

Meeting Date: 1 June 2023

CYCLONE GABRIELLE AND EXTREME WEATHER EVENTS - UPDATE

SECURITY AND RELIABILITY COUNCIL

This paper updates on the impact of recent weather events on power system security and reliability and gives information about other work and reporting on infrastructure resilience.

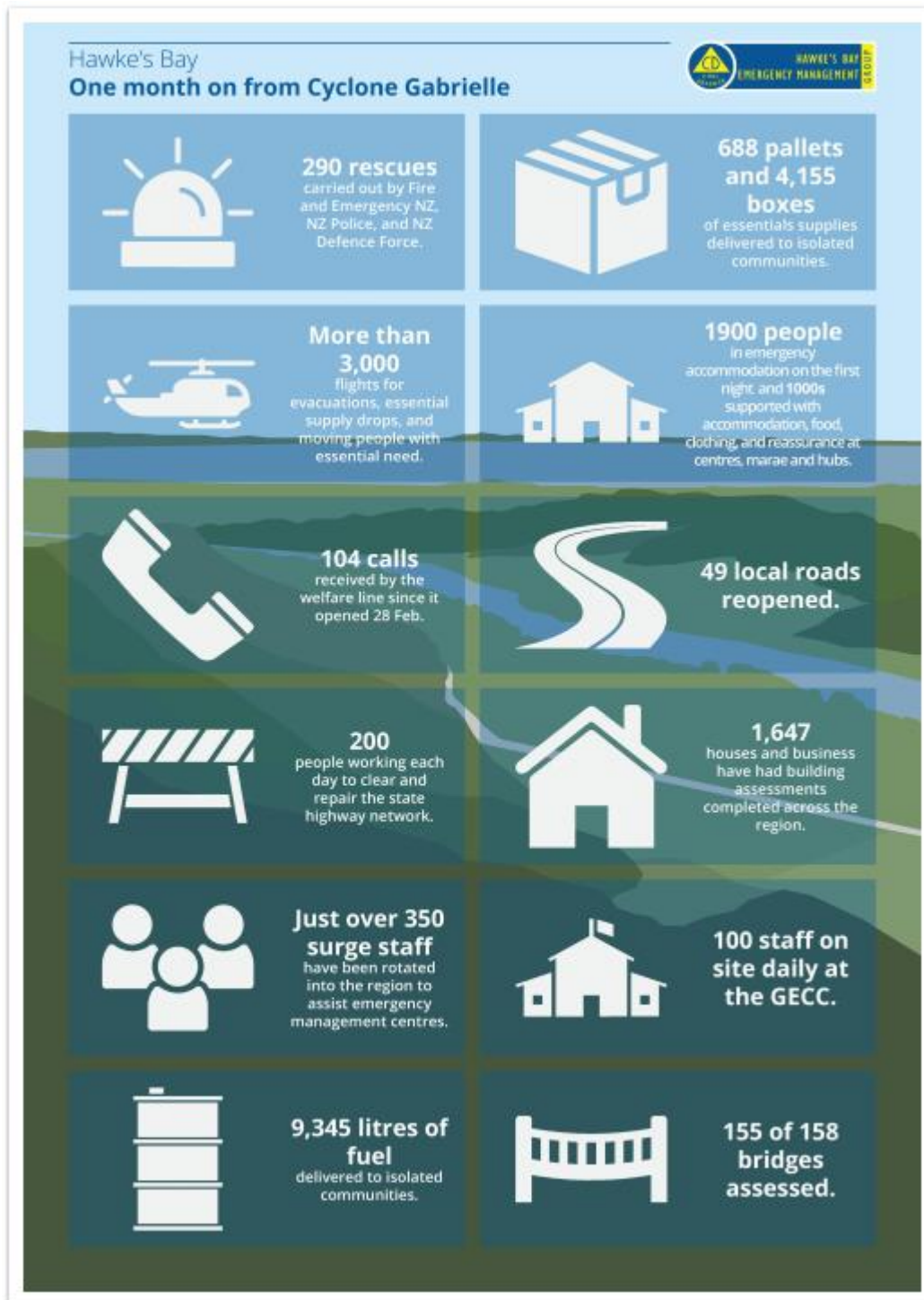
Note: This paper has been prepared for the purpose of the Security and Reliability Council (SRC). Content should not be interpreted as representing the views or policy of the Electricity Authority except where specifically noted.

Cyclone Gabrielle and extreme weather events

- 1.1.1 The SRC has asked the secretariat to provide information on reports arising from the Cyclone Gabrielle and related weather events. The purpose is to enable deeper consideration of the security and reliability impacts of these events, to inform the SRC's advice to the Authority Board.
- 1.1.2 At the SRC's March meeting, the grid owner gave an update on its initial reporting and actions since February 14.
- 1.1.3 For the June meeting, the secretariat has invited Te Waihanga, the New Zealand Infrastructure Commission, to update at this meeting on its work and to give its view on the implications of these events on electricity infrastructure resilience. Ross Copland, Infrastructure Commission CE, will give a verbal presentation at the meeting.
- 1.1.4 The secretariat has also gathered other information, included below, as an update on post-event resilience work to address impacts from these events and plan for the future.

General Update

- 1.1.5 The following graphic sets out some key numbers, released by the Hawkes Bay Civil Defence Management Group (HBCDEM) a month on from the events. The secretariat notes HBCDEM are not directly monitoring or reporting on electricity outages as the supply from a consumer's perspective, was quickly restored.



1.1.6 HBCDEM scaled back their response six weeks after its coordination centre was activated on 14 February. According to CDEM, this is only the third time a national emergency has been declared.

1.1.7 Ongoing work will continue in accordance with the Regional Recovery Framework¹ recently announced for Hawkes Bay, with appointment of Keriana Brooking as its Interim Recovery Manager. The approach for the framework is that it will be locally led, regionally coordinated and government supported.

