply risks to this region. We have been installing improved indication on the subtransmission network to help identify fault locations. For this reason, supply to the emergency community hubs in this area is quite vulnerable, particularly Ākitio on the coast. We have been working with this community on a potential off-grid solution to support the community hall.

Figure 45 – We are working with the community at Ākitio on potential backup supply options.

Gas analysis for other regions

Analysis focused on assets at risk to inland inundation with varying levels of flood occurrence rates and at risk to coastal inundation for SSP 1-1.9 and SSP 2-4.5 climate change scenarios to 2050. Climate effects were modelled by a contractor and overlaid onto our gas distribution GIS maps. Vulnerable assets were then identified using the intersection of the flooding area and asset locations. Table 14 shows the number of each type of asset at risk to the two climate risks.

We have modelled our gas network to specifically identify regulator stations and special crossing assets vulnerable to inland flooding and sea level rise (coastal inundation) across our network. Regulator stations step pressures down to lower distribution pressures, which are safer, cheaper, and more reliable to reticulate throughout the network. They are integral to the supply of gas to our customers, and we are looking to maintain the operation of these stations as inundation of a station prohibits its ability to regulate gas pressures effectively.

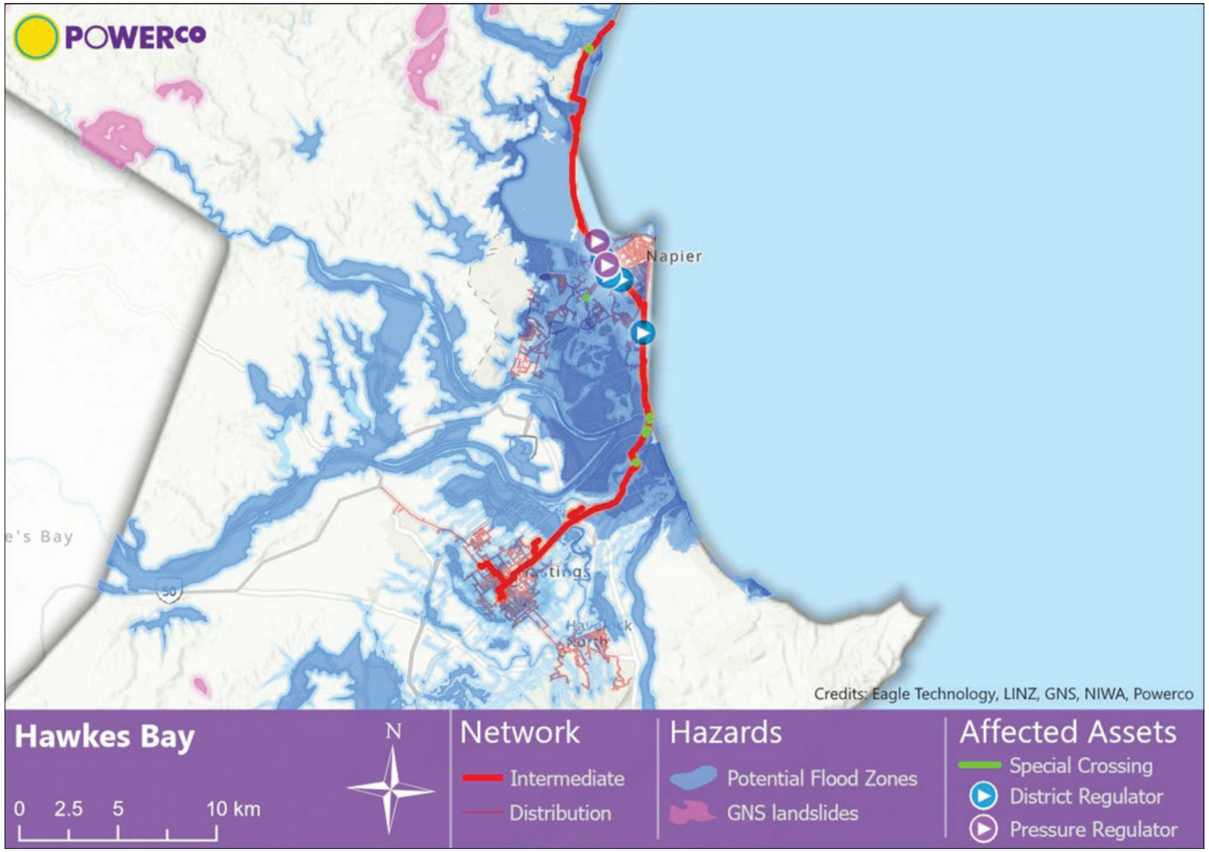
Special crossings are designed to provide above or below ground passage for a pipeline to ensure that the asset is kept safe at points of our network that are exposed to external factors, such as a river (bridge), road (national significance) or rail crossings. Our climate analysis focused on above ground bridge crossings on state highways that span rivers. These are generally bridges that span large distances, making them more prone to flooding and damage from slash. This was illustrated during Cyclone Gabrielle in 2023, when the pipeline attached to the Ngaruroro River bridge crossing was damaged almost to failure during flooding, which was caused by slash from forestry works up stream.

