AGENDA

Information Reports

Te Kaunihera o Te Tairāwhiti
GISBORNE
DISTRICT COUNCIL

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MEMBERSHIP: Larry Foster (Chair), Colin Alder, Andy Cranston, Debbie Gregory, Ani Pahuru-Huriwai, Rawinia Parata, Aubrey Ria, Tony Robinson, Rob Telfer, Teddy Thompson, Rhonda Tibble, Nick Tupara, Josh Wharehinga and Her Worship the Mayor Rehette Stoltz.

OPERATIONS - INFRASTRUCTURE/NGĀ WHAKAMAHI - TE HANGANGA Committee

DATE: Thursday 2 March 2023

TIME: 1:00PM

AT: Te Ruma Kaunihera (Council Meeting Room), Awarua, Fitzherbert Street, Gisborne

AGENDA – OPEN SECTION

Operations

Reports to:	Council
Chairperson:	Cr Cranston – Environment & Communities Cr Foster - Infrastructure
Deputy Chairperson:	Cr Ria – Environment & Communities' Cr Thompson - Infrastructure
Membership:	Mayor and all Councillors
Quorum:	Half of the members when the number is even and a majority when the membership is uneven.
Meeting frequency:	Six weekly (or as required).

Functions

- To provide governance oversight of Council's operational programmes, services, activities and projects (including major projects) related to environmental operations, community development and infrastructural assets.
- To enable the progress of the Council's operational activities, projects and services.
- Its scope includes:

  Environment Services and Protection
  - Building Services
  - Enforcement
  - Environmental Health
  - Pests and Plant management
  - Biodiversity
  - Integrated catchments
  - Land management
  - Animal control
  - Harbour management

  Infrastructure Services
  - Urban Stormwater
  - Wastewater
  - Water Supply
  - Land, Rivers and Coastal
  - Local Roading Network – including associated structures, bridges and retaining walls, walkways, footpaths and road reserve, landscaping and ancillary services and facilities, street lighting and traffic management control
  - Solid Waste – including landfill and transfer stations, recycling and waste minimisation

Communities

- Cultural Activities including Theatres, Museum and Public Art, Library and Tairawhiti Navigations
- Recreation and Amenity – including open spaces, parks and gardens, cemeteries, community property and& the Olympic Pool complex

Planning and Development

- Customer Engagement
- Support Services

Terms of Reference

Operational oversight

- Provide governance direction for the Council's operational activities as outlined in the general purposes and scope section.
- Review and adjust relevant working programme priorities within agreed budgets, activity management plans and levels of service as per the Council's Long Term Plan.
- Receive updates on programmes, major projects/projects and activities.
- To have input into, and make decisions on, operational proposals, options and cost of projects/major projects.
- Contribute to the development of short term plans for community services and community facilities.
- Consider the strategic regulatory and compliance issues.
- Prepare submissions on any matter that is within its rationale and terms of reference for Council approval and submit on behalf of Council when timelines do not allow Council prior approval.

Asset management

- Oversee the management of all Council's physical assets – including land, buildings and roads.
- Make decisions on infrastructure and assets becoming Council's and on infrastructure and community assets on behalf of Council.
- Progress the sale of properties as approved in the Long Term Plan and Annual Plan.
- Contribute to the development of and oversee delivery of economic development projects.
- Consider proposals to change the status or revoke the status of a reserve as defined in the Reserves Act 1977 (including the hearing of submissions).

Power to Act

To make all decisions necessary to fulfil the role and scope of the Committee subject to the limitations imposed.

To establish subcommittees, working parties and forums as required.

To appoint non-voting advisory members and/or Tangata Whenua representatives to assist the Committee.

Power to Recommend

To Council and/or any standing committee as it deems appropriate.

9. Reports of the Chief Executive and Staff for INFORMATION

Te Kaunihera o Te Tairāwhiti
GISBORNE
DISTRICT COUNCIL

23-39

Title:	**Tonkin & Taylor Flood Investigation Report –2022**
Section:	Community Lifelines 4 Waters Operations - Land Rivers & Coastal
Prepared by:	Mangala Wickramanayake – Team Leader, Land Rivers & Coastal
Meeting Date:	2 March 2023

Legal: No	Financial: Yes	Significance: Medium

Report to OPERATIONS - INFRASTRUCTURE/NGĀ WHAKAMAHI - TE HANGANGA Committee for information

PURPOSE - TE TAKE

The purpose of this report is to provide an overview of the Tonkin & Taylor Flood Investigation Report completed after the East Coast flooding in March 2022.

SUMMARY - HE WHAKARĀPOPOTOTANGA

In May 2022 Tonkin & Taylor Limited (T+T) was engaged by Gisborne District Council (Council) to investigate and provide an assessment of the floods in March 2022. This study also reviewed the response to flooding, identified the gaps and improvements needed and recommended high-level mitigation options in the short, medium and longer term for the Ūawa, Mangahauini, Waiotu and Anaura Bay catchments.

T+T completed the study and submitted the final report in September 2022. The report suggests a range of potential options based on their short, medium and long-term impacts to manage the future flood risks under the PARA (Protect, Accommodate, Retreat & Avoid) framework.

Community meetings were held with communities in Anaura and Tokomaru Bay to present the report findings and options in September and October 2022.

RECOMMENDATIONS - NGĀ TŪTOHUNGA

That the Operations - Infrastructure/Ngā Whakamahi - Te Hanganga Committee:

1. Notes the contents of this report.

Authorised by:

David Wilson - Director Lifelines

Keywords: flood forecasting, flood warning, emergency planning, climate change, awareness

BACKGROUND - HE WHAKAMĀRAMA

1. The Tairāwhiti Region was severely affected by heavy rainfall (nearly to the level of a 100-year event) on 22-23 March 2022. This caused flooding along central East Cape and Tokomaru, Anaura and Tolaga Bays. The flood inundated many properties, cutting off SH35, washing out the Mangahauini River and Waiotu Stream, and caused severe damage to the residents at Arthur Street, Tokomaru Bay. Some houses were red stickered after this flood event.
2. The four principal catchments considered and analysed by T+T for the study were:
    - Hikuwai River, Ūawa, Tolaga Bay
    - Mangahauini River, Tokomaru Bay
    - Waiotu Stream, Tokomaru Bay
    - Anaura Bay
3. In the Ūawa catchment, the Hikuwai River overtopped its banks and flowed overland onto the floodplains. Bridges caught extensive woody debris, likely reducing the capacity of the waterways and increasing overbank flow upstream of the bridges. These included Wigan Bridge, Mangatokerau River Bridge on Paroa Road, and at the mouth of the Waitoroko Stream where it joins the Hikuwai River. Roads became flow paths, leading to surface flooding where the capacities of culverts were exceeded or blocked. This resulted in surface water ponding on roads and neighbouring paddocks. Surface flooding was exacerbated in areas where rainfall exceeded the capacity of the drainage infrastructure.
4. In the Mangahauini River Catchment there was fluvial flooding across floodplains along the river margins, with inundation of lower-lying property boundaries. Fluvial flooding was observed on properties neighbouring the Mangahauini River. Riverbank lateral erosion was reported on the Mangahauini River, along over half the river length, cutting into roading infrastructure including the northern Tokomaru Bay SH35 bridge. This resulted in isolation of communities and limiting evacuation routes due to bridge and road flooding and wash outs. The high school and a few properties at Toa Street, including a church, and Taro Street properties were in danger as a result.
5. Waiotu Stream flooding caused inundation internally into houses on Arthur Street and at the Hatea a Rangi School, as well as under the floors of many other properties. SH35 south of Tokomaru Bay became a flow path during the event, cutting evacuation routes from the town until floodwaters receded on the 23 March. Following the flooding, Council surveyed flood depths in and around houses along the Waiotu Stream. Of the properties surveyed, seven properties were inundated above floor levels with depths ranging between 0.03m and 1.07m, including five houses and two sheds on Arthur Street and the Hatea a Rangi School.
6. In Anaura Bay there was both fluvial and pluvial (surface water) flooding. Flooding from streams pooled on Lockwood and Anaura Roads, and in low-lying paddocks. Floodwater entered above the floorboards of two houses and caused erosion damage to the urupā. Landslides carried debris into one house and cut off roads from the bay for three days.

7. There are historical records of flooding of these townships, Tolaga, Anaura and Tokomaru Bays, associated with rainfall intensities greater than 40 mm/hour or 24 hour totals greater than 200 mm. These floods occurred in 1916,1917, 1938, 1963,1964, 1988, 2005, 2021, 2022. Interestingly there are extended intervals of 20 -25 years between major storms events or groups of storms.

DISCUSSION and OPTIONS - WHAKAWHITINGA KŌRERO me ngā KŌWHIRINGA

8. The report identifies that Severe Weather Warnings were distributed to communities through various public information channels, but no further proactive measures were taken ahead of the March 2022 flood. Overall, public information communications were reactive and mainly focused on recovery efforts and supporting services for the affected communities.

9. In context of the requirements of national legislation and the Tairāwhiti Resource Management Plan 2018, the report concludes that the recent flood impacts indicate that some objectives in relation to flood hazard risk management are not being fully met.

10. The report discusses and recommends the PARA (Protect, Accommodate, Retreat and Avoid) approach be considered, as historically hard engineering options have often been the solution for flood damages. With future climate change and associated changing hazard profiles, hard engineering Protect options may not be the best investment for communities as per this analysis.

11. Also, this study identifies that the Accommodate options help to manage existing, future, and residual risk, and should be considered with or without other options. This includes development of community resilience through evacuation planning and property level alterations.

12. The report includes a list of option to address and manage the flood risk for the Tolaga Bay, Tokomaru Bay and Anaura Bay communities, these are summarised as:

    a. Review, identify and prioritise key management options through appropriate business case processes. This could include coordination of appropriate funding mechanisms across parties.

    b. Early consideration of short term impacts including:

    c. Targeted emergency planning at community and council level, establishing emergency action plans covering flood warning triggers and associated actions (e.g., communications) along with evacuation plans for communities.

    d. Increased awareness of flood risk within all communities across Council, be they within a modelled catchment or not.

    e. Increased flood risk asset management to identify drainage and flood management assets, their associated ownership, condition and expected performance to inform maintenance and future potential capital works.

f. Review flood response procedures, including associated training and exercising across Council, TCDEM and other Risk Management Agencies to enhance coordination and communication during readiness, response and recovery.

g. Coordinate within Council regarding prioritised policy and management options.

h. Engage with Risk Management Agencies to identify and coordinate responsibilities to reduce and/or manage flood risk.

i. Engage with communities to understand preferred options to manage future flood risk.

ASSESSMENT of SIGNIFICANCE - AROTAKENGA o NGĀ HIRANGA

Consideration of consistency with the Engagement Policy
This Report: High Significance

The effects on all or a large part of the Gisborne district
This Report: Medium Significance

The effects on individuals or specific communities
This Report: High Significance

The impact on the relationship of Māori including the importance of tikanga and their relationship with ancestral land, water sites, waahi tapu, valued flora and fauna, and other taonga
This Report: High Significance

The level or history of public interest in the matter or issue
This Report: High Significance

Impacts on Council's delivery of its Financial Strategy
This Report: High Significance

Consistency with Council's current strategies and policies including the Strategic Priorities in the Long-Term Plan
This Report: High Significance

impacts on Council's, Long Term Plan, Annual Plan, and levels of service (also including the Regional Land Transport Plan, if applicable)
This Report: Medium Significance

Whether the decision is reversible.
This Report: Low Significance

13. The decisions or matters in this report are considered to be of **High** significance in accordance with Council's Significance and Engagement Policy.

TANGATA WHENUA/MĀORI ENGAGEMENT - TŪTAKITANGA TANGATA WHENUA

14. Most communities in the affected areas were Māori. Māori engagement was carried out through the Council's Māori liaisons team. Lillian Ward has been the contact person on matters related to Māori engagement and Tangata Whenua.

COMMUNITY ENGAGEMENT - TŪTAKITANGA HAPORI

15. Post flood meetings were held and consultation processes were carried out with the community at Anaura Bay and Tokomaru Bay.

16. Council staff have had continuous discussions on finding solutions since the floods occurred. Council inspected flood damage many times, documented all public information, visited all flooded houses and flood heights were recorded at Tokomaru Bay.

CLIMATE CHANGE – Impacts / Implications - NGĀ REREKĒTANGA ĀHUARANGI – ngā whakaaweawe / ngā ritenga

17. Climate change impacts are evident in that the region has experienced more high intensity rainfalls and frequent flooding. The March 2022 event was estimated as close to a 100-year event.

18. The same areas have been flooded twice since the T&T report, once in November 2022 and again in January 2023. The recent flood event in January 2023 was almost close to a 100-year flood. Damage was as severe on the Mangahuini River in the January 2023 flood as it was in the March 2022 event.