¹ <https://www.hbemergency.govt.nz/index.php/news/article/112/approach-for-regional-cyclone-recovery-announced>

- 1.1.8 The work has transitioned into recovery, led by councils, iwi organisations and “other recovery structures” work on building back from the disaster. While the transitional phase has begun there is further work ongoing “to ensure those that still need emergency food and supplies get what they need”.
- 1.1.9 On Saturday 13 May, State Highway 2 between Wairoa and Napier opened. Progress on the recovery in Auckland was hampered by heavy rain and thunderstorms resulting in a state of local emergency being declared.
- 1.1.10 Transpower issued a media release last month on work underway to improve security of supply in Hawke’s Bay,² Tairāwhiti and Northland. This will strengthen security by removing reliance on a single circuit through creation of two new circuits connecting the Tuai substation directly to the Fernhill substation in Hastings. According to Transpower this will add additional resilience to the region and significantly reduce the risk of prolonged outages in future.
- 1.1.11 Additional work in Northland involved moving two 220kv circuits to temporary towers on firm ground, which has “vastly reduced the risk of power cuts for residents of Northland”.
- 1.1.1 A recent Energy News article noted the impact of events on [weather-related damage to Top Energy’s distribution network](#).
- 1.1.12 The secretariat has previously made Energy News available to members, enabling members to keep up to date on further reporting and actions.

Infrastructure action plan

- 1.1.13 The government has released its infrastructure action plan³. Members may wish to review the first section of the plan (up to page 16) and look at the relevant electricity actions noted in annex 1.
- 1.1.14 Te Waihangā will monitor and report on progress toward the actions and objectives outlined in the action plan. The secretariat has asked Te Waihangā to give its view on how these events impact power system security and reliability and how it shapes the response and future planning required.
- 1.1.15 Members may wish to ask Te Waihangā representatives about additional concerns they may have about aspects of the action plan and its implementation.

Grid owner report to the Commerce Commission

- 1.1.16 As noted in the March SRC papers, and in significant media coverage at the time, Cyclone Gabrielle had a major impact on power system resilience, impacting the national grid and local distribution networks.
- 1.1.17 The grid owner is required to report to the Commerce Commission and others on a range of issues. Members can use this link to access grid owner disclosures: <https://www.transpower.co.nz/our-work/industry/regulation/rcp3/rcp3-updates-and-disclosures>.
- 1.1.18 The grid owner is also required to report on “unplanned interruptions over one system minute, or which last 12 hours or longer”. A copy of the grid owner’s

² <https://mailchi.mp/transpower.co.nz/news-from-transpower-apr23>

³ <https://www.treasury.govt.nz/sites/default/files/2023-05/infrastructure-action-plan-2023.pdf>

published report (also available on via the above link) is included in appendix B to this paper.

- 1.1.19 The grid owner will also be undertaking a lessons learnt review, with results to be made public in due course.
- 1.1.20 Due to limited time in the June agenda, in lieu of another verbal update or presentation from the grid owner, the secretariat can take further SRC questions or feedback and pass these onto the grid owner team.
- 1.1.21 Representatives from Te Waihanga, the New Zealand Infrastructure Commission, will give a verbal presentation on general implications for network resilience and be available for questions.

Questions for the SRC to consider

The SRC is asked to consider the following general questions.

- Q1. What, if any, additional points would the SRC like considered by the grid owner, as part of its lessons learned review to be made public in due course?**
- Q2. What further information would the SRC like to see about the infrastructure impacts of extreme weather events and the work ahead?**
- Q3. What further information, if any, does the SRC wish to have provided to it?**
- Q4. What advice, if any, does the SRC wish to provide to the Authority?**

Appendix A: Grid owner report to Commerce Commission



24 April 2023

Regulation Branch

Commerce Commission

By email: regulation.branch@comcom.govt.nz

Copy to: Matthew.Clark@comcom.govt.nz;

Interruption Report: Hawkes Bay loss of supply – 14 February to 22 February 2023

In the early morning of 14th February 2023, severe weather from Cyclone Gabrielle impacted the operation of the National Grid in the Hawke's Bay and neighbouring regions. Hawke's Bay telecommunications circuits, and several Central North Island transmission circuits were lost initially. Then Redclyffe (RDF) and Whirinaki (WHI) 220 kV substations tripped off due to inundation, resulting in 103 MW loss of supply across the five grid substations in the region – Tuai (TUI), WHI, Whakatu (WTU), RDF, and Fernhill (FHL) – as well as disconnecting generation at TUI and WHI.

In addition to flooding at the RDF and WHI substations, the impact of Cyclone Gabrielle included outages in the Central North Island caused by exceedingly high winds, slips undermining transmission towers on hills in the Hawke's Bay region, the collapse of one tower due to flood waters and debris, damage to conductors from fallen trees, and the loss of most fibre-based telecommunications. The extent of immediate damage to our grid and telecommunications infrastructure was confirmed on the 14th and 15th February. It has been addressed as part of progressively restoring our network over the following days and weeks. Additional damage to towers and transmission lines was identified as further inspections were completed.

The RDF and WTU interruptions started at 0739 on 14th February. These were partially restored on 17th February with livening of the bypass to the WTU bus, and on 20th February with a first supply to RDF. They ended at 1828 on 22nd February when a second RDF supply was made available.¹ The WHI 11 kV bus tripped earlier in the morning, at 0532 on 14th February disconnecting supply to Pan Pac Forest Products.

¹ At this point in time, we were able to supply all load demanded at our grid exit points. This was less than full load due to damage to local networks.