Table 14 – Total number of gas assets vulnerable to inland flooding and coastal inundation.

	Hazard			
Asset type	Inland flooding	Coastal inundation	Exposed to both hazards	**Total**
Regulator stations	29	9	8	46 (24%)
Special crossings	2	3	5	10 (3%)

Assets identified as vulnerable to both inland flooding and coastal inundation will be evaluated to consider different resiliency options in the planning stages. This will help determine the best option because of the dual risk they face. The following discussion looks at hazards by region and then investigates locally significant assets and trends we see throughout each region. Refer to Table 3 Section 4.2 Main document: 'Geography by region and historical climate variables and associated climate impacts' for insight into the geographic causes of the climate risks we see below.

Hawke's Bay



Overview

Large portions of the North Island's east coast are highly susceptible to flooding. Even under the best-case global warming scenario (SSP 1-1.9), much of Napier and its surroundings towards Hastings would be affected.

Flooding around Powerco assets occurs once every 60 to 100 years, indicating high impact but low likelihood.

Powerco has a single pipe running through the heavily impacted areas of Awatoto and Clive, serving as the sole feed for all of Napier. While Napier faces significant flood risks even in the best-case scenario, Hastings, being further inland, has no affected assets of concern.

Table 15 – Hawke's Bay inland and coastal flooding – exposed assets.

	Hazard			
Asset type	Inland flooding	Coastal inundation	Exposed to both hazards	**Total**
Special crossings	0	1	5	6
Regulator stations	0	4	2	6

Special crossings – Hawke's Bay

This map highlights three special crossings in Clive, just south of Napier. All three face similar climate risks, including inland flooding (once every 20 to 60 years) and coastal inundation scenario (SSP 1-1.9).

These crossings are part of the main pipeline feeding Napier and approximately 3,100 customers, including six major customers. Adaptation works for these assets are a high priority during the next planning cycle. Each crossing is on a bridge vulnerable to being washed away during a 1-in-60 to 1-in-100-year flood.