19. With future climate change and associated changing hazard profiles, soft solutions will be the best option for the communities as per the analysis. Also, this study identifies that the Accommodate Options will be the best option in the context of Climate Change.

CONSIDERATIONS - HEI WHAKAARO

Financial/Budget

20. Council's Land, Rivers & Coastal (LRC) section has submitted a proposal to the Climate Resilience Fund for funding for the Mangahauini and Waiotu River Schemes. The estimated cost is $1.8 million for Tokomaru Bay. This estimate was prepared before the more recent damage to the Mangahauini River Scheme.

21. The total Council approved budget for the Mangahauini River Erosion Protection Funding at Tokomaru Bay recovery in the 2022/2023 Year is $669,050 of which $225,000 has been spent to date. This consists of Year 2 LTP - $51,700, Year 5 LTP - $327,000 and a loan of $250,000.

22. No other budgets have been allocated for this report although some recommendations will be met from internal budgets e.g. updating the flood monitoring manual and possibly emergency action plans.

Legal

23. There are no legal implications as most of the affected communities only pay general rates. Council has no agreement on Level of Services in these rural townships.

POLICY and PLANNING IMPLICATIONS - KAUPAPA HERE me ngā RITENGA WHAKAMAHERE

24. A multi-channel warning approach to disseminate flood warnings and the understanding of flood hazards in the Gisborne region with individual at-risk properties need to be identified in advance of a flood, and the evacuation priority established ahead of time.

25. As these catchments are not covered by the Council's flood forecasting system (ARROW.2 models), these communities do not have emergency management planning in place, such as warnings and evacuation planning. It is a priority to undertake targeted emergency planning at community and Council level, establishing Emergency Action Plans covering flood warning triggers and associated actions (e.g., communications) along with evacuation plans for communities.

RISKS - NGĀ TŪRARU

26. The same areas were flooded twice after the March 2022 event, in November 2022 and again in January 2023. The Hikuwai River catchment was the worst affected during the recent storm due to Cyclone Hale.

    Identified risks are:

    - Repeated flood damage in all catchments within a short period of time. Most of the Mangahauini River stabilisation work done with limited funding was adversely affected and damaged.
    - Successive flooding causing damage before remedial works were completed will require significant additional works.
    - Contractor availability.
    - Community at a risk of flooding.
    - Schools at Tokomaru Bay at a high risk of flooding and collapsing.
    - Tokomaru Bay Township is at a risk of flooding as the stopbank was damaged in January 2023. This stopbank was constructed in 1964 and a 100m length was washed away in January 2023. This was the only protection for the town over the past 60 years. In 1963 Tokomaru Bay township was fully flooded.

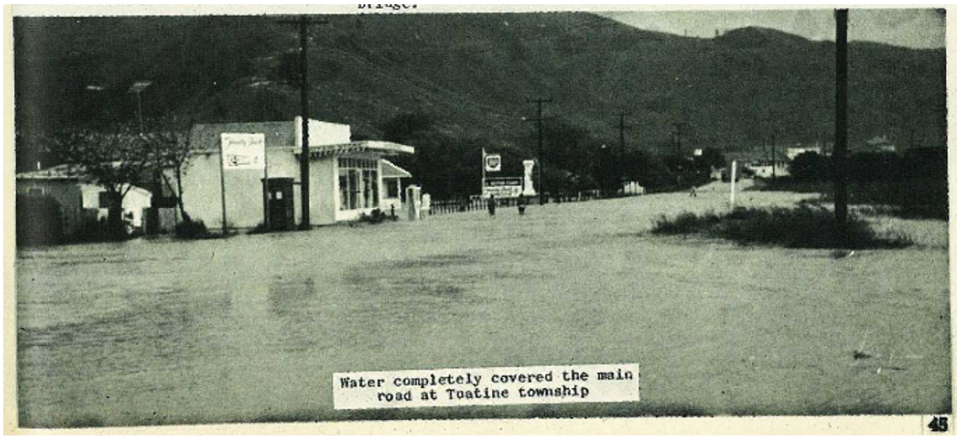

Figure 1: Flood waters of the Mangahauini river. Looking North, taken from intersection of Mangahauini Street and SH35 (Flash Flood - Gisborne Photo News - No 126 : December 3, 1964; www.photonews.org.nz).

- Hikuwai agricultural lands are repeatedly at a risk.
- Loss of income to the farming and agriculture community.
- Rivers and streams are flooded with woody debris with potential damage to the road infrastructure.
- Safety issues due to excessive silt on public roads mainly Paroa Road.
- Anaura Bay Urupā is at a high risk of water logging, many graves were washed away, and this will continue.
- Anaura Bay Lockwood Road and the Marae are at risk of inundation.
- LRC is very stretched with the volume of work, and routine work has generally been delayed due to the repeated emergency work.
- High cost of emergency procedures.
- Repeated damages for river infrastructure.

27. In some cases, public perception was positive as Council could deploy faster during the last two flood events than in the March event. Waiotu Stream was not affected due to the fast action taken.

NEXT STEPS - NGĀ MAHI E WHAI AKE

Date	Action/Milestone	Comments
30/06/2023	Review, identify and prioritise key management options	
31/07/2023	Establish Emergency Action Plans covering flood warning triggers and associated actions	
30/04/2023	Review flood response procedures	
30/06/2023	Work on medium-term and long-term solutions	

ATTACHMENTS - NGĀ TĀPIRITANGA

1. Attachment 1 - Tonkin Taylor Flood- Investigation Report.final.v.3 2022 [**23-39.1** - 87 pages]

NOT FOR FURTHER DISTRIBUTION
EMBARGOED UNTIL 10 OCTOBER 2022

Tonkin+Taylor

Flood Investigation

Tokomaru, Anaura and Tolaga Bays

Prepared for
Gisborne District Council
Prepared by
Tonkin & Taylor Ltd
Date
September 2022
Job Number
1020246 v3

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Document control

Title: Flood Investigation					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
19/7/2022	1	Working draft for client review	M Hitchcock	A Cartwright	T Bassett
25/8/2022	2	Final Report	M Hitchcock	A Cartwright	T Bassett
14/9/2022	3	Final Report with minor clarification updates added	M Hitchcock	A Cartwright	T Bassett

Distribution:

Gisborne District Council	1 PDF copy
Tonkin & Taylor Ltd (FILE)	1 PDF copy

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1 Introduction

In March 2022 a complex storm system moved across the Tairāwhiti Region, generally from north to south. Heavy rainfall overnight on the 22 and 23 March 2022 caused flooding along the central East Cape communities of Tokomaru, Anaura and Tolaga Bays. The flood inundated many properties, including at least 10 houses, cutting off and damaging roads, washing out the Mangahauini River State Highway bridge in Tokomaru Bay, and isolating households and communities for up to 10 days. The Uawa catchment in Tolaga Bay was also impacted but to a less disruptive extent.

This was the second heavy rainfall and flooding event within a year to hit the communities of Tokomaru Bay and Anaura Bay.

In May 2022 Tonkin & Taylor Limited (T+T) was engaged by Gisborne District Council (GDC) to investigate the March 2022 flooding in Tokomaru, Anaura and Tolaga Bays. The overall objectives were to provide analysis and assessment of the recent event, to review the response to flooding, and to identify high-level mitigation options to reduce flood risk to the community and to public infrastructure in the short, medium and longer term.

The detailed scope is set out in the agreement between GDC and T+T (ref. 1020246, dated 4 May 2022). The overall approach to the investigation comprises of:

- Identifying the meteorological conditions and stream processes in the March 2022 flood event, along with consideration of previous flood events in Tokomaru, Anaura and Tolaga Bays;
- Understanding the legal obligations of GDC and other organisations for flood management, and actions taken during the March 2022 flood event, and
- Considering future options within the PARA framework: Protect, Avoid, Retreat, Accommodate.

2 Study area

The study area for this report is the central East Cape communities of Tokomaru, Anaura and Tolaga Bays. Aspects of the study area are described below within three categories: communities, catchments, geology and morphology.

2.1 Communities

From consultation, most of the people living in Tokomaru and Anaura Bays were born in the bays or whakapapa back to the bays. The majority of settlements are coastal with small pastoral farming communities further inland.

Tokomaru Bay and Anaura Bay (at 2018 census) had a population of 950 people living across 360 dwellings. The population ethnicity is 82% Māori and 34% European (with some people identifying as multiple ethnicities). Over half the population (60%) are adults aged 15 to 65 years; 10% of the population has "Activity limitations"[1] which equates to approximately 95 people living in these bays who might require assistance in an emergency.

Tolaga Bay (Wharekaka area on Statistics New Zealand) includes coastal communities south as far as Tatapouri Point, has a population of 1,850 people living across 670 houses. The population is 64% Māori, 50% European (with some people identifying as multiple ethnicities). Over half the population (63%) is aged between 15 and 65 years, and 8% has 'Activity limitations', which equates to approximately 150 people.

[1] Activity Limitation as described by Statistics New Zealand is the proportion of people who have 'a lot of difficulty' or 'cannot do at all' one or more of the following activities: walking, seeing, hearing, cognition, self-care, and communication.

Communities along the coast are primarily connected by Waka Kotahi's State Highway 35 (SH35), a primary collector road which loops around the whole East Cape. SH35 is also known as the Pacific Coast Highway and Waiapu Road from Tolaga Bay to Ruatoria. The regional roading network links communities to SH35 and are managed by GDC.

2.2 Principal catchments

The topography of the hinterland from Tolaga to Tokomaru Bays is 90% hill country, with limited flat to moderate sloping land located along river and stream margins or at the coast. The coastline consists of open bays that alternate with steep slopes and crumbling or slumping cliff faces where the hill country meets the sea (Ross 2021). The underlying geology generally comprises soft, weak rocks, mainly tertiary mudstones and sandstones.

Widespread clearing of indigenous bush in the early 1900s increased overland flow and surface flooding, resulting in widespread sheet and gully erosion of hillsides. In the 1960s the planting of exotic pine forests was introduced to reduce erosion problems, and to limit the sediment delivered from the hills onto the limited pastoral farming areas (Borland, 1988).

The four principal catchments (shown in Figure 2.1 below) are:

- Uawa, Hikuwai River, Tolaga Bay;
- Mangahauini River, Tokomaru Bay;
- Waiotu Stream, Tokomaru Bay, and
- Anaura Bay.

Uawa, Hikuwai River, Tolaga Bay

Tolaga Bay is a broad bay where the Uawa River meets the coast. The inland topography is hill country with extensive river flats along the river and its tributaries. The Uawa River catchment is over 530 km^2, made up of the Uawa River and numerous tributaries. The catchment land uses are more primary industry focused with exotic forest (43%), high producing exotic grassland (21%), and manuka or kanuka scrub (16%).

Mangahauini River, Tokomaru Bay

The Mangahauini River has a catchment of 25 km^2. It is the principal catchment to Tokomaru Bay, flowing from north west to the south east and to the coast in the middle of the bay. Land use within the catchment is predominantly low producing grassland (34%), exotic forest (23%) and manuka or kanuka (22%). Only 1% of the catchment is urban, being Tokomaru Bay township at the mouth of the river.

Waiotu Stream, Tokomaru Bay

Waiotu Stream also flows into Tokomaru Bay, about 1 km south of the Mangahauini River mouth. Small stream valleys have created limited areas of moderate gently sloping land near the coast (Ross 2021). The Waiotu catchment is an example of this, with a catchment area of 8.5 km^2. Land use within the catchment is predominately low producing grass land (51%), manuka or kanuka (23%), and broadleaf hardwoods (20%). Approximately a third of the Tokomaru township sits within the Waiotu Stream catchment. The Waiotu Stream has two main sub-catchments south of SH35: the Kaiawha Stream and Mangapuketea Stream which flow from south to north. The confluence of these streams is 500 m upstream SH35, also joined by an unnamed tributary to become the Waiotu Stream flowing 1,200 m to the coast.

Anaura Bay

Earthquakes over the past few thousand years have raised a narrow coastal plain from the foot of the coastal cliffs, and Anaura Bay is one of multiple examples along this East Cape coastline (Ross 2021). Anaura Bay has a catchment of 7 km^2 containing seven smaller sub catchments which flow east from the hills to the sea. There are four principal sub catchments, being Waipare Stream, Hawai Stream, Nuhiti Stream and Anaura Stream, with stream lengths between 1.6 km and 2.7 km. Catchment land use within Anaura Bay is high producing exotic grassland (37%), manuka or kanuka (23%) and native broadleaf hardwoods (18%).