Transpower must publicly report on unplanned interruptions over one system minute, or which last 12 hours or longer, including about:

- the cause of the unplanned interruption
- the start date and time of the unplanned interruption
- the end date and time of the unplanned interruption
- the megawatts affected by the unplanned interruption
- the grid exit point(s) and grid injection point(s) affected by the unplanned interruption
- actions Transpower took to minimise the effect of the unplanned interruption
- a description of steps that Transpower proposes to take to mitigate the risk of future unplanned interruptions of this type.

Please find **attached** our report in accordance with clause 26.1 of our Individual Price-Quality Path (IPP) Determination 2020. This letter and the attachment will be published on our website. We will submit a Normalisation Event application in accordance with clause 20 of the IPP, following the end of the disclosure year. This will include outages to date, plus additional outages required for remedial work resulting from Cyclone Gabrielle.

This was a major natural disaster and civil emergency. It is the single largest event we have experienced in terms of damage to the Grid and the associated interruptions to supply and connections. We are pleased with the response and recovery to date, particularly the dedication of our teams and service providers, Unison Networks, Eastland Network, and Genesis Energy, telecommunication infrastructure providers (coordinated through the Telecommunications Emergency Forum), and Waka Kotahi New Zealand Transport Agency (NZTA), working in extremely difficult work environments. Our work with customers to complete restoration was of note, particularly given the limitations of telecommunications and communications infrastructure at the time. That said, we will seek to learn from the experience to inform future planning and event response. The results of our lessons learned review will be publicly available in due course.

Yours sincerely,



Mark Ryall

General Manager, Grid Delivery

INTERRUPTION REPORT – HAWKE’S BAY INTERRUPTION 14-22 FEBRUARY 2023

Summary

The Event

In the early hours of 14th February 2023, severe weather from Cyclone Gabrielle started to impact the operation of the National Grid in the Hawke’s Bay region. Just after 0100, the Rangipo_Wairakei_1 and Rangipo_Tangiwhai_1 circuits tripped and the Rangipo point of connection was lost², and at 0404, telecommunications were lost to the Tuai (TUI) and Whirinaki (WHI) substations due to fibre optic cable damage.³ Over the next three hours, three circuits tripped, suspected to be due to strong winds – in each case they successfully auto-reclosed, maintaining supply.

At 0719, the Transpower National Grid Operations Centre (NGOC) received reports that water levels were rising around the Redclyffe (RDF) substation. A Transpower service provider attempting to access the RDF site was also unable to reach the site around this time due to flooding on Springfield Road. At 0739 the RDF 220 kV bus tripped and telecommunication connections to the site were lost due to flooding, resulting in total loss of supply (103 MW, approximately 92,000 customer connections) across the five grid substations in the region – RDF, WHI, TUI, FHL and WTU.⁴ Generation from Genesis Energy’s Waikaremoana scheme, which injects into the 110 kV system at TUI was also disconnected.⁵ The System Operator declared a Grid Emergency at 0800, without visibility (due to telecommunications failures) and site access the full status of the site was not possible to obtain until 1600 that day once a responder was able to get to site.⁶ Given the way the telecommunications failures occurred we were reasonably confident there was major equipment damage which meant we could start considering approaches to restoration. The power system outside the Hawke’s Bay region continued to operate as expected, though there were several short duration outages caused by the same weather system.

² We were unable to access the circuit until daylight due to safety concerns of forest managers. The circuits and connection were restored at 1005.

³ While we have three diverse telecommunications cable routes between WHI, Napier and TUI, all were damaged at different places.

⁴ It was later determined that the WHI bus had tripped earlier, at 0532 on 14th February, but this was not obvious at the time due to loss of telecommunications.

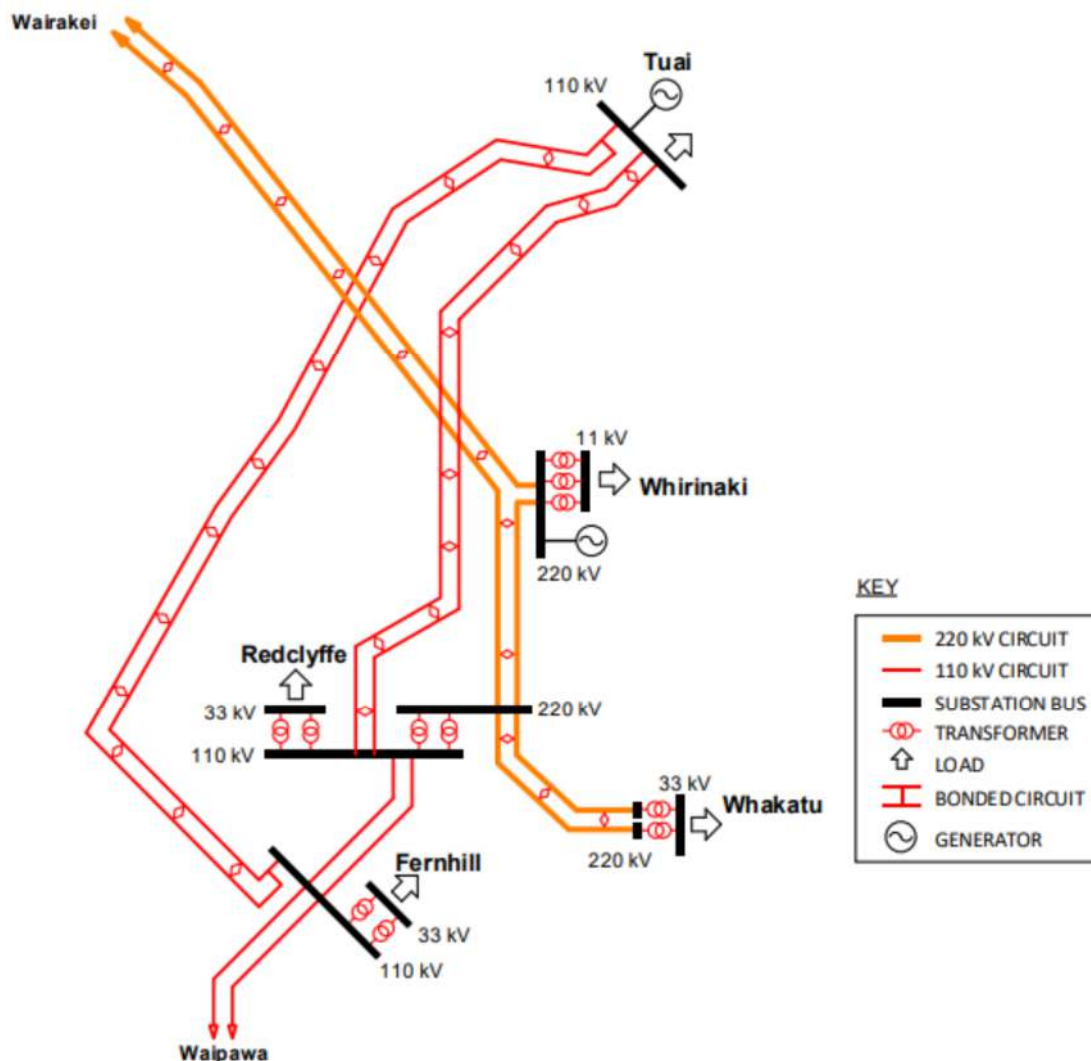
⁵ The Waikaremoana stations at TUI were generating at the time of the tripping (excluding three units which were out of service). The Whirinaki station was also disconnected and was not generating at the time of the tripping.