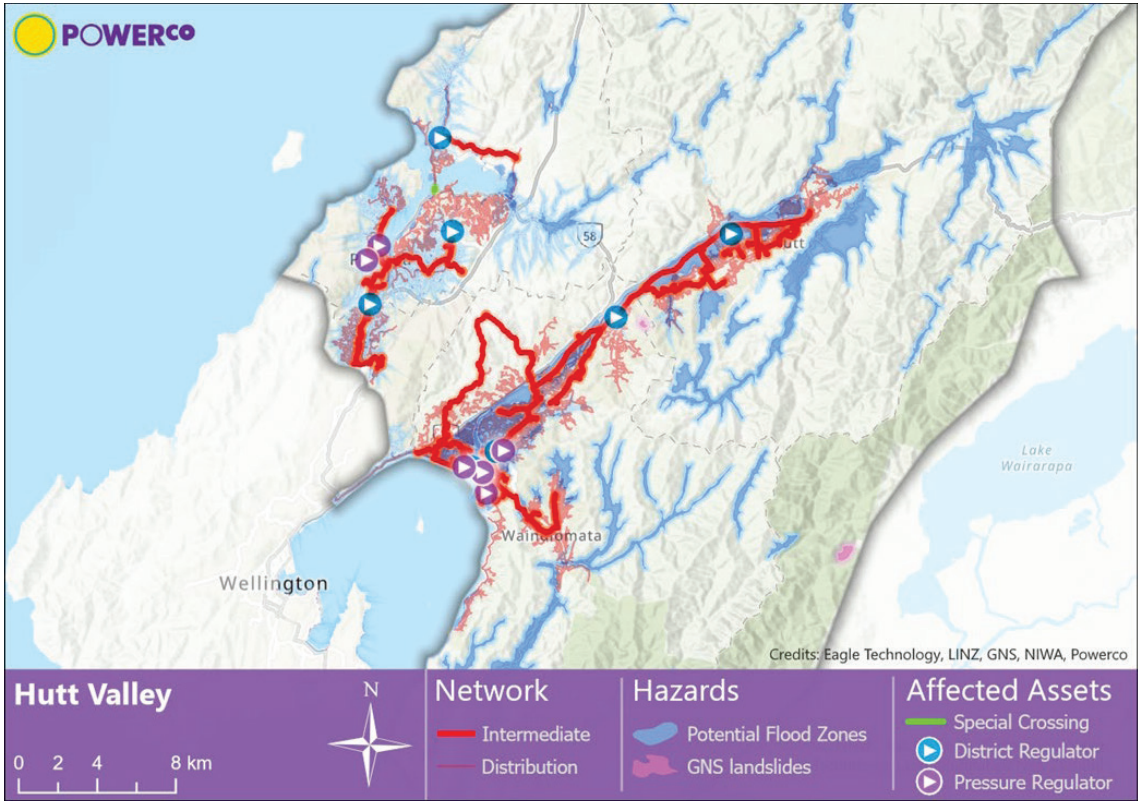
The Waitangi (Tūtaekurī) River bridge was the most affected during Cyclone Gabrielle in 2023, prompting ongoing investigations into proactive measures.

Future asset resiliency projects should consider the impact of upstream and downstream assets, and the asset's ability to perform its primary function.

For special crossings, the primary function is to protect a pipe across a bridge to ensure gas delivery. If one crossing fails, it can disrupt the gas supply to customers. Therefore, if multiple crossings on the same feed are at risk from the same event, all should be protected to maintain customer supply.

External factors, such as bridge design, location, and clearance will be considered during planning.