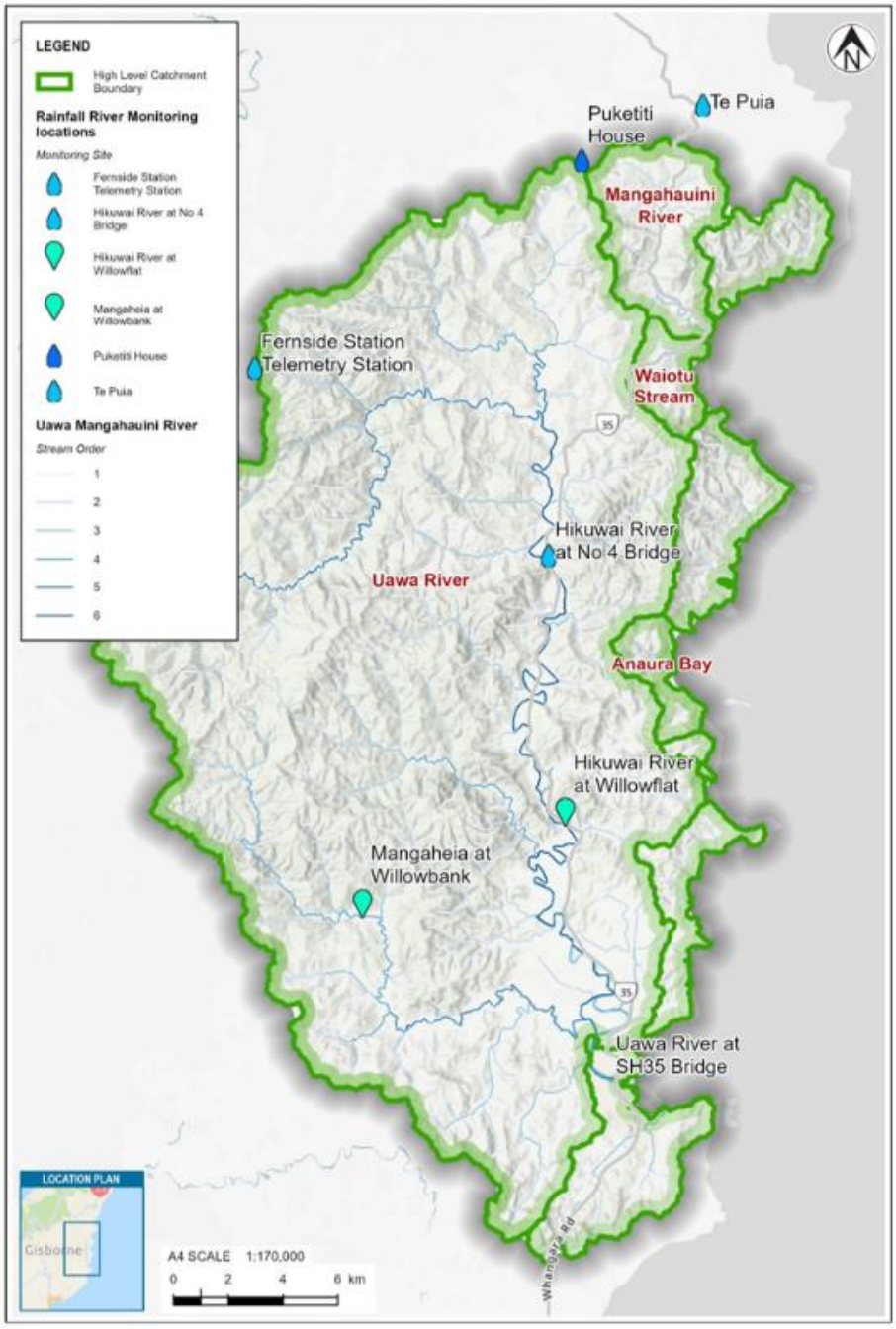


Figure 2.1: Map showing some of the rainfall monitoring locations (blue drops) and river monitoring sites (green pins) relative to Tolaga Bay, Anaura Bay and Tokomaru Bay primarily used in this study. The main river and stream catchment boundaries are outlined in green with catchment names in red.

2.3 Geology and river morphology

The geology of the region from Tolaga Bay to Tokomaru Bay is characterised by very weak sandy mudstones that are 3 to 15 million years old (Miocene and Pliocene), which tend to crumble on exposure to wetting and drying (Beetham and Grant, 2005; Mazengarb and Spenden, 2000). The area is known for its highly erodible slopes and high suspended sediment loads in the rivers, and for rapid aggradation of river beds (Hicks et al. 2011, Mazengarb and Spenden, 2000). Regionally, suspended sediment yields to the New Zealand coast are dominated by the East Cape area (approximately 69 Mt/y). The Waiapu and Waipaoa Rivers at East Cape deliver 35 Mt/y and 15 Mt/y, respectively, and their combined yield represents 42% of the yield from the North Island catchments, and 24% of the total yield to the New Zealand coast.

Some river and streams are likely to demonstrate a bed degradation and aggradation evolutionary response, where some larger and less frequent events will cause rapid and extreme channel infilling, while smaller and more frequent events will promote channel degradation. Some studies demonstrate that the degradation/aggradation response is more complex than a simple frequency/magnitude relationship. These geomorphic responses are well studied in rivers along East Cape, such as the Waiapu River and its tributaries (Philips 1988, 1989).

2.4 Potential sources of flooding

Potential sources of flooding in Tokomaru, Anaura and Tolaga Bays derive from three processes: fluvial flooding, pluvial (surface water) flooding and coastal inundation:

- ***Fluvial flooding*** results from river or other water body levels rising above the banks overflowing the channel onto the adjacent flood plain.
- ***Pluvial flooding***, also termed stormwater or surface flooding, occurs as localised overland runoff following heavy rainfall
- ***Coastal inundation,*** when sea water flows onto low lying coastal areas. Coastal flooding is usually driven by high tides in conjunction with a large storm event and low barometric conditions that raise the sea level, and may be exacerbated by significant waves.

Further sources that contribute to flood risk include infrastructure failure, groundwater flooding, tsunami and landslides triggered flooding. Infrastructure used to collect and safely convey flood waters can exacerbate any flooding if it does not perform as designed or if the design capacity is exceeded. Blockage from woody debris and / or log jams against bridges have contributed to fluvial flooding impacts in Anaura Bay, primarily associated with Nuhiti Stream. Likewise, in Tolaga Bay debris in the rivers have likely exacerbated fluvial flooding impacts to land along the rivers and tributary rivers of the Uawa Catchment.

Landslides triggered by rainfall can exacerbate flooding by reducing the capacity of infrastructure to convey water or blocking it completely. Landslides can also limit or block streams, thus diverting flows out of the natural channels. Likewise, riparian vegetation or end of life willow or poplar trees can become mobile in a flood or landslide and block waterways.

3 Flood management legislation and risk management agencies

The requirements for the management of flood hazards in the Tairāwhiti Region have been identified from a legislative review. GDC is a Unitary Authority, and therefore is responsible for the service delivery associated with territorial and regional councils. GDC is the sole council of the Tairāwhiti Civil Defence Emergency Management Group (TCDEM).

Key responsibilities of GDC include identifying hazards and managing the associated risk (either by infrastructure or planning rules), while also educating public about the hazards, and helping prepare communities for the risks. Requirements are given by varied national legislation[2], with guidance on how GDC plans to do this, outlined within Regional Plans and Policy Statements.

Flood hazard identification and risk management are principally regulated by the Resource Management Act 1991 (RMA), the Soil Conservation and River Control Act 1941, and the Local Government Act 2002 (Table 3.1). Other acts that provide legislative guidance on the management of natural hazards are listed in Table 3.2.

Table 3.1: Key flood management legislation

Legislation	Description
Resource Management Act (RMA) 1991	Under the RMA (1991) Councils are required to control land use for the purpose of avoidance or mitigation of natural hazards (sections 30 (1)(c) and 31(1)(b). Local authorities have a duty under the RMA to set out the responsibilities for natural hazard management, through their regional policy statements. The RMA requires local authorities to keep a record of natural hazards.
The Soil Conservation and River Control Act 1941	Local authorities now carry the responsibilities identified as catchment boards in The Soil Conservation and River Control Act 1941. Objectives of the Act are to promote soil conservation, prevent and mitigate soil erosion, prevent damage by floods and utilise land in a manner that helps achieve these objectives.
The Local Government Act 2002	The Act contains specific mechanisms relating to stormwater control and flood protection works, but does not include any specific requirements for hazard identification or control of land use. The Act does, however, require councils to assess the adequacy of their stormwater systems.

[2] legislation refers to Acts, Bills, secondary legislation, and Supplementary Order Papers (although Bills and Supplementary Order Papers relate only to proposed legislation)

Table 3.2: Wider legislation on management of natural hazards

Legislation	Description
Building Act 2004	The Building Act requires developers to seek a building consent for a building or major alteration if land is subject to, or likely to be subject to a natural hazard, or if the build works if likely to accelerate, worsen, or result in a natural hazard on that land or any other property. Building consent can be granted by council where a natural hazard has been identified, subject to conditions which are added to the land title. This can then have insurance implications for the property.
Civil Defence Emergency Management (CDEM) Act 2002	The purpose of the CDEM Act is to require communities to achieve acceptable levels of risk by among other things identifying, assessing, and managing risks. The Act also requires local authorities within a region (known as the Regional Civil Defence Group) to make a Civil Defence Emergency Group Plan. GDC is the sole council of the TCDEM.
Earthquake Commission Act 1993	The Earthquake Commission Act provides for compensation for residential buildings, residential land and personal property in the event of a natural disaster, that is privately insured. The Commission can consider if a property is likely to suffer from the same damage again and that the likelihood of damage could have been avoided and decline any further claims for loss. A notice of limitation if issued, will be added to the property title and may have future development issues for that site.
Local Government Official Information and Meetings Act 1987	The Local Government Official Information and Meetings Act requires hazard information to be listed on the Land Information Memoranda (LIM)s on property title, or requires ways in which public can access site specific scientific and practical flooding information about flooding.

Figure 3.1 highlights the relationship between the key pieces of legislation for the management of natural hazards in New Zealand.

Risk management in New Zealand is hindered by a complex legislative framework, with inconsistencies in purposes, terminology and integration (Crowley et al., 2016). These contribute to diverse interpretation of policy and implementation of guidance. The relationship between the key pieces of legislation for the management of natural hazards in New Zealand is shown in Figure 3.1 below (The RMA Quality Planning Resource, n.d.).

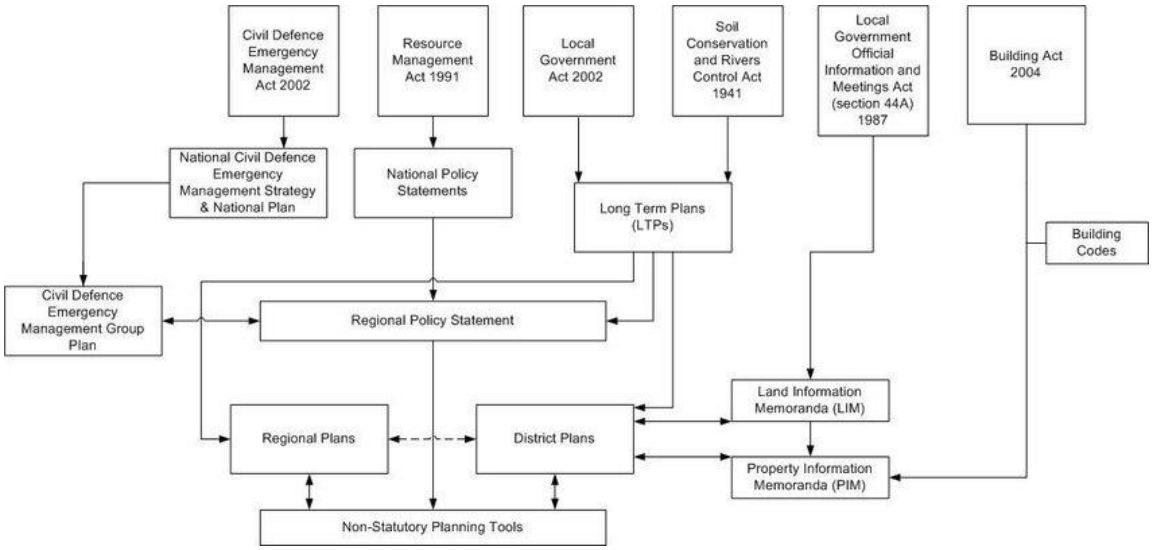


Figure 3.1: relationship between the key pieces of legislation for the management of natural hazards in New Zealand(The RMA Quality Planning Resource, n.d.)