⁶ The RDF 220 kV yard and control room was flooded to 1.5m, with 1.0m of flooding in the 110 kV yard. Flooding was around 2.0m at the Whirinaki substation.

Normal transmission

Under normal conditions, transmission into the Hawke's Bay region is via two 220 kV circuits (on the same towers) from Wairakei (WRK), as shown in Figure 1. These directly supply the WHI and WTU loads, and two 220/110 kV interconnecting transformers at RDF. There are also two 110 kV circuits connecting the Hawke's Bay 110 kV system at FHL to Waipawa; however, under normal conditions these are open at Waipawa. As such, the 110 kV grid in Hawke's Bay is normally supplied via the RDF interconnecting transformers.

Figure 1: Hawke's Bay Grid



Response

As we had lost 220 kV supply to RDF substation and everything downstream, our first step towards restoring supply was to execute our Hawke's Bay 110 kV contingency plan. The contingency plan had been updated post the 2016 snowstorm event, and further enhancements incorporating protection operation and resilience for the region were completed in September 2021. The System Operator and National Grid Operations Centre use this plan as part of grid emergency scenario training. The plan worked well and resulted

in the closing of splits in the 110 kV circuits at Waipawa, which enabled supply from Bunnythorpe (BPE) into FHL. Switching was completed, and supply made available at 0954 with Unison notified at 1001 on 14th February. While only 20 MW could be supplied from BPE, this also enabled us to liven the FHL–TUI circuit, which:

- allowed FHL (which supplies Hastings, including the hospital, and Havelock North) to be increasingly supplied by generation from TUI over the course of this and following days, and
- enabled synchronisation of the TUI generators to the 110 kV system, as a precursor to restoring supply to Eastland Network and back to FHL. Generation from TUI was injected from 1207 on 14th February enabling supply to Gisborne and Wairoa, which increased over the course of this and following days.

As soon as we were able to do so, we carried out inspections of our substations. RDF substation was a key focus, being a 'hub' for 220 kV transmission into the region. Telecommunications services to the substation were unavailable from 0739 on 14th February, and it was not until the afternoon, when waters receded sufficiently around the site, that our service provider first responder was able to undertake a preliminary⁷ visual inspection. A full fly-over inspection of the network was carried out on 15th February.⁸ WHI substation was reached by motor vehicle on 16th February. WTU substation had not been directly affected by flooding but its connection to the 220 kV bus via RDF had been lost, whilst assets were serviceable, without local supply, battery backup and the installation of an emergency generator supported secondary assets and enabled quicker restoration of services. On 3rd March, to assess the risk associated with potential fall distance trees, we carried out an aerial inspection of assets in the forestry corridor around the RDF–TUI circuits. Roads remained inaccessible, so personnel were subsequently flown in to fell trees and mitigate identified risks.

The RDF 220 kV control room and switchyard had been inundated following the overtopping of stop banks up-river from the site⁹. It was quickly recognised that it would take

⁷ The site was still under water, with deep silt to varying levels.

⁸ Helicopters were initially unavailable as were understandably prioritised for search and rescue, one became available late afternoon on 14th February, but strong winds precluded flying the network on the 14th February. On 15th February, conditions allowed a helicopter patrol from Wellington, Transpower also joined a Waka Kotahi New Zealand Transport Agency (NZTA) reconnaissance flight.