Hutt Valley and Porirua



Overview

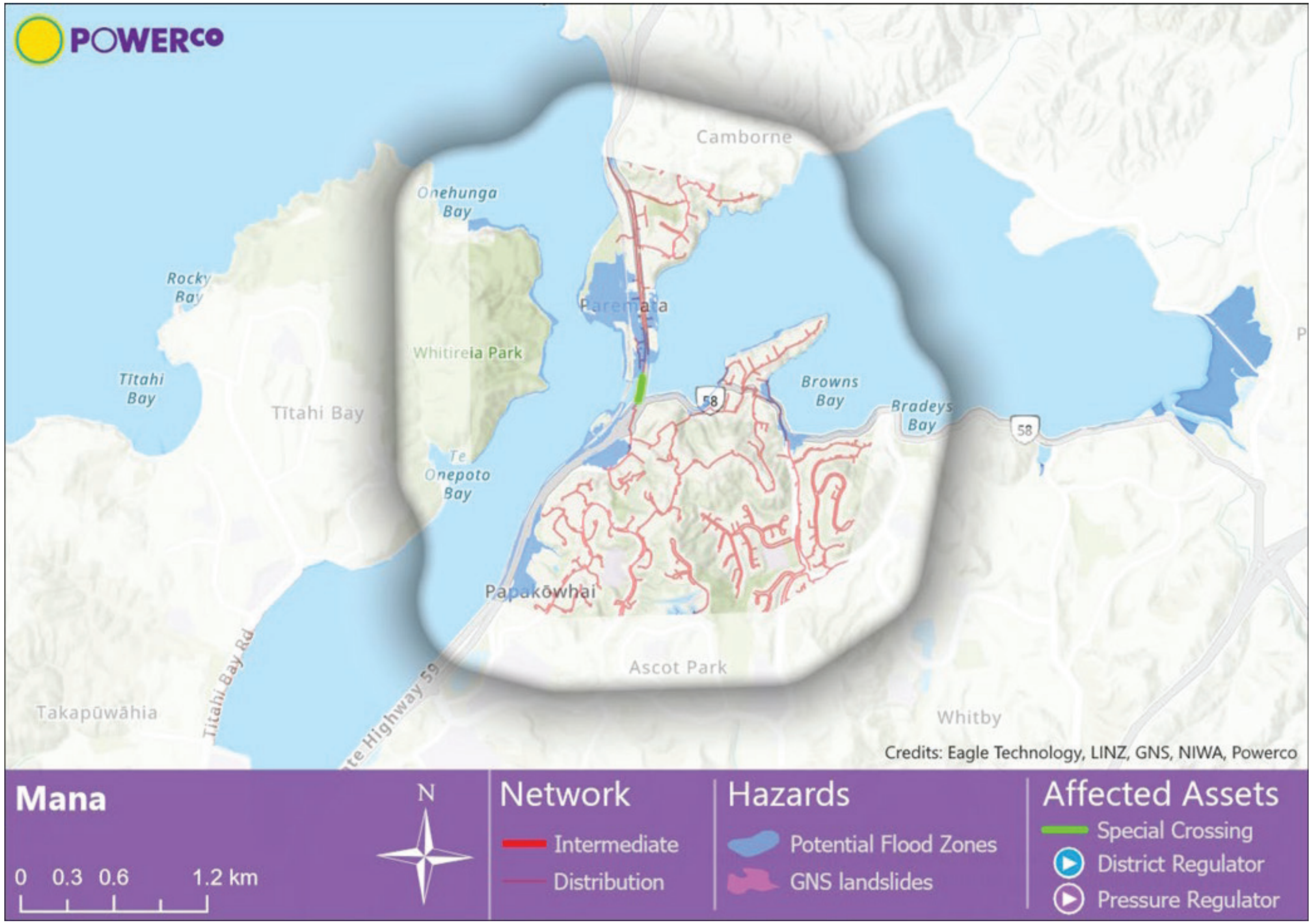
Assets that are susceptible to 1-in-100-year flooding are in the flood plains of the Hutt Valley. As a result, 14 regulator stations are at risk of inland flooding, with a concentration around the Hutt River.

Only a small proportion of the land area in the region is at risk to coastal flooding, mostly around the Petone and Porirua areas.

In Porirua, the risk is related to coastal inundation where a bridge spans an estuary. The likelihood of an event occurring is between 1-in-60 and 1-in-100 years. As a result, only a small number of assets need to be considered in resiliency planning.

Table 16 – Hutt Valley and Porirua inland and coastal flooding – exposed assets.

	Hazard			
Asset type	Inland flooding	Coastal inundation	Exposed to both hazards	**Total**
Special crossings	0	2	0	2
Regulator stations	13	1	1	15