3.1 Flood management agencies

Responsible agencies for flood management in the Tairāwhiti Region include:

- MetService;
- GDC (Unitary Authority);
- TCDEM;
- Emergency services;
- Lifeline Utilities;
- Other agencies, and
- Landowners.

MetService

The MetService is the only agency authorised in New Zealand (under the Meteorological Services Act 1990) to provide Severe Weather Warnings and other public safety weather information. Warnings (and weather watches) are sent to media and civil authorities in the affected areas whenever specified weather conditions[3] are expected (including widespread heavy rain, damaging sea swells and storm surge).

Severe Weather Warnings relate to conditions expected in the next 24 hours, with Severe Weather Watches issued when conditions are expected in more than 24 hours but less than 72 hours, or if there is significant uncertainty for the next 24 hours. The MetService classifies Severe Weather Warnings as either Orange Warnings or Red Warnings – depending on the expected severity and impacts of the event.

It is not the responsibility of MetService to provide recommended actions to communities that are within Severe Weather Warning areas.

Gisborne District Council

GDC holds the primary responsibility for flood management under the national legislation. The GDC approach is outlined in the Tairāwhiti Resource Management Plan 2018 (Tairāwhiti Plan). The Tairāwhiti Plan meets the requirements under the RMA for territorial local authorities (i.e. GDC) to prepare regional policy statements that outline how environmental risk and natural hazards will be managed.

The primary section of the Tairāwhiti Plan related to flood risk management is B5: Environmental Risks including Natural Hazards, which has the following objectives (B5.1.2):

> *1. A pattern of human settlement that:*
>
> > *- Provides a high level of personal safety from natural hazards for its inhabitants.*
> >
> > *- Avoids or mitigates the risk to property and infrastructure from natural hazards.*
> >
> > *- Does not accelerate or worsen the effects of natural hazards upon the natural and physical environment.*
>
> *2. Rehabilitation, where practicable, of aspects of the environment degraded by natural processes that were induced or accelerated by human activities.*

[3] Weather warning criteria can be found at https://www.metservice.com/warnings/home#weather-criteria

Secondary to this is B8 Land Management, with three objectives (B8.1.1):

> *1. Rehabilitation of eroded land and stabilisation of erosion-prone land.*
>
> *2. To protect downstream natural and physical resources from the adverse effects of accelerated soil erosion.*
>
> *3. To minimise the degradation of the soil and land resource caused by poor land management systems and unsuitable land uses*

Sections B5 and B8 highlight the GDC responsibility for managing and reducing flood risk through risk reduction and recovery. Responsibilities for responding to natural hazard (flood) events are not outlined in the Tairāwhiti Plan.

Tairāwhiti Civil Defence Emergency Management Group

TCDEM is staffed and financed by GDC. The Group Plan 2016-2021 Goals are detailed in alignment to the 4R's of emergency management:

- **Reduction** promoting robust reduction activities that reduce the hazards to Tairāwhiti;
- **Readiness** communities that understand, are prepared, and participate in CDEM;
- **Response** enhancing the CDEM Group's ability to manage emergencies in Tairāwhiti, and
- **Recovery** enhancing Tairāwhiti ability to recover from emergencies.

A range of powers within the CDEM Act 2002 are available to the Controller with and without a formal Declaration of an Emergency. The Declaration of an Emergency is normally decided by the Mayor (or the Minister if the Mayor cannot[4]), following advice and guidance from the CDEM Group.

Emergency services

Fire Emergency New Zealand (FENZ) emergency management functions include rescuing people trapped, or from swift water, urban search and rescue, assisting with weather events and medical emergencies with operational support and logistics. The Fire and Emergency New Zealand Act 2017 provides a statutory remit to protect and preserve lives, property and the environment.

The New Zealand Police role in emergency management is to maintain law and order, protecting life and property, assisting in the movement of rescue, medical and other essential services, assisting the Coroner as required, coordinating movement control over land and conducting inland search and rescue.

Surf Lifesaving New Zealand is a charitable trust primarily committed to prevent drowning and injury of the public, and is also a key support agency for search and rescue functions under the Tairāwhiti Group Plan.

While not a formal emergency service, New Zealand Defence Force provides support during natural hazard events, if available and directed. There is no legislation requiring its assistance.

Lifeline Utilities

The CDEM Act requires that every lifeline utility must ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level during an emergency. In addition, lifeline agencies also need to meet readiness and response activities as described by the CDEM Group Plan. Lifeline utilities include both national, regional and local utilities organisations, and are categorised into four key sectors: Energy, Telecommunications, Transport and Water. Key lifeline utilities for the region detailed below.

[4] For example during an election cycle.

- **Energy**
  - Transpower and Eastland Network are the lead agencies for electricity lifelines
- **Telecommunications**
  - Spark, Vodafone and Chorus are the lead agencies
- **Transport**
  - **Waka Kotahi** (New Zealand Transport Authority, NZTA) is responsible for land transport planning, operations, maintenance, renewal and upgrades of the state highway network. In an emergency Waka Kotahi is responsible for restoring the network to a satisfactory operating condition as quickly as possible
  - The regional roading network is owned and maintained by GDC, which shares similar responsibilities to Waka Kotahi
  - Recognising the shared responsibilities, Waka Kotahi and GDC formed a shared business unit called **Tairāwhiti Roads in 2015** with the aim to "*deliver more effective and efficient maintenance, operations and renewal programmes for the regions state highways and local roads*". However, this joint venture was abandoned in 2020.
- **Water**
  - Currently managed by GDC, including four waters: water supply, wastewater and stormwater, flood protection and river management.

Other agencies

Other agencies that are key to both response and recovery actions include:

- Ministry for Primary Industries, central government ministry focused on the primary sector including animal welfare, farmers and growers;
- Te Puni Kōkiri, central government's principal policy advisor on Māori wellbeing and development;
- Ministry of Social Development (MSD), the principal social policy advisor responsible for a range of income support and employment services
- TRONPnui, Te Kaupapa Rautaki provides the strategic direction of Te Runanganui o Ngati Porou, and
- Rural Support Trust, established to work with rural communities when times are tough. It provides ad hoc advice for dealing with floods, preparation, during and after.

Landowners and community

There is no clear legislation about the requirements of individual landowners for the management of flood risk. Individuals are required to follow lawful instructions associated with differing powers, including those within the CDEM Act and Policing Act.

4 History of local flooding

Flooding is not uncommon for these central East Cape communities. There are records from the early 1900s reporting extraordinary rainstorm deluges that caused flash flooding, surface flooding and landslides. The meteorological conditions causing the storms and flooding to these bays are generally characterised by a low pressure system located off the east of North Island resulting in easterly airflow bringing heavy rain and floods (Tait 2006). Conditions that bring disruptive flooding are typically with rainfall greater than 40 mm/hour, or when 24 hour totals are greater than 200 mm.

Reported flooding in Tolaga, Anaura or Tokomaru Bays, associated with rainfall intensities greater than 40 mm/hour or 24 hour totals greater than 200 mm, occurred in 2021, 2005, 1988, 1964, 1963, 1938, 1917, 1916 (refer Appendix for more details on each flood). Floods since the early 1900s have washed out bridges:

- Two bridges on the Mangahauini were washed away in in the 1910s floods;
- The 1930s floods on the Uawa River washed out two bridges;
- The 1960s floods washed over the Waiotu Stream bridge;
- The Mangahauini River bridge was rebuilt in 1966, and
- The 2021 flood washed out the Waiotu footbridge.

The 2022 flood washed out the SH35 Mangahauini River bridge. Through the 1960s and 1980s local contractors were employed by the Waiapu County Council, to maintain and clear roadside drains. In consultation residents report that when many of these contractors retired (such as Papa Jim in Tokomaru Bay) the contracts were not renewed. GDC has now contracted out the roading maintenance and river protection for the whole region to Fulton Hogan. Residents consider that historically contractors only cleared the mess on the roads after a storm, and that they didn't do much maintenance on drains before a storm.

Houses in Arthur Street, Tokomaru Bay flooded in 1963. In response the Poverty Bay Catchment Board built a stopbank along the Waiotu Stream on the Arthur Street side. At some point the stopbanks have been either removed or not sufficiently maintained so that they have effectively disappeared. The stopbanks were on the GDC asset list in 2003, as well as rock protection work and 16 m of gabions.

The Mangahauini River protection scheme on the GDC asset database reports to have 17 rail and rock groynes and one length of stopbank. The stopbank was built in the 1960s to reduce floodwater from the river entering the Tokomaru town main street. The groynes were installed between 1991-1993, with additional groynes added from 2012-2015. GDC outsourced their river protection management in the 1990s and 2000s to Hawkes Bay Regional Council (HBRC). Erosion issues on the Mangahauini River in HBRC reports from 2012 and 2015 indicate that riverbank erosion began to become an issue in the early 1990s and that possibly the lower river groynes were installed then to control lateral erosion.

The low head weirs in the Mangahauini River Gorge were installed in the 1960s by the Poverty Bay Catchment Board to control the flow and prevent erosion as reported in the Gisborne Photo News[5]. The low head weirs were not recorded on the current GDC Asset Database, nor any description provided on the design level of service of any of the river protection structures.

[5] East Coast Page - Gisborne Photo News - No 145 : July 13, 1966

River morphology

Philips (1988 and 1989) describes three East Cape storms in the 1980s with similar rainfall intensities, and total rainfall durations, that resulted in different stream morphological responses, and subsequent differences in flood effects.

The landslides associated with the December 1980 storm were widespread and where there was high connectivity to the stream network (i.e. the streams were close to the toe of hillslopes), landslide derived sediment was stored directly in the channel as bank attached bars, or benches. This occurred primarily in the upper reaches of the catchments. Some sediment was likely to have been transported into the lower reaches also, and the channels would likely have displayed a minor aggradation response in the downstream reaches. There was minimal flooding, i.e. the resulting flows were accommodated generally within the river channel system.

In April 1982 Cyclone Bernie made landfall on the East Coast. Similarly, to 1980 there were landslides in the catchments, but fewer than during the 1980 event. Channel cross-section analysis from between 1981 and 1983 showed channels primarily displayed degraded characteristics (e.g. the channel incised). This suggests that landslide sediment was either again stored primarily in the upper reaches, or was potentially 'decoupled' from the stream network as a result of previous landsliding. It is also likely that the flow was not sufficient from the 1982 event to mobilise large quantities of sediment from the upper reaches, but was sufficient to strip finer grained sediments deposited during the 1980 event from the lower reaches

Cyclone Bola in 1988 has had differing impacts reported with regards to landslides and sedimentation. Philips (1989) noted that Cyclone Bola was a channel-infilling event, where previous storms had 'exhausted' landscape response to rainfall, so there were considerably fewer landslides during Cyclone Bola, and there was consequently more 'energy' to mobilise and transport previously stored sediment. More recent research by Parkner et al. (2007) suggests that the "Cretaceous and Tertiary terrains doubled in size during this period. The largest increase in mean gully size (~eightfold) occurred within the remaining areas of steep land indigenous forest following a major cyclonic storm in 1988 (Cyclone Bola)". Both reports lead to similar results, with material from the upper reaches being transported 'en masse' into the lower reaches, causing bed aggradation through the mid-lower reaches. The widths of the flood plains were reported to have increased by up to 10 m in places. The spatial disparity of sedimentation within the channels placed more stress on the channel banks in places, particularly on the outside of meander bends.

As such, Cyclone Bola's flooding effects were more widespread than the 1980 and 1982 storms even though the 24 hour rainfall totals were comparable, as there was less space in the aggraded channels to convey the river flows.

5 March 2022 flooding

This section details the March 2022 flood event. Information in this section is provided firstly at a regional level, then related to the four principal catchments.

The following information is collated from impacts observed through sites visits, recorded by Council staff, documentation supplied, and impacts as recounted in consultation with various parties. It is most likely not an exhaustive list, but is considered to capture the nature and range of impacts experienced as a result of the March 2022 flooding.

A timeline of key forecast communications from the MetService is provided in Table 5.1 below. This is followed by data provided by local hydrometric monitoring locations and recorded rainfall.