⁹ The 220 kV switchyard dates to the 1970s and sits lower than the 110 kV yard, as such it is a one-off design, we have no other 220kV substations of this low-slung bus design. The 33 kV switch room which incorporates protection was built about 10 years ago, to a 1-in-450-year design standard.

considerable time to return the 220 kV system to service, and solutions were sought to restore power to Hawke's Bay as quickly as possible, with a basic protection system.¹⁰

The following staged response was developed and implemented, working closely with Unison throughout:

- A bypass solution to enable supply to WTU. This connected a 220 kV circuit from Tauhara (TAB), through RDF 220 kV Bus B to WTU.¹¹ Extensive changes were made to physical protection and current transformer settings at TAB, RDF and WTU. Detailed commissioning plans and switching sequences were required, and substantial cleaning and silt removal, involving up to 50 crew members and 12 hydrovac trucks, was carried out in the 220 kV yard at RDF. This stage of work was completed on the afternoon of 17th February, providing sufficient capacity to supply the region, and enabling supply to Napier city (though demand remained restricted due to damage within, and the configuration of, the local Unison network).
- Initial 33 kV supply was made available through Transformer T2 at RDF 33 kV Bus B via a 110 kV connection to TUI. This was completed on 20th February.
- A second supply to RDF (33 kV Bus A) was made available on 22nd February in conjunction with Unison, by installing a temporary 33 kV tie line (backfeed) from WTU using the 220 kV line.
- Commissioning of the WHI 220 kV bus via WHI_WRK_1, providing for supply through the WHI 220 kV bus.¹² Once livened on 3rd March, these assets were removed from service to enable continued clean-up of the WHI site without the risk of working around live assets. This was possible because the customer connected at WHI was not yet ready to take supply/connect. Supply from WRK to RDF 220 kV Bus A via RDF_WHI_1 and the WHI 220 kV bus was livened, on 8th March. Between WRK and WTU a telecommunications connection could be established via an unaffected telecommunications network path to provide line protection signalling for this circuit.
- A collapsed tower on the FHL–RDF circuits was replaced with a monopole, enabling bypasses at RDF, and allowing FHL_RDF_1 and RDF_TUI_1 to be livened on 11th March, and FHL_RDF_2 and RDF_TUI_2 on 17th March. WHI restorations were

¹⁰ The basic protection system implemented made deliberate exceptions to our normal standards in order to restore service as soon as possible, this comprised lines protected by existing far end protection and transformers on site having single differential protection.

¹¹ The connection utilised the primary switch gear at RDF to electrically connect Redcliffe_Tauhara_1 (RDF_TAB_1) to RDF_WTU_1, jumpered across to bypass some RDF primary plant and all RDF protection, telecommunication, control, and secondary systems.

¹² The bus remained isolated from transformer bays and was only used to connect to the WHI_WRK_1 and RDF_WHI_1 circuits at this stage. WHI transformers T1, T2 and T3 were not energised.

completed as follows: T3 and local service on 8th March, T2 and Bus B on 28th March, and T1 and Bus A on 4th April.

At RDF and WHI, both of which had been inundated with floodwaters, extensive works were required to progressively return the substations to working condition. This included bringing in diggers and hydrovac trucks to remove silt, condition assessments of primary and secondary assets, maintenance (water blasting, drying, contact cleaning, testing), repair or replacement of equipment, and updating of protection settings. New assets were sourced from spares or other projects, and telecommunications restored. Management of site security and worker health and safety were key focus areas, given reports of looting and the contaminated silt.

Our ability to undertake this work was significantly limited by flooding, road closures and loss of telecommunication services, which affected remote operations and Supervisory Control and Data Acquisition (SCADA) indications for our NGOC.¹³ In most cases we could not undertake remote switching, and manual switching was difficult to arrange in some cases due to operational communication challenges and no road access to sites. Access to accommodation, fuel, food, and ability to provide logistics and support to crews in the region also challenged the ability to respond. Damage to the Unison and Eastland networks (as well as Whirinaki power station and Pan Pac Forest Products) restricted their ability to utilise supply when we made it available.

As telecommunications services were available at FHL (unaffected from flooding) by working closely with Unison's fibre teams, using a fibre connection supplied by them, we could bypass RDF and restore telecommunications with WHI.

A secure encrypted Starlink terminal was installed at TUI to restore SCADA visibility of site. Genesis power station staff at site provided us capacity on their network as a contingency for line protection signalling, as well as providing onsite technical assistance with the Starlink installation terminal installation.

The Telecommunications Emergency Forum (TEF) provided coordination of all telecommunication fibre optic restoration activities in the region, assisting through prioritisation the establishment of connections to our sites, including mobile coverage of RDF.

Optical fibre asset owners assisted us to get connections through to TUI and Taupo, and Transpower in return provided technical staff to assist them with jointing works and restoration of their cables. Restoration of supply was very much a collaborative effort

¹³ We could not access ~90% of our assets in the region by motor vehicle in the days after supply was lost. Severe damage to roads and rail corridors caused by flooding, together with slips resulted in the fibre telecommunications cables used by Transpower also being severely damaged.

between Transpower as System Operator, Transpower as Grid Owner, and its service providers, working very closely with Unison Networks, Eastland Network, and Genesis Energy.

Communication and stakeholder engagement

We quickly provided information to government stakeholders when supply was lost in the region and provided regular updates on the extent of the damage and the implications for supply as the situation became clearer. This included Ministers' offices, Department of Prime Minister and Cabinet, Ministry of Business, Innovation and Employment (MBIE) and the Electricity Authority. The Commerce Commission was not on our stakeholder contact list for crisis situations but was added the next morning given the situation. We kept the Electricity Desk Lifeline Liaison at the National Emergency Management Agency National Coordination Centre updated and responded to requests for information.

We also worked closely with media and used our website and Facebook page to inform the public and other stakeholders in the affected areas about what had happened, what we were doing to restore supply, and the likely duration of the outage. We were able to make contact with the Communications Manager at Unison a couple of hours after the event started, and worked closely with them from that point on. We had no communication initially with the communications contact at Eastland as a result of disruption to telecommunications channels in the area, but we began working closely with them as soon as contact could be re-established.