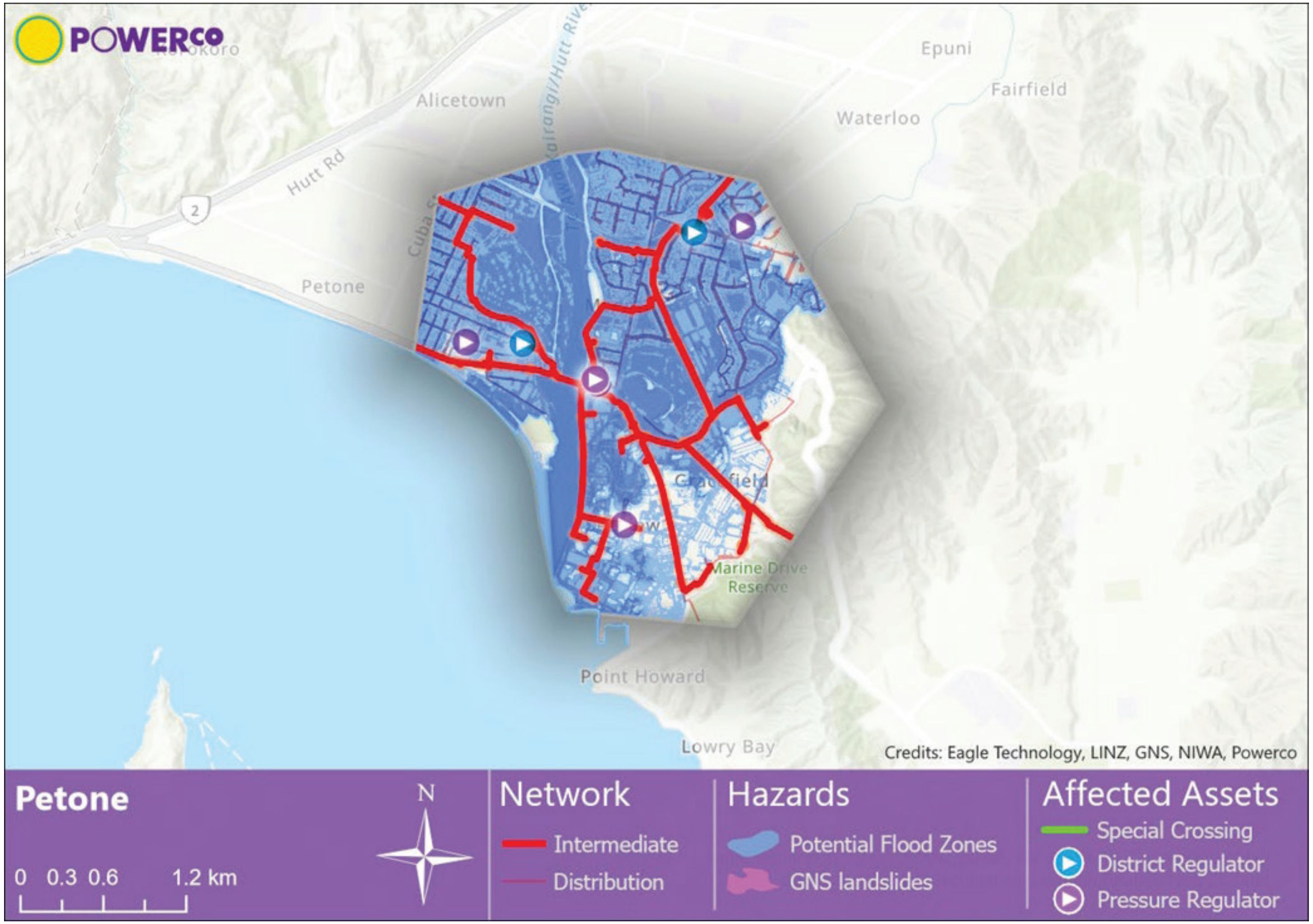
Special crossings – Hutt Valley and Porirua

The only affected special crossing in the greater Wellington region is the bridge connecting Mana to Paremata.

There are two pipes running parallel to each other across the bridge, connecting a single length of pipe on either side of the bridge to maintain capacity. It is considered difficult and unnecessary to improve the resiliency of the pipes across the bridge because:

- Other utilities in the same vicinity makes strengthening difficult.
- The dual feed from the Pāuatahanui and Waitangirua gas gates to this area ensures that losing this crossing would not disrupt customer supply.
-

In the event of a loss of containment, isolation at each end of the bridge would be used to reduce emissions and safety risk to nearby personnel.