Table 5.1: Timeline of key forecast communications from MetService (sourced from MetService social media channels), with reference to key GDC and TCDEM actions

Date	Time	Events
Friday 18 March	14:45	• Thunderstorms in upper North Island, with forecast of "moderate confidence" for heavy rain for Bay of Plenty, north half of East Cape for 21 to 23 March, low swirling over Tasman moving to Northland.
Sunday 20 March	10:29	• Watch issued for heavy rain for end of East Cape. • Heavy Rain Watch issued for midday Monday (21st) to midday Tuesday (22nd) for East Cape North of Tolaga Bay but with low confidence.
Monday 21 March	08:00	• Forecast heavy 10 to 25 mm / hour rainfall for the Bay of Plenty and North side of East Cape, low thunderstorm risk for Gisborne region, but heavy rain watch extended to cover more of East Cape.
	16:30	• For Bay of Plenty and Gisborne north of about Tolaga Bay, there is HIGH confidence of rainfall amounts exceeding warning criteria on Wednesday. • There is the potential for extreme rainfall in these areas, with dangerous River conditions and significant flooding possible. • People in Bay of Plenty and northern parts of Gisborne are advised to keep up to date with the latest forecasts as Heavy Rain Warnings are likely to be issued for these areas closer to the time.
Tuesday 22 March	08:00	• Forecast thunderstorms for this afternoon evening and night, moderate risk with heavy rain 10 to 25 mm / hour.
	10:47	• Forecast update upgraded localised downpours 25 to 40 mm plus / hour, potentially causing flash flooding.
	11:24	• Orange Warning, with potential for upgrades to a Red Warning.
	11:30	• MetService communications "If your place is prone to flooding this is an event worth keeping an eye on!".
Wednesday 23 March	08:00	• TCDEM declaration of emergency.
	10:13	• MetService in Consultation with GDC upgraded rain warnings to Red Warning, and shared "get ready info" for information on what to do in an emergency.
	10:17	• MetService share video of what its Severe Weather Warning categories mean.

A forecast of a potential heavy rain event was provided with four days warning. The Heavy Rain Watch was issued two days before the event, and the high confidence was issued 48 hours prior to the start of rain. Within six hours of the rainfall onset, MetService advised flooding was likely.

On Wednesday morning of a state of emergency was declared. MetService in consultation with GDC upgraded the forecast for 23-24 March 2022 to Red, including information on how to "get ready" and a video on what the warning categories mean.

Rainfall and River Monitoring

There are four rain gauges operated by GDC in and of near the Tolaga, Anaura and Tokomaru Bay catchments: Te Puia, Hikuwai at Hikuwai No4, Hikuwai at Willow Flat, and Fernside. There is also a privately owned but publicly viewable rain gauge located at Puketiti, on the northern boundary of the Mangahauini River catchment (refer Figure 2.1).

GDC also operates two river flow monitoring sites located in Tolaga Bay: Hikuwai at Willow Flat, recording flow in the Hikuwai River draining the northern two thirds of the Uawa Catchment (approximately 260 km^2); Mangaheia at Willow Bank, recording flow from the southern Uawa tributary (approximately 26 km^2).

Based on the track of the storm, and proximity of the catchments, the Te Puia gauge provides a useful representation of the rain across the Tokomaru Bay Catchment. The Hikuwai at No 4 record also provides a useful indication of the rain that fell at Anaura Bay.

From midday Monday 21 March light rain fell across the catchments, with hourly rainfall totals between 5 and 15 mm over the next 24 hours to midday Tuesday 22 March. The preceding week had been dry, with 5 to 10 mm total rainfall recorded across the catchments.

From 18:00 Tuesday 22 March to 21:00 rainfall turned heavy from Te Puia down to Anaura Bay, and across the Hikuwai Catchment. This continued through to 03:00 Wednesday 23 March. Hourly rainfall totals between 30 to 45 mm / hour were recorded, with the highest one hour rainfall of 57 mm (recorded at Te Puia and Hikuwai at No.4 bridge from 01:00 to 02:00 on the 23 March 2022, refer Figure 5.1).

A second more moderate downpour fell the next day from 15:00 Wednesday 23 March until 19:00. Hourly rainfall totals between 15 and 25 mm were observed at Te Puia, and 15 to 20 mm at Hikuwai at No4 bridge from 18:00 to 22:00.

The total three-day rainfall recorded from midnight Monday 21 March till midnight Wednesday 23 March was between 355 and 528 mm across the rain gauges. The frequency of the three-day rainfall totals was approximately 100 year Average Recurrence Interval (ARI) or 1% Annual Exceedance Probability (AEP) (based on HIRDs V4). The return frequency of the one hour rainfall was 40 year ARI or 2.5% AEP.

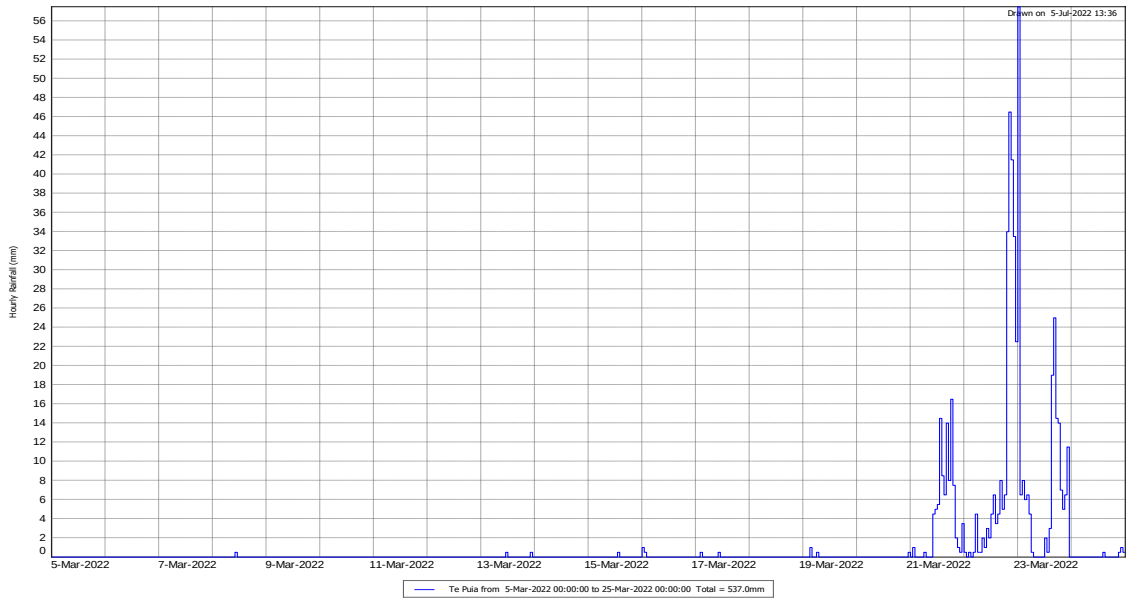


Figure 5.1: 10 days antecedent conditions and storm as one hour rainfall totals for the GDC rainfall monitoring site Te Puia. (Data source GDC).

5.1 Tolaga Bay

Both the flow monitoring sites in the Uawa Catchment recorded double peak flow responses to the March rainfall. The first peak at both stations was between 03:00 and 06:00 on Wednesday 23 March. Flows in the tributaries had receded through Thursday, and then started to rise again by 17:00 to peak again between 19:00 and 01:00 the 24 March (Figure 5.2). There are no stream, surface water level or flow monitoring sites in Tokomaru and Anaura Bays. However, the Tolaga Bay sites, together with anecdotal evidence, provide insights into the potential flow patterns in the Mangahauini River, Waiotu Stream and the Anaura Bay streams.

Flooding impacts

The sources of flooding in the Uawa catchment were both fluvial and pluvial.

Observations from the site visit and conversations with GDC staff indicate that the Uawa tributaries, such as the Hikuwai River, overtopped their banks and flowed overland onto the floodplains. Bridges caught extensive woody debris, likely reducing the capacity of the waterways and increasing overbank flow upstream of the bridges. These included Wigan bridge, Mangatokerau River bridge on Paroa Road, and at the mouth of the Waitoroko Stream where it joins the Hikuwai (Figure 2.15.3). Wigan bridge had woody debris on the bridge deck indicating that it was overtopped during the event.

Roads became flow paths, leading to surface flooding where the capacities of culverts were exceeded or blocked. This resulted in surface water ponding on roads and neighbouring paddocks. Surface flooding was exacerbated in areas where rainfall exceeded the capacity of the drainage infrastructure.

Mostly paddocks received the flood waters in the Uawa catchment. Some coastal erosion was observed at the Uawa River mouth, as observed since around 2020 with lateral erosion at the river mouth migrating towards the Solander Street legacy landfill.

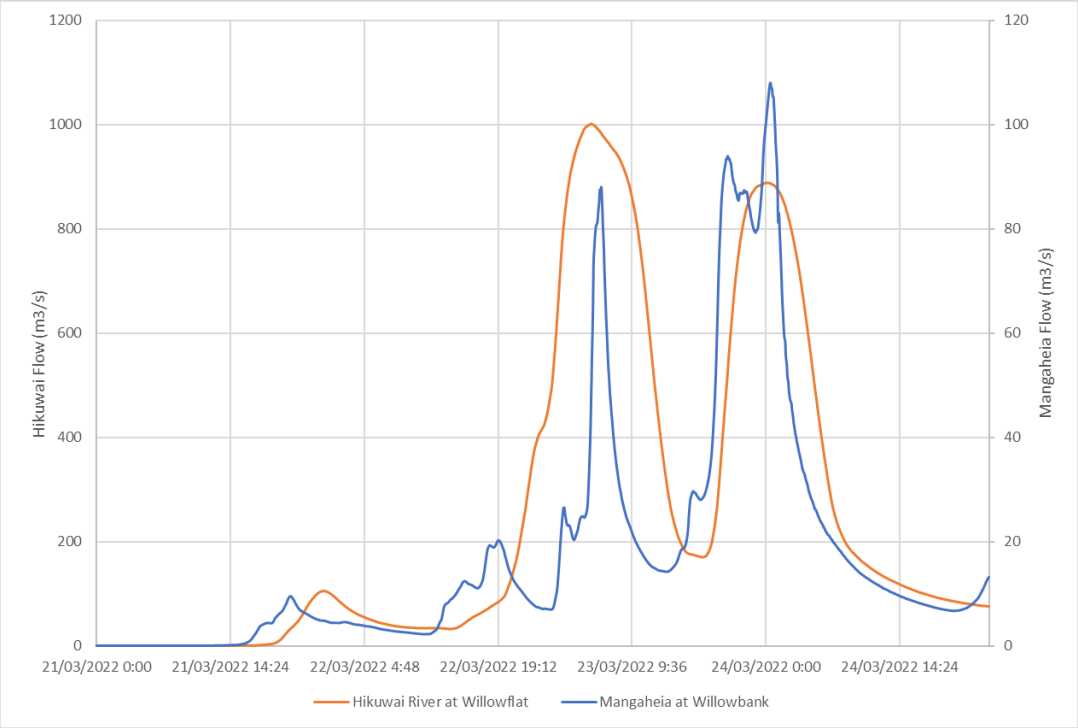


Figure 5.2: Hikuwai at Willow Flat (orange) and Mangaheia at Willow Bank (blue) stream flow responses to the 22 to 23 March 2022 rainfall (Data source GDC)

Figure 5.3: Photo of wood debris on the Waitoroko Stream showing the river damming impact of large amounts of wood debris.

Infrastructure performance

Bridge infrastructure capacity limitations contributed to flood impacts in Tolaga Bay. Flooding inundated pasture and horticultural crops, blocked roads and thus limiting evacuation routes. Table of Tolaga bay impacts in appendix.