Other damage

Other substantial damage to our network was identified through a combination of aerial and ground patrols on 15th and 16th February, and interim repairs or replacements completed. This damage did not cause additional loss of supply but did require substantial resources to resolve. In some cases, this work required access roads to be constructed, and equipment to be brought in by air. This included:

- One tower (FHL-RDF-A0009) collapsed due to flood water from the Ngaruroro River and a build-up of debris around its base, it was dragged 200m downstream. We replaced the tower with a permanent new monopole and restrung both circuits across the river by helicopter.
- Several towers (FHL-DEV-A0736, RDF-TUI-A0099 and WRK-WHI-A0226) were undermined by slips requiring immediate and/or longer-term earthworks, installation of temporary guys, slope protection reinstatement, foundation repairs or tower replacement. Due to access tracks and roading having suffered catastrophic damage, access to some locations required personnel to be flown in via helicopters, including the use of a heavy lift Black Hawk helicopter to transport a 2-tonne digger to work sites.

- Conductor on one circuit (RDF-TUI-A0086-0096), in the Kaiwaka Forest was damaged by fallen trees. Repairs were completed underslung from a helicopter, and trees within fall distance of the line which were undermined by slips were felled. Additional damage to structures has been subsequently identified through ground patrols, and will require further structure guying and remediations.
- Slips in the Northland region affecting our circuits, required substantial resources to be allocated. The worst slip location required relocation of both the 220kV Henderson Marsden A line and the 110KV Henderson Maungatapere A line (all four circuits into Northland), due to one tower of each line being at high risk due to the slip. This work included removing conductors from the 110kV tower at risk, reclamping 220kV insulators as a temporary measure to reduce loading, establishing more than 4km of new access tracks, clearance of forestry to make room for the temporary 220kV route alignment, engineering design and installation of three temporary Lindsey Tower Emergency Response Structures (ERS), including more than 60 ground anchors for guy wires, movement of two 220kV circuits (one duplex and one simplex) onto the ERS, associated conductor pulling, clamping, jointing, sagging of these conductors.

We were in close communication and supported by Vector, Top Energy, and Northpower during this work, as well as receiving offers of help from Waka Kotahi via the Northland Lifeline Utilities Group. Work to come includes removing the two redundant towers adjacent the slip, installing a new permanent 110kV line deviation, then installing a new permanent 220kV line route.

- Also resulting from the Cyclone (and previous floods) were two tree strikes (one requiring tree removal from the HEN-MPE-A line), three helicopter patrols of all Northland, more than 40 other slips that are being monitored, 9 of which are being investigated further by Engineering Geologists for risk and remediation advice (but do not pose immediate concern).

Recovery

With the RDF control room flooded to up 1.5m, we had to completely rebuild our communications and protection assets, including repurposing, and raising the emergency accommodation on site for use as a temporary control room, running new telecommunications and protection cables, and installation of new equipment. This has been planned and implementation is progressing in significantly compressed timeframes with items sourced from spares and other projects throughout the country.

Full 'Recovery' will restore the system to normal operating resilience, with appropriate protection on all circuits. Recovery requires us to reverse many of the short-term changes made to enable power to be supplied during the initial response. The recovery phase will

continue involving a large team of our most skilled service providers over a period of 3-4 months. Some planned outages will be required during that period to complete the works.

Future planning

Alongside returning the system to normal operation, we are considering the longer-term approaches at our RDF, WHI and WTU substations. These sites were identified, in a 2020 desktop study, as three of 12 sites nationally that are at risk of inundation in a 1:100-year flood. RDF and WTU rely on stop banks for protection, as was the practice when they were built.¹⁴ Prior to this event we had planned to address flooding risks at these sites in RCP4 and RCP5 as part of the proposed resilience portfolio in our RCP4 submission. We are reconsidering this approach and whether it is sufficient, in light of this event.

This work is discussed further in our response to clause 26.1.7.

Clause 26.1.1 – the cause of the unplanned interruption

Catastrophic rainfall due to Cyclone Gabrielle caused rivers to breach their banks or stop banks, resulting in inundation of our RDF and WHI substations, causing total loss of supply to Hawke's Bay. The cyclone also caused considerable damage to other parts of the network, bridges, roads, culverts, and access tracks due to slips, floodwaters and debris, and tree fall. Our telecommunications network also sustained significant damage.

Meteorological data reviewed at our daily Operations meeting on 13th February indicated that the weather system would hit the Hawke's Bay with high winds, lightning and more than 10mm of rain. This forecast did not give us any reason to expect more significant impacts on our assets than we deal with normally. However, data collected to date indicates that rainfall significantly surpassed forecasts.¹⁵

Clause 26.1.2 – the start date and time of the unplanned interruption

The RDF and WTU interruption started at 0739 on 14th February 2023.

The WHI interruption started at 0532 on 14th February 2023.

¹⁴ Note that the new RDF 33 kV switch room is an exception to this: it was built to a 1:450-year average recurrence interval assuming stop bank failure did occur. Equipment was unaffected by flood waters in this event.

¹⁵ <https://www.hbrc.govt.nz/home/article/1415/rainfall-data-shows-intensity-of-cyclone-gabrielle>

Clause 26.1.3 – the end date and time of the unplanned interruption

The interruption to WTU was resolved at 1616 on 17th February. The RDF interruption first restoration occurred at 2114 on 20th February. The interruption ended at 1828 on 22nd February when full service was available, albeit with single protection.

For the WHI interruption, supply was initially made available on 8th March, with additional supply made available to Pan Pac on 28th March and 04th April (at which point full service was available). However as of 12th April, Pan Pac is not ready to take any load.

Clause 26.1.4 – the megawatts affected by the unplanned interruption

The impact of the outage was total loss of supply to the Hawke's Bay region (103 MW at the time of interruption). Loads were restored progressively over the following hours and days.

The outage also caused an interruption to generation from the Waikaremoana hydro generation stations (approx. 13 MW at time of interruption). Generation was fully restored at 1207 on 14th February, as soon as it reconnected. The ability to inject supply from the Whirinaki station was also interrupted, but output was zero at the time of interruption.