Regulator stations – Hutt Valley and Porirua

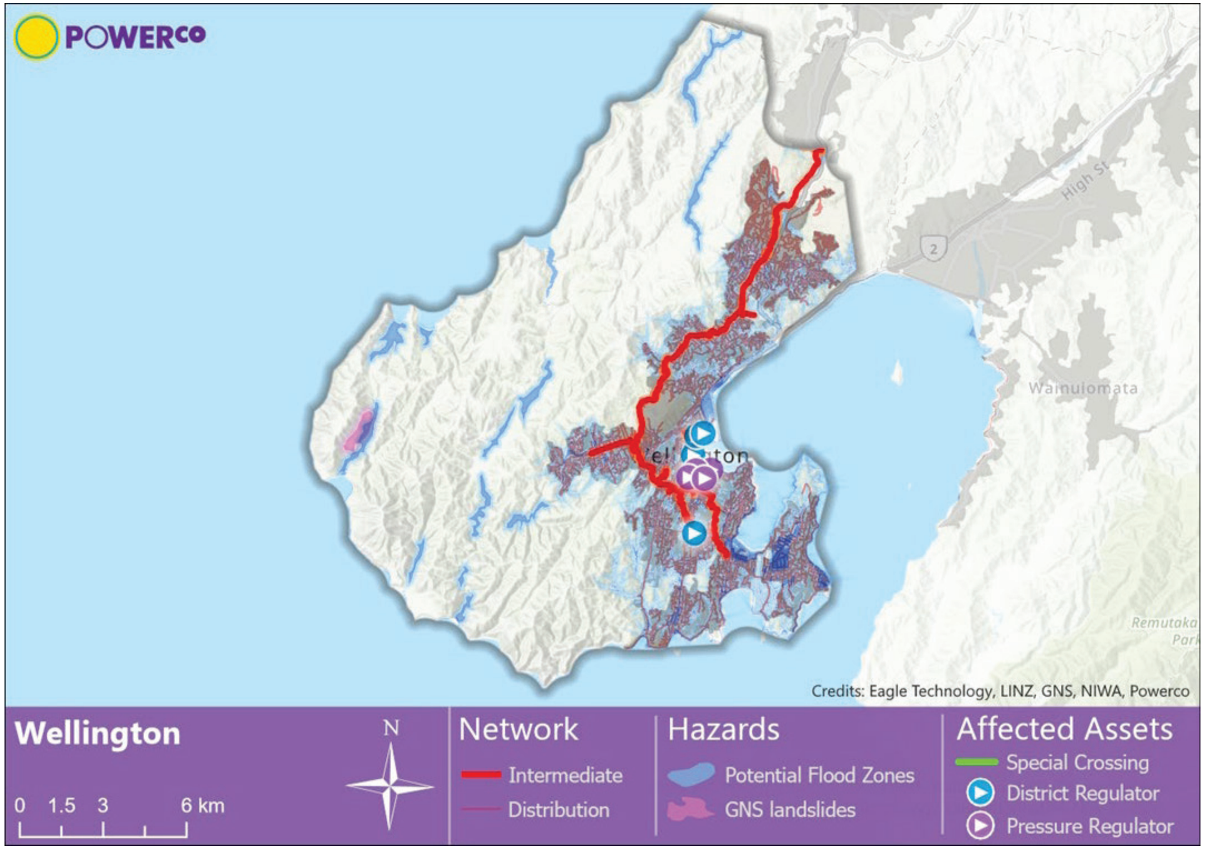
In Petone, at-risk regulator stations are impacted by either a 1-in-60 years flood, or 1-in-100 years coastal inundation flooding.

The flat topography of Lower Hutt and Petone makes them susceptible to flooding risks. The Hutt River flows south into the Wellington harbour, and even with existing flooding protection, this area is vulnerable.

The purple assets all feed fewer than 10 customers each, whereas the northern most blue station would lose supply to almost 7,000 customers.

Work with the Hutt City Council will need to be carried out to determine the efficacy of flood banks or other solutions to protect homes and buildings of the community surrounding the river.

Wellington



Regulator stations – Wellington

Nine of the 11 affected assets in the region are in the Wellington CBD, as illustrated by the accompanying map.

All but one station is affected by the best-case coastal inundation scenario, and five face a 1-in-60 to 1-in-100-year flood risk.

The Wellington CBD is especially vulnerable to a large-scale climate event because of its reclaimed land. Despite the high number of stations, adequate backfeed can supply most customers during an outage, provided no more than one station is compromised.

While there are many customers in this area, none are critical. The maximum number of customers served by a pressure regulator station is 52, making these stations less strategic for maintaining supply compared to the district regulator stations in the area.

Table 17 – Wellington inland and coastal flooding – exposed assets.

	Hazard			
Asset type	Inland flooding	Coastal inundation	Exposed to both hazards	**Total**
Special crossings	0	0	0	0
Regulator stations	3	4	4	11

POWERCO