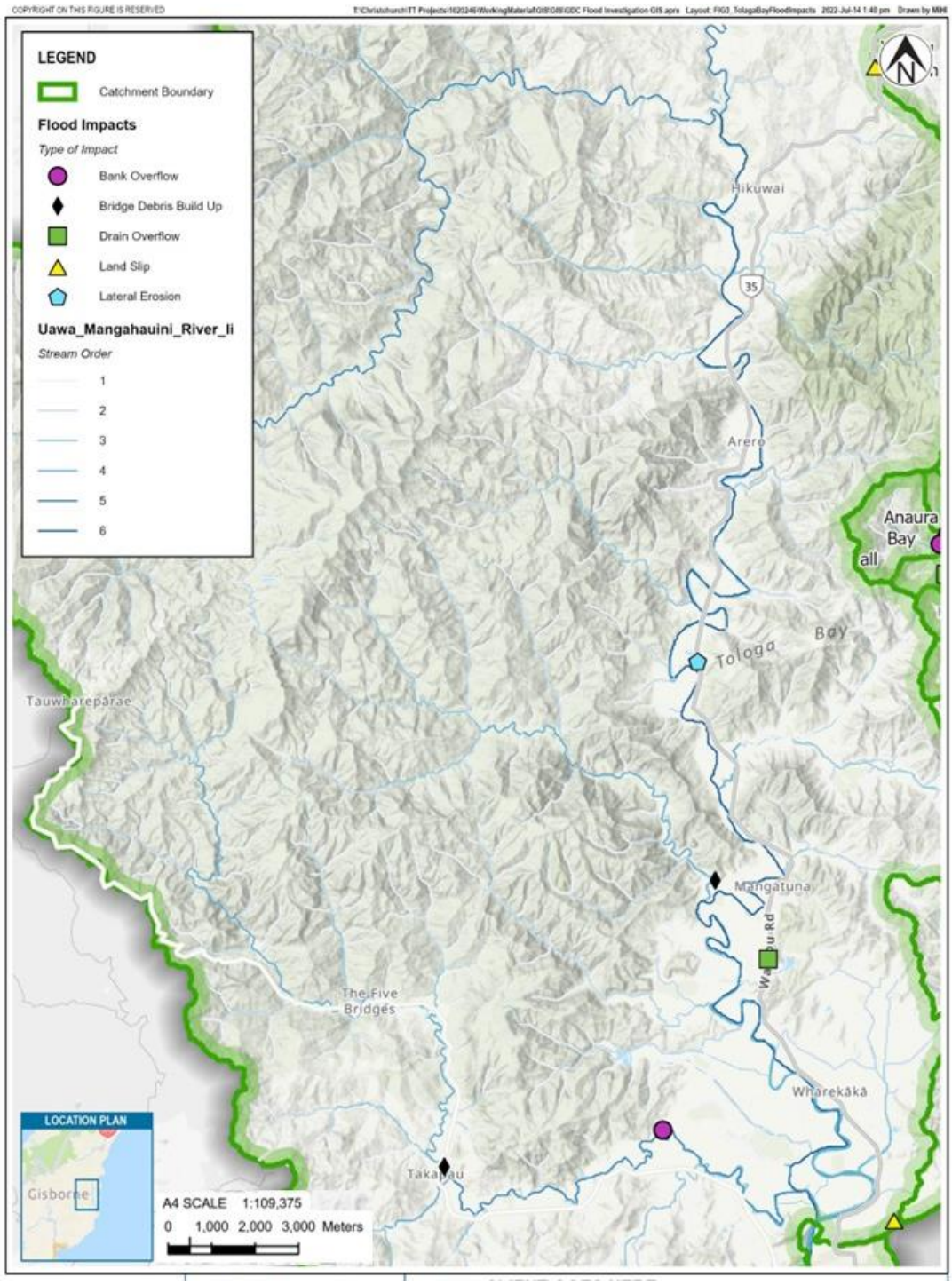


Figure 5.4: Tolaga Bay flood impacts as identified through site visit, talking to community and GDC documents

5.2 Mangahauini River, Tokomaru Bay

No evidence, monitoring or anecdotal, was available regarding the timing or duration of flood flows in the Mangahauini River. There are no gauges on the river. However, the Mangahauini River catchment is a similar size to the Mangaheia at Willow Bank and it is expected that the Mangahauini was likely to have had a similar double peaked response and similar flow rates to the Mangaheia.

Flooding Impacts

The principal source of flooding that inundated properties was pluvial, transported by roadside gutters and drains and flowing under houses and over roads. This also occurred due to the limited capacity of some drains that flow under SH35 north of Tokomaru Bay. Surface ponding was observed on the flats around the township.

There was fluvial flooding across floodplains along the river margins, with inundation of lower-lying property boundaries, however, there are no reports from GDC of houses above the floorboards being inundated from the river. Fluvial flooding was observed on properties neighbouring the Mangahauini River.

River bank lateral erosion was reported on the Mangahauini River, along over half the river length, cutting into roading infrastructure including the North SH35 bridge. This resulted in isolation of communities and limiting evacuation routes due to bridge and road flooding and wash outs. Full table in appendix.

Infrastructure performance

There is a river protection scheme along the Mangahauini River, comprising about 17 groynes and a 360 m long stopbank, in the lower 1,700 m of the river. The stopbank is on the true right bank upstream of SH35 towards Taro Street. The river groynes down the Mangahauini River during this flood (and the June 2021 flood) were outflanked and / or undermined in many places. The design standard for this flood protection and river training infrastructure is unknown.

The Paikea Street Transfer Station, located on the true left bank of the river, 1 km upstream of the river mouth, was flooded and waste was washed downstream and much of it out to sea. It is located on top of a historic landfill. During the March 2022 flood, protection works constructed following the June 2021 flooding were damaged.

Water flowed along Taro Street, perhaps from overtopping of the stopbank downstream of 12 Taro Street, or from overflow upstream of the stopbank at about 19 Taro Street. In larger floods it is likely that both processes occur.

The SH35 Bridge over the Mangahauini River washed out blocking access across the river and along the coast. This also damaged power and network cables carried on the bridge. The bridge was reopened after ten days. A temporary ford was constructed for 4WD and heavy vehicles (e.g. logging and supply trucks) across the river from Taro to Paikea Streets.

On SH35 there were at least two road wash outs north of Tokomaru township, reducing SH35 to one lane in each location.

Blocked Waiapu Road culverts caused additional surface runoff to flow down SH35 and into the side roads of Te Wehi Road, Toa Street, Marotiri Streets, overwhelming existing surface or road side drains.

The Waka Kotahi design standard for bridges and major culverts is for a serviceability performance between 1 in 25 year frequency and a 1 in 100 year frequency. The rainfall return period for this storm was over 100 years at some frequencies. It is likely that the river and stream flows would also have had a similarly frequencies.

NZTA Bridge Manual requires additional freeboard to bridges and culverts vulnerable to debris blockage. The design standard for major culverts is to pass capacity for flows up to a 1 in 100 year frequency. This study has not assessed bridge design against the Manual, however, anecdotal evidence clearly indicates that these bridges and culverts are vulnerable to blockage.

It is noted that there is a legacy landfill located next to the Mangahauini River, which sustained damage in June 2021 floods and again in March 2022. While this has not been reviewed as part of this assessment, while the historic landfill remains in the floodplain, each future flood event will increas the landfill's vulnerability to future flooding and erosion.

Figure 5.5: Aerial view of the Mangahauini River and the north end of Taro Street, with the transfer station at the bend in river (at the bottom of the photo). Lateral slips can faintly be seen in the middle of the photo at the foot of the hills (Photo source GDC).

Figure 5.6: Mangahauini River SH35 bridge washout, with the stopbank on the true right bank (Photo source GDC).

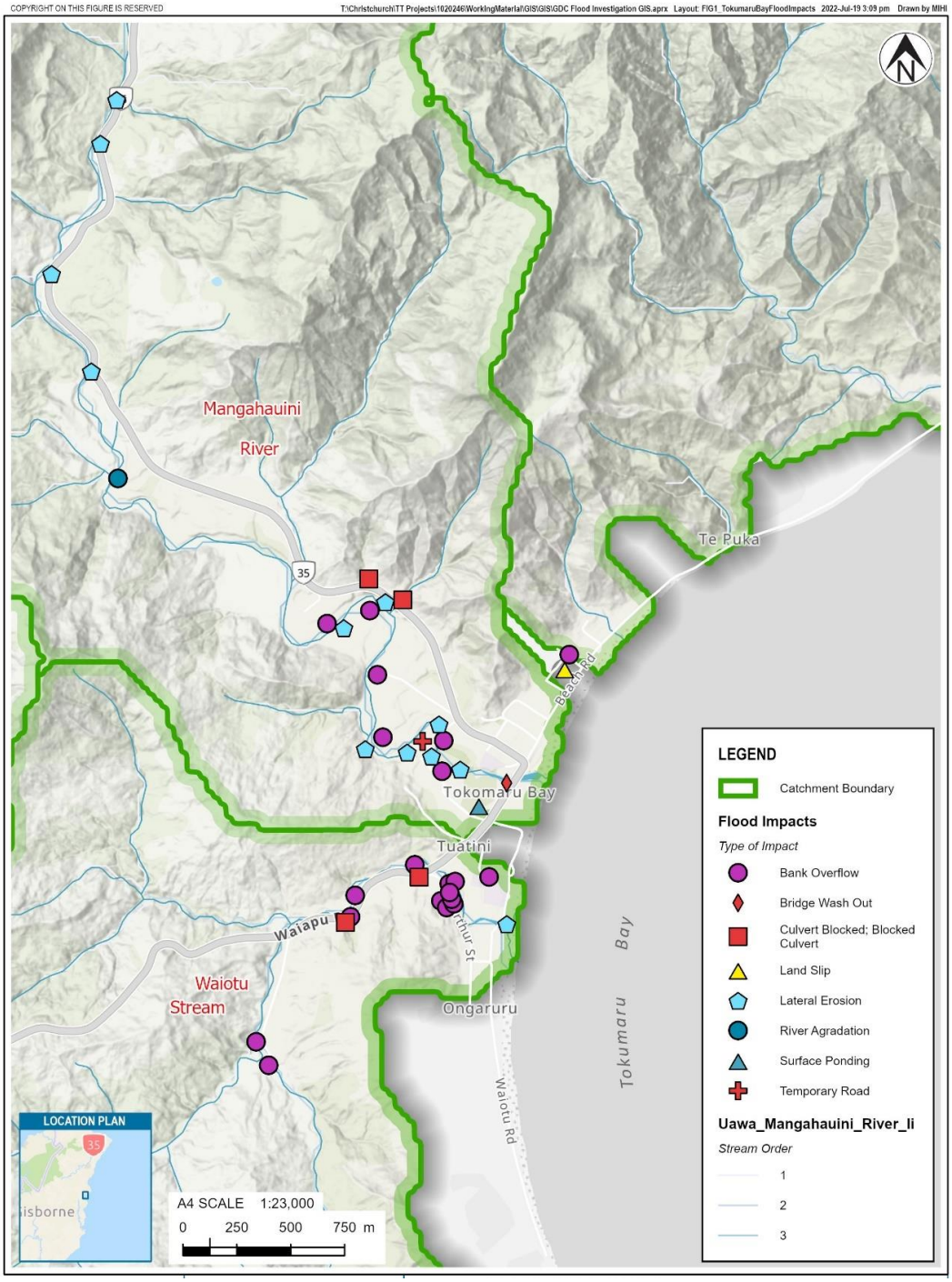


Figure 5.7: Flood impacts from the Manghauini River and Waiotu Stream, Tokomaru Bay, as identified through site visit, talking to community and GDC documents (refer table of impacts in appendix)

5.3 Waiotu Stream, Tokomaru Bay

Tokomaru Bay residents experienced flooding to land and flooding below and above the floorboards of properties. Residents reported that houses in Arthur Street were flooded three separate times during the March 2022 storm. This is plausible, associated with two separate periods of heavy rain overnight and a third downpour on Wednesday afternoon that may have caused the third river peak.

This anecdotal evidence suggests that the catchments are flashy, with watercourses responding quickly to heavy rain. High tides at Tokomaru Bay were at 22:30 on Tuesday, 11:00 and 23:30 on Wednesday, which could have impacted all flood peaks.

Flooding impacts

Flooding caused inundation internally into houses on Arthur Street and at the Hatea a Rangi School, as well as under the floors of many other properties.

SH35 south of Tokomaru Bay became a flow path during the event, cutting evacuation routes from the town until floodwater receded on the 23 March.

Following the flooding, GDC surveyed flood depths in and around houses along the Waiotu Stream. Of the properties surveyed, seven properties were inundated above floor levels with depths ranging between 0.03 m and 1.07 m, including five houses and two sheds on Arthur Street and the Hatea a Rangi School.

Table 5.2: Floor level inundation at Waiotu Stream properties

	Water Depths
Houses	0.36 m to 0.65 m
School	0.03 m to 0.24 m
Sheds	0.59 m to 1.07 m
Source	GDC, March 2022

Flood flow discharges and velocities are unknown. From observation reported during the flood it is likely that in many locations there was depths greater than 0.3 m flowing down the streets. Guidelines outline that standing floodwater depths greater than 0.3 m start to become hazardous and unsafe for vehicles, children and the elderly. Flood waters deeper than 2 m are likely to result in structural damage for all buildings (Australian Institute for Disaster Resilience, 2014).

The Waiotu Stream overflowed along SH35 upstream of the South SH35 bridge, and also downstream on the true right under the south SH35 bridge. The flooding inundated the southern SH35 access road to Tokomaru Bay, Arthur Street on the right bank and the school on the left.

Arthur Street fluvial flooding was likely exacerbated by limited culvert and stormwater systems capacity to drain the flood water away. The high tide and storm surge also potentially limited flood waters flowing to the coast.

Infrastructure performance

A small catchment draining directly into the south side of Arthur Street appeared to have been impounded by the fluvial flooding on the street. The lower Waiotu footbridge abutments possibly had an impounding effect on the stream flows and likely caught debris from the river.