Clause 26.1.5 – the grid exit point(s) and grid injection point(s) affected by the unplanned interruption

Redclyffe (RDF), Fernhill (FHL), Whakatu (WTU), Tuai (TUI) and Whirinaki (WHI).

Clause 26.1.6 – actions Transpower took to minimise the effect of the unplanned interruption

To minimise the effect of the unplanned interruption, Transpower:

- In the week prior to the event, postponed several outages for substation and tower painting work in the Manawatu and Wellington areas. This recognised the risk of interruption in the North Island generally, caused by the pending weather system, and ensured that key circuits would be available. (There was no indication, prior to the event, that the impact in Hawke's Bay would be as significant as it was in terms of the ferocity of the cyclone conditions.)
- Implemented the Coordinated Incident Management System (CIMS)¹⁶ process to manage the incident, scaled for the event magnitude. Roles were allocated to focus

¹⁶ CIMS is a standardised approach to managing response and recovery, including principles, structures, functions, processes and terminology. Customised guides and templates are available on our incident management Teams channel to assist with implementing CIMS.

on RDF, WHI and transmission lines assessment/restoration, approach to and planning for Hawke's Bay partial restoration, logistics (equipment and resource requirements), as well as health and safety of workers. Coordination meetings were held twice daily for the first two weeks of the response.

- Implemented our 110 kV contingency plan for the loss of RDF substation. This plan was developed some years ago following several weather-related losses of supply into Hawke's Bay, recognising that both 220 kV circuits into the region are on the same towers. The plan involves closing splits that are normally open on the 110 kV circuits at Waipawa and altering the grid configuration. Having the circuits from Bunnythorpe to FHL closed enabled the Waikaremoana generators at TUI to be re-synchronised with the 110 kV system to supply both Eastland Network and FHL. Limited supply was available at FHL in less than 3 hours, and generation was injecting at TUI just 4.5 hours after supply was lost.¹⁷
- As part of our contingency planning, we had established an Emergency Operating Contract with Genesis Energy at Waikaremoana, enabling switching to be carried out in the event our service providers could not reach the site. Use of the emergency switcher enabled generation to be restored much more quickly than would otherwise have been possible.
- Commenced aerial and ground patrols of the Hawke's Bay network and substations as soon as this was feasible. We were able to access the perimeter of the RDF substation from the ground on the afternoon of 14th February and started digging our way in on the 15th. We flew every substation and line in Hawke's Bay the following day. As a precaution we also flew the circuits from Woodville to TUI. From the patrols we were able to create a prioritised list of work required.
- On 14th and 15th February, Transpower prepared resources, equipment and material from outside the region to help with the response. As soon as the first road access was available into the region on 16th February, resources and plant were mobilised to support the local resources.
- Used existing Digital Engineering (3D) models of the RDF site, overlaid with flood water levels, to assist with planning for repair and replacement of assets.
- Engaged with Telecommunications Emergency Forum (TEF) and worked closely with Unison, Chorus, 2Degrees and Spark to share resources (fibre and people) to recover telecommunication services to the region with prioritisation of WHI and sharing of intelligence and situational awareness information.

¹⁷ We have contingency plans of this type in place in several parts of the country. As they include pre-calculated protection settings and switching sequences, they can be implemented quickly.

- Worked closely with Unison engineers, to develop and implement an innovative staged response to fully restore power to the Hawke's Bay as quickly as possible, with a basic protection system.¹⁸ For each stage of the work, detailed commissioning plans, protection settings and switching sequences were developed. This work provides a temporary full supply solution; much of it will be reversed during the 'recovery' phase of work.

The work above was supported by:

- Multiple workstreams at various locations involving multiple parties, completing assessment, restoration planning, clean up, procurement and logistics, electrical works, switching, protection, and reinstatement of communications and telecommunications.
- Highly experienced and knowledgeable teams at Transpower and our four service providers (Electrix, Ventia, Northpower and Downer), as well as working closely with Unison and Eastland Networks.
- Managing health and safety, including worker fatigue and welfare, logistics, transport, fuel, accommodation and security, recognising the extended nature of the works required and the changing hazards over time.
- Work carried out following Cyclone Bola in 1988 to improve the resilience of the 220 kV circuits into WHI and RDF, and to raise the height of much of the equipment at WHI.

While the unplanned supply interruption ended on 22nd February with a second supply to RDF, returning the system to usual levels of resilience and protection will occur as part of the staged 'recovery' process. We expect to complete this work within 3-4 months.

Clause 26.1.7 – a description of steps that Transpower proposes to take to mitigate the risk of future unplanned interruptions of this type

We are pursuing mitigation measures across several areas including individual substation resilience measures, mitigations to address telecommunications vulnerabilities, and spares strategies.

Substation resilience measures

We are considering mitigation measures for our substations over the medium term (0-24 months) and longer timeframes.

¹⁸ The basic protection system comprises lines protected by existing far end protection and transformers on site having single differential protection.

Medium term focus

Our medium-term focus is on mitigating the risk of further unplanned interruptions of this type at our Hawke's Bay sites. This comprises:

- Implementing measures focussed on reducing the risk of flooding at RDF and WHI in the period until the Council completes the rebuild of its stop banks and we can implement longer term solutions for our substations.
- Addressing the known equipment failure risk over the next 6-24 months caused by substation equipment being submerged. Based on experience with such events, it is essential that we are proactive about this.

The washed out stop banks along the Tutaekuri River, near Redclyffe substation, are currently being rebuilt.¹⁹ Vulnerability will remain until such time as repairs are completed (6-12 months) and afterwards in the event the banks are washed out or overtopped. Interim options to protect the RDF site over these periods include circumferential flood protection around the entire site, or around specific assets, and raising of some equipment. We are currently doing an options analysis to determine which approach we take.