The rainfall return periods were greater than 1 in 5 years (the GDC urban drains and culverts design standard), and exceeded the drain and culvert capacities. The culverts along Arthur Street are 400 mm diameter, three of these culverts direct flow into a single 500 mm diameter culvert under Arthur Street, which is likely to act as a throttle in higher flows. The design standard for street gutters as primary flow paths is a 1 in 5 year event. The standard for streets as secondary flow paths is up to 200 mm deep in gutters in a 1 in 2year event (GDC, 2000).

While Arthur Street drainage systems could have been more effective if better maintained, the overall drainage effect is likely to have been limited, given that the flood event overwhelmed the

capacity of the drainage system. While larger drainage systems (e.g. increased pipe diameters) is an option, the fluvial flood flows would likely continue to overwhelm the Arthur street drainage systems with similar rainfall events, even with increased drainage capacity. Increased maintenance and capacity of drainage systems across the region will have a positive effect on reducing flood impacts in lower intensity rainfall events.

The Waiotu Stream overflowed its banks and flowed on SH35 Waiapu Road, making it impassable as it became the flooding flow path. The road flooding blocked access to evacuate people from flooded Arthur Street houses. Most flooding in Arthur Street was fluvial from the Waiotu Stream, with smaller contributions from pluvial flooding.

5.4 Anaura Bay

There are no stream monitoring sites in Anaura Bay. However, anecdotal evidence indicates that flood waters flowed around houses in the middle of the bay at 03:00 on Wednesday 23 March (refer Figure 5.8).

Flooding impacts

Sources of flooding in Anaura Bay were both fluvial and pluvial. Flooding from streams pooled on Lockwood and Anaura Roads, and in low-lying paddocks. Floodwater entered above the floorboards of two houses and caused erosion damage to the urupā. Landslides carried debris into one house, and cut off roads from the bay for three days.

The Hawai Stream overflowed its channel into the paddocks. At the Lockwood Road culvert, the stream overflowed into the roadside drain, onto Lockwood Road and the paddocks upstream and downstream.

The Nuihiti Stream overflowed at Anaura Road, due to debris caught on the bridge. The flood water flowed into the Department of Conservation campground. It was reported by an Anaura Bay resident that *"…full size grown pine trees, roots and all came down the Stream and jammed against the Nuhiti bridge"*[6].

There were numerous landslides, damaging and blocking the main road into the bay and the north end of Anaura Road. The whole community was isolated for three days, and localised landslides restricted the evacuation of vulnerable people from damaged homes. Landslides also blocked stormwater drains and culverts, impeding surface drainage paths and redirecting flows overland. Pluvial flooding from all the hill sides was evident exceeding the capacity of the stormwater roadside drains.

Lockwood and Anaura Roads flooded, further limiting movements and evacuation attempts within the bay. Reports are that flood depths and silt were ankle depth within at least two Anaura Road properties.

There was erosion at the mouths of at least four of the streams flowing into the bay, and extensive erosion of the urupā at the south end of the bay required exhumation of graves. Coastal inundation is reported by residents to occur often, where sea water flows inland up the drains in high tides. High tides during this March event may have impeded drainage of fluvial and pluvial flood waters to the coast.

[6] Council staff reported that there were some trees but the majority was rubble, and sediment and a mix of root material small woody debris: not all of it looked like pine.

Figure 5.8: Aerial photo of Anaura Road properties in the middle of Anaura Bay (scource GDC)

Figure 5.9: Aerial photo of Lockwood Road, the Hawai Stream and urupa erosion at the south end of Anaura Bay (scource GDC)

Figure 5.10: Aerial photo of the Hawai Stream catchment looking east. Note the landslides throughout the hills and overland stream flow along the Hawai Stream (scource GDC)

Infrastructure performance

The capacities of road side drains and culverts were exceeded during the event. The drainage infrastructure was overwhelmed with rainfall combined with water from fluvial and coastal overflows. This resulted in in surface ponding.

The dimensions of the drains are unknown, but may have reduced over time with limited maintenance: anecdotal evidence from a local resident was that "*as a kid I used to ride my bike in the roadside drains, kids couldn't do that now*".

The GDC stormwater drainage capacity standard is capacity to convey a 1 in 5 year rainfall event. The storm was greater than a 5 year return period event and so exceeded that standard. It is uncertain that the stormwater infrastructure capacity met the requirements of the standard.

Many of the drains in the bay are also on private property and privately managed. The capacity of these drains is unknown, but some residents have upgraded culverts since March to increase drainage capacity. One resident reported that *"when we moved here we dug drains in the swamps behind the dunes, at the toe of the hills to create platforms for our houses"*.

Bridges waterway capacities were limited by debris and silt, resulting in over flows and fluvial flooding of paddocks.

As mentioned above, the main road into Anaura Bay was blocked by landslide damage and debris for three days.

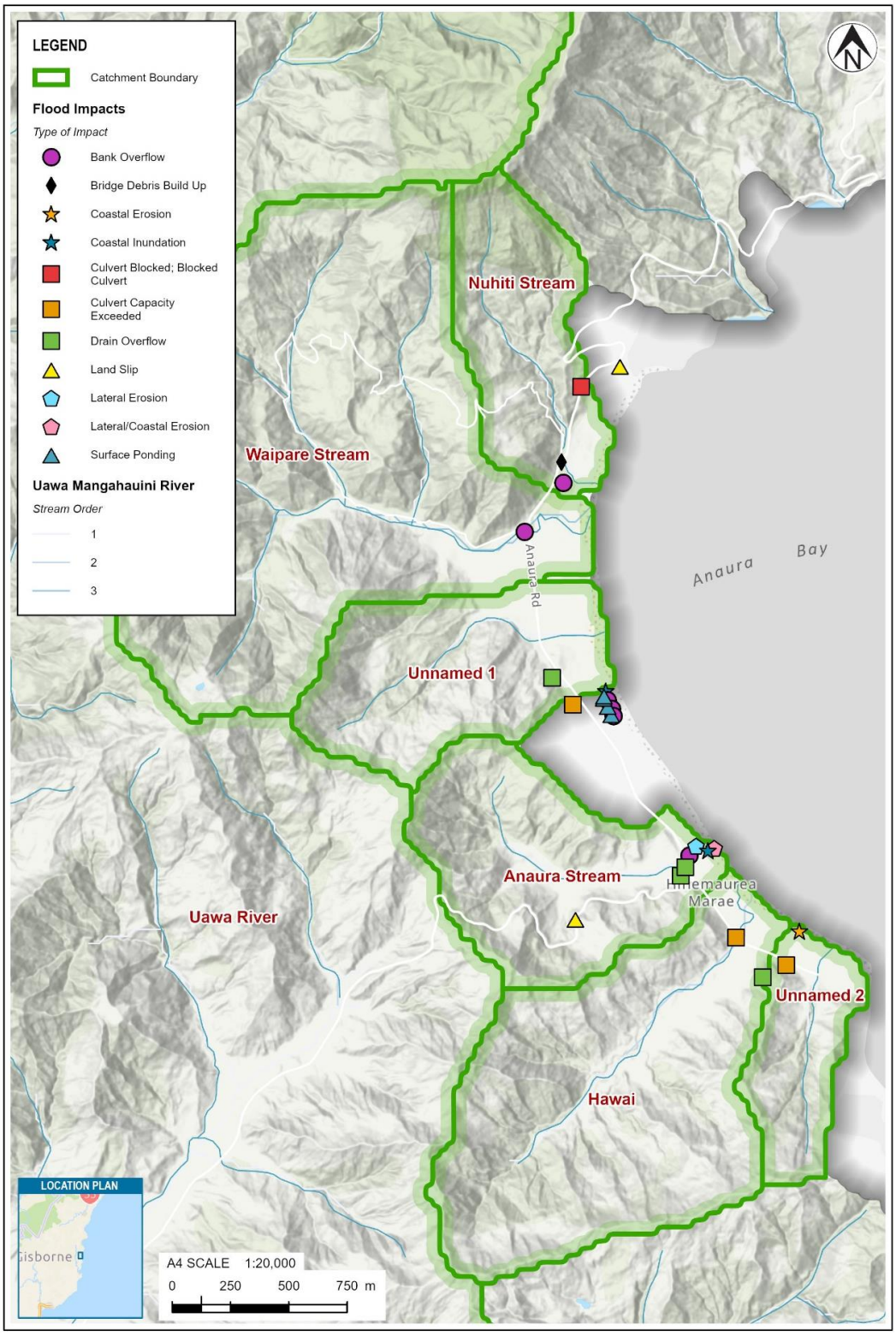


Figure 5.11 *Anaura Bay flood impacts as identified during site visit, community consultation, and from GDC documents (refer also table of impacts in appendix)*

6 Actions of risk management agencies

This section summarises the actions taken by risk management agencies (identified in Section 3) during the March 2022 flood event.

Based on the available information from relevant agencies, Severe Weather Warnings were distributed to communities through various public information channels, but no further proactive measures were taken ahead of the March 2022 flood. Recovery efforts focused on supporting residents of properties served with building notices (s124 and Red Sticker – see Table 6.1 below). Partial losses in power, telecommunications and transport were the focus for Lifeline Utilities, with the restoration of key roading network (bridge) by Waka Kotahi taking 10 days.

Further details of individual risk management agencies' responses are provided below, primarily focusing on Readiness, Response and Recovery actions.

MetService (forecast and warning)

MetService discharged its requirements under the Meteorological Services Act, providing Watches and Warnings to the community and other risk management agencies (stakeholders) prior to the event. The first warnings were provided four days beforehand and recognised the low confidence in the forecast. Two days before the event the MetService forecast heavy rain with high confidence.

The MetService also provided information on how "to get ready" and how to interpret its warnings approximately four days after the first warning was issued, and six hours after flooding had been reported. These communications were issued nationally.

The sharing of the "get ready info" and a description of what each of the weather warning categories means, could indicate that there were concerns among responders that the warnings were not understood effectively by some stakeholders or the public. Alternatively, the messaging could be interpreted as the best time to raise awareness of flood warnings directly after flooding as people have it fresh in their minds.

It is noted that there were numerous national Severe Weather Warnings over this period, with the potential for specific local warnings to be missed if not following local channels or using the MetService National Severe Weather Information service.

Gisborne District Council and Tairāwhiti Civil Defence Emergency Management Group

Given GDC as a Unitary Authority, and its sole membership of the TCDEM, actions of each agency have been combined below. The Tairāwhiti Plan identifies the need to avoid or mitigate the risk to people, property and infrastructure from natural hazards, including flooding. A review of GDC and TCDEM logs and Situation Reports, along with public information channels, has provided information of actions taken immediately before, during and after the March 2022 event.

With regards to public information channels:

- The Tairāwhiti Civil Defence Facebook page shared one post each day from the MetService and Severe Weather Warnings from 20 March;
- GDC shared one Severe Weather Warning from the Gisborne District Council Facebook page at 14:00 Wednesday 22 March;
- The Uawa Civil Defence Community Facebook page shared the Severe Weather Warnings one per day on 20 and 21 March. Accompanying the Severe Weather Warning on the 22 March was a bulletin providing tips to help the community prepare for flooding, and
- Overall, public information communications focused on Recovery efforts, with little Readiness and Response information.

TCDEM has flood response procedures and staff have been trained to support with readiness. An example of this is tsunami warning training in the Bays after the 7.3 East Cape earthquake in March 2021. The tsunami threat was the most recent TCDEM engagement in the Bays.

While the GDC and TCDEM flood response procedures were not reviewed as part of this assessment, it is understood that these document a multi-channel warning approach to disseminate flood warnings and the understanding of flood hazards to Gisborne, with individual at-risk properties identified in advance of a flood, and the evacuation priority established ahead of time. As the catchments are not covered by the GDC flood forecasting system (ARROW.2 models), it is presumed that these communities do not have such flood warning communications plans and associated evacuation planning in place. No evacuation plans existed or were therefore not utilised before or during the March 2022 flood event.

The first Situation Report (SITREP) from TCDEM was issued at 07:32 on 23 March 2022, with an incident classification of "***R3*** – *a* ***major regional*** *response*"[7]. From the information provided, there were no proactive flood management steps (such as drainage and roading inspections and clearances, community engagement, or support with flood diversions and evacuation planning).

A State of Emergency was not declared ahead of the flood event, with the declaration made at 06:30 Wednesday 23 March. GDC stated that the principal reason for the declaration was to speed up the recovery efforts. It is understood that this was primarily driven by experience of the June 2021 event, when insurance processes were hampered due to a lack of declaration. Community members reported that evacuations were coordinated by individuals and their families, seeking support within the community to leave their homes safely.

Key priorities listed in TCDEM SITREP during the first two days following the declaration included:

- Increasing intelligence on roading and infrastructure to identify support restrictions;
- Identifying the welfare support requirements;
- Delivery of medical supplies, and
- Establishing and maintaining lines of communication to area coordinators, and community links to personnel to maintain situational awareness.