We are also undertaking some lesser remedial works at WHI (relocating batteries, chargers, and local service distribution boards from the basement to a higher level) and WTU (resealing the basement).

The second issue relates to the longevity of our inundated assets. Our response phase included cleaning and servicing assets that had not been irreparably damaged, before returning them to service. Our service providers are now undertaking a full condition assessment of all such equipment, as we are aware from past inundation events (such as flooding of Melling substation in 1998, and Pauatahanui substation in 2016) that some of this equipment will likely fail over the next 6-24 months. We will ensure that sufficient spares are available to keep the assets in service until the longer-term solution for the site is determined and implemented.

Longer term focus

In the longer term our focus is on improving the resilience of our most vulnerable sites.

¹⁹ Previously the stop banks provided a level of protection of approximately 1 in 100 years. However, as the stop banks are not yet rebuilt, and flooding has changed the profile of the bottom of the rivers, we do not yet understand the level of protection that will be provided going forward.

In 2020 we completed national resilience screening, together with desktop studies of sites identified as susceptible to extreme flooding.²⁰ This work identified twelve sites – including Redclyffe, Whakatu and Whirinaki – as both vulnerable to flooding and critical for local network resilience. Out of this work and prior to Cyclone Gabrielle we had developed a resilience plan for RCP4 and beyond, including proposing some funding specifically for proactive substation flooding remediation / resilience works (~\$110m), however we are now reviewing this plan, and will put forward an application for increased resilience funding in RCP4. We expect to have a detailed discussion with the Commerce Commission on the appropriate level of funding required for resilience work.

A detailed assessment of risk and planning for improved resilience at the RDF site was scheduled to begin later in 2023. We are currently re-assessing the flooding risk and considering long term site strategies that would provide resilience against future flood events. Our investigations will use updated flood mapping, from rainfall through to river flow through to substation flooding. The focus is on the location of the 220 kV yard, being the lowest point of the site.²¹ We will be considering a range of options, from a targeted rebuild of the 220 kV yard in the current location to moving the yard to an entirely new land parcel. This investigation is well progressed and will be completed over the coming months.

Damage at WHI was considerably less than at RDF, despite also being inundated. This was largely because we had raised the height of much of the equipment there following previous flood events. (The raising of equipment has also been successful at other sites, such as Wairau Road (Auckland) which was seriously flooded earlier this year but remained in service throughout.)

We will be developing site strategies to increase the resilience of both WHI and WTU substations, against both flooding and tsunami events. For WHI this is likely to warrant a co-ordinated approach with other industrial installations in close proximity. We will also be considering options to improve the resilience of the 220 kV circuits into Hawke's Bay.

We will also be continuing with developing site strategies for the other sites we identified in our 2020 study. In parallel we are reassessing our overall approach to resilience, and the funding that will be required to meet the expectations of our customers.

²⁰ This work estimated flooding at RDF substation during a 200-year average recurrence interval (ARI) event to be 0.5m at the lowest point on the site. Around the 500-year ARI event upstream stop banks would be overtopped. Depths and velocities could not be estimated for this event.

²¹ The 110 kV and 33 kV yards (and equipment in the 33 kV indoor switch room), located on higher ground, suffered minimal damage.

Telecommunications

Transpower's internal telecommunications

We have our own internal telecommunications network, TransGo, which provides telecommunications capability throughout New Zealand to all Transpower sites. TransGo provides a number of services including protection signalling for HV assets, SCADA connectivity and data and voice at substations.

In the Hawkes Bay region, substation connectivity is provided over leased fibre optic cable capacity supplied by a number of telecommunication providers: 2degrees, Unison, Spark and Chorus. The New Zealand Telecommunications Forum (TCF) activated the Telecommunications Emergency Forum (TEF) during as part of the cyclone response. The TEF greatly assisted prioritisation of repairs to assist Transpower in the early recovery of Telecommunications.

Significant cable failures occurred across all these providers isolating WHI, TUI and RDF from the rest of the TransGo network. Equipment at the RDF site was also inundated and failed as a result.

Temporary TransGo Service was restored as soon as the associated cable or cables were repaired by the fibre suppliers with service restored to WHI at 1800 on 18th February, TUI at 1235 on 19th February and RDF at 1228 on 3rd March.

Starlink equipment was also installed at WHI and TUI to provide telecommunications at these sites within the first few days of the cyclone.

We are considering options to improve resilience of our fibre infrastructure, including utilising Optical Ground Wire (OPGW) on our power transmission towers or installation of new overhead connections, for river and flood plain crossings where a suitable parallel connection can be established.

External Telecommunications

We use a number of technologies for telecommunications to sites, staff in the field and contractors, e.g., mobile phone, Fleetlink radios and satellite phone connections.

The same cable that provides connectivity to Transpower's sites also connects mobile phone and Fleetlink repeater sites. This meant that, with the associated loss of power, there was no mobile and limited Fleetlink coverage in the region from the day of the cyclone and for an extended time after that.

Loss of cellular communications over the first few days of the event had a significant impact on operational communications with our service providers and connected parties. We relied heavily on Fleetlink (VHF handsets in vehicles) and also put in place mobile satellite links (after the event) for these communications. Going forward, we will be considering the adequacy of handheld and satellite communication, and how we might make these more resilient.

Equipment, parts and spares

The Hawkes Bay response required an unprecedented volume of equipment, parts and spares to be sourced from stores and other locations, including requisitioning and redeploying some equipment and cabinets from projects to respond to the situation. An immediate priority has been to replace these. We were able to access all the equipment, parts and spares we needed for the restoration and recovery phases. However, we will also be reviewing our spares policy in light of this massive event to determine whether it remains fit for purpose.