Table 6.1 summarises the GDC notices served during the flooding event. Numbers were confirmed from the TCDEM Recovery SITREP dated 17 May 2022, which provided updated information on properties that suffered damage that could be dangerous or uninhabitable from the first recovery SITREP dated 8 April 2022.

Table 6.1: GDC Notices served regarding flooding (TCDEM Recovery SITREP 17 May 2022)

Notices	Notices Served
Section 124 Building Act (if a building is deemed to be dangerous and poses a risk to peoples' safety or is insanitary)	Currently four properties with s124 notices in place, one further property has had its s124 notice lifted. Currently one property being assessed for s124 notice.
Red Stickers (building is deemed uninhabitable)	Currently 10 properties with red stickers. GDC Building Control is waiving council consent fees on those houses that may need lifting in order to clear dirt/silt deposits.
Other Assessments	26 further property related issues being assessed and determined, none currently requiring escalation. Satellite imagery work confirmed, process underway to secure images.

[7] In accordance with the Coordinated Incident Management System (CIMS) third edition

Emergency services

Information from individual Emergency Services (such as callout logs) have not been obtained in this investigation.

Community members have reported that Tolaga Bay Police helped with the evacuation of one resident from Anaura Bay three days after the storm.

The TCDEM SITREPs reported that FENZ rescued a resident from a vehicle trapped in Waiotu Stream floodwaters on SH35, along with NZDF being on site and supporting with food distribution from 25 March.

Lifeline utilities

No information has been obtained from Lifeline Utilities. It is unknown whether any proactive steps were taken before the event (such as drainage inspections or bridge debris clearance within transport corridors).

Following the outage of State Highway Bridge across the Mangahauini River, Waka Kotahi and its contractors worked to restore the bridge in 10 days. During the outage, a detour route was established by a ford across the Mangahauini River.

The damage to the bridge also damaged electricity and telecommunications cables, increasing the duration of power and communication lines outages already suffered through downed power lines. Both the cell network and radio communications network were also not functioning due to either flooding or landslide damage. The restoration time and duration of this outage are unknown.

It is noted that GDC recognised that the roading network was in a fragile state due to the rainfall directly prior to the event, with network recovery actions following the June and November 2021, and February 2022 storm events still unfinished.

Other agencies

No information has been obtained for the support provided by Te Puni Kōkiri, MSD, TRONPnui, MPI or the Rural Support Trust.

Landowners and community

The Anaura Bay community reported that residents cleared their drains of any blockages. It is presumed that this principally related to surface clearance of gullies and drain openings, with little clearance of silt from within drainage conduits.

Residents reported that self-evacuation occurred where required. Lack of telecommunications and power made information sharing difficult for residents, who reported that family outside the bay needed to contact the Tolaga Bay police station to organise evacuation for family in the bay.

The post-event recovery and clean up required a full community effort, with residents reporting low morale given another clean-up was required so soon following the June 2021 flood.

7 Options to reduce flood risk

Flood risk to people and property is the result of the likelihood and consequence of flooding. The Australian Water School (2022) identified four factors that influence flood risk, being:

- **Hydraulic** How fast, deep and wide are the floods? Where will the floodwaters go?
- **Evacuation** Will there be loss of evacuation access or isolation of people due to flooding?
- **Exposure** What population, assets, infrastructure, etc are in the path of the flood?
- **Vulnerability** Is the land use and / or the community sensitive to flooding or do people already manage their lives to live within the flood regimes of the natural systems?

Flood risk can be managed by reducing the likelihood of flooding and / or reducing the consequences of flooding by adjusting the four factors above. To manage flood risk, there is generally no single solution as each of the factors can be adjusted by different mechanisms. Therefore, numerous options and combinations should be identified and assessed.

An industry example[8] published by Sayers et al (2014) provides 10 golden rules for strategic flood management (refer schematic in Appendix A), that could be considered when assessing options:

1 Accept that absolute protection is not possible.
2 Promote some flooding as desirable.
3 Base decisions on an understanding of risk and uncertainty.
4 Recognise that the future will be different from the past.
5 Do not rely on a single measure, but implement a portfolio of responses.
6 Utilise limited resources efficiently and fairly to reduce risk.
7 Be clear on responsibilities for governance and action.
8 Communicate risk and uncertainty effectively and widely.
9 Promote stakeholder participation in the decision-making process.
10 Reflect local context and integrate with other planning processes.

Managing risk

A commonly used method to group risk treatment options within a flood management context is the PARA categorisation framework. This identifies flood risk treatment options within four broad areas:

- Protect
- Accommodate
- Retreat
- Avoid.

These are outlined in Table 7.1. These categories are useful to focus discussions, and to indicate which organisation / agency may be responsible for implementation.

The PARA framework dates back to the first Inter-governmental Panel on Climate Change assessment report (1990), which included the PAR framework that outlined the Protect, Accommodate, and / or Retreat options. The fourth option, Avoid, has since been added by practitioners. It has become widely accepted as a useful framework in fluvial, pluvial and / or coastal

[8] Endorsed by International Association for Hydro-Environmental Engineering Research, International Association of Hydrological Sciences and the International Network of Basin Organizations (Sayers, et al.2014)

flooding (British Columbia Ministry of Environment, 2013; Eichhorst et al., 2011; Harford, 2016; Middle, 2018, Ministry for the Environment, 2018).

Table 7.1: PARA Framework explanation

Protect	A reactive strategy to protect people, property, and infrastructure that have been impacted by a hazard, by reducing either the extent or the frequency of the flooding. Typically done through structural mechanisms but can also encompass soft engineering and nature-based solutions. Examples include building flood walls, stopbanks, deploying barriers, expanding channels, seawalls, dams etc. These options are also sometimes referred to as "Defend" options. ***The overall aim of these options is to proactively reduce the extent and / or frequency of the flood hazard.***
Accommodate	An adaptive strategy that enables the continued occupation of areas exposed to hazards by making changes to human activities and/or infrastructure to adapt to the hazard. This can involve retrofitting existing buildings (e.g. raised floor levels or property flood resilience (PFR) measures such as waterproofing), developing evacuation plans, issuing early warnings, community preparedness, etc. ***The overall aim of these options is to reduce the consequences of the flood hazard.***
Retreat	A strategic decision to withdraw, relocate or abandon private or public assets due to the risk presented by the natural hazard. Retreat is an adaptive strategy to limit protection and discourage development in areas subject to a high risk from hazards, and promotes a shift to locations where communities and the built environment are exposed to a lower risk (e.g. relocation, land swaps, property purchase, etc). It may also include financial incentives. ***The overall aim of these options is to relocate existing people, property and assets (communities) from locations that are exposed to the flood hazard.***
Avoid	Involves ensuring new development does not take place in areas exposed to subject to existing hazards, or where there is a low risk at present but where that risk will increase. A wide range of planning tools may be involved when applying this approach, such as building restrictions and new development rules. ***The overall aim of these options is to ensure that new development of property and vulnerable assets is not exposed to the flood hazard.***
Source	British Columbia Ministry of Environment (2013) Ministry for the Environment (2018)

7.1 Potential flood risk management options

Following our desktop analysis, site investigations, and discussions with residents and GDC staff, various potential flood risk management options have been identified. These options have varying levels of impact on flood risk factors, along with differing timeframes for implementation and effectiveness. As mentioned above, no single option will provide the comprehensive solution, and implementing options in conjunction is fundamental to effective flood risk management.

The potential options have been grouped by their mechanisms, along with identification of relevant PARA category. Historically hard engineering options have often been the default. However, with future climate change and associated changing hazard profiles, hard engineering Protect options may not be the best investment for communities. Accommodate options help to manage existing, future and residual risk, and should be considered with or without other options. This includes development of community resilience through evacuation planning and property level alterations.

When considering flood risk management options, early decisions are required to identify and prioritise a range of options that will have benefits realised in the short, medium and long term.

While some options are stand alone, others are interdependent. Option selection must recognise that there is an existing flood risk for communities, along with a future flood risk. This means that some options may provide only short term benefits, but are vital to support management of existing flood risk, while longer term options are incorporated to manage future risk.

Establishing appropriate funding mechanisms for differing options can take time, reinforcing the need for early consideration of options to provide short, medium and long term impacts. Prioritising short term options whilst also undertaking further strategic and business case processes can help reduce existing flood risk in the short term. These options are often referred to colloquially as “no regrets” or “quick wins”, meaning those options that can be implemented with little concern for negative impacts to future risk reduction measures.

Table 7.2 provides a summary of potential options for consideration, based on their short, medium and long term impacts. These and future identified options to manage and reduce risk can be found in Table 7.3.

Table 7.2: Priority options for early consideration with varied timeframes for impacts

Timeframe	Option Description
Short term ***(‘quick wins’)***	• Targeted emergency planning at community and Council level, establishing Emergency Action Plans covering flood warning triggers and associated actions (e.g. communications) along with evacuation plans for communities. • Increased awareness of flood risk within all communities across Tairāwhiti, be they within a modelled catchment or not. • Increased flood risk asset management to identify drainage and flood management assets, their associated ownership, condition and expected performance to inform maintenance and future potential capital works.
Medium term	• Flood early warning system to provide consistent and clear messaging ahead of flood events to communities, emergency services, lifeline utilities etc. • Investigate in more detail the natural hazard processes (including flooding and associated river morphology) to understand more clearly what flood management options are appropriate to reduce the adverse effects of the flooding and stormwater hazard and improve the resilience and safety of the communities. • Engagement with insurers to understand and collectively work toward long term reduction in flood risk. • Training and exercising for Council, risk management agencies and communities to increase readiness for flood events. • Increased infrastructure and water-sensitive urban design to improve flood flow path channels, stormwater and flood channels. • Planning control implementation (rezoning and development constraints).
Long term	• Discussion and planning of managed retreat for key identified properties / communities. This may result in as little as a few houses identified for retreat, to community wide retreat. Early engagement with community and practitioners is key to success of manged retreat. • Hard engineering options to protect communities from flood events.

* see Table 7.3 for further information on option reference number

Use of differing options groups and PARA categories is key for successful flood risk management. Increased investment in early warning systems and evacuation planning are key across all options. Without further investment, these Accommodate options help to raise awareness and response lead times of existing and future flood risk, resulting in increased ability to reduce risk for communities.

Should hard engineered solutions also be considered to Protect, early warning systems and evacuation planning support management of residual risk are required.

Planning controls will provide longer term flood risk management, however, their consideration and implementation need to occur in the short term for good effect in future years. This includes rezoning and development constraints to enable managed retreat. Therefore, these options alone will not manage flood risk in the short to medium term: consideration is also required of soft and hard engineered options along with building controls to provide increased protection in the short to medium term. This could be achieved through identified capital projects, along with flood resilience options at the property level. Working with insurance organisations to better enable access to enhanced recovery options will be crucial for future flood events.

Table 7.3: Potential flood risk management options

Option Group	No.	Option Description	PARA Category
Natural Hazards Research	**1**	Investigate the river and stream morphology and sediment life cycles to identify when river channel-in filling or degradation process are happening in the catchments. This will provide an 'envelope' of river response which will enable a range of sustainable management actions to be developed in the short and medium term. This should also identify an affordable level of service for the local communities.	Accommodate
	2	Flood hazard mapping of depth, velocity and flood extents for these communities (as recommended by T+T Natural Hazards Review summary report 2022). Particularly to identify the Waiotu Stream floodplain so that recovery steps are appropriate and long term sustainable.	Accommodate
	3	Further research to understand landslides likelihood and impacts in the region (as recommended by T+T Natural Hazards Review summary report 2022).	Accommodate
Early warning System	**4**	Develop community warning network to increase time for community to act (e.g. evacuate). This system could be council or community based (e.g. local phone tree when a river level reaches a certain height at the south SH35 bridge, to ring the fire siren, or text alert). Community based warning systems could also be considered (e.g. Water Watch or RiverTrack). The short steep catchments with heavy rainfall are likely to continue to cause the river and streams to rise very quickly, so flood warnings through data and visual observations are likely to give flood warning only within hours or minutes (not days of lead and preparation time).	Accommodate
	5	Create a section within the GDC hydrology flood response procedure for Tokomaru and Anaura Bays. GDC to add telemetry rainfall alarms from the Te Puia and Hikuwai no 4 gauges into GDC hydrology flood warning manual to notify communities of potential imminent flooding risk. Add MetService forecast heavy rain warnings into the hydrology flood response manual for the East Cape north of Tolaga Bay.	Accommodate
CDEM Planning /	**6**	Map secondary flow paths and identify evacuation routes for individual communities. Identify safe locations for evacuated people.	Accommodate

Option Group	No.	Option Description	PARA Category
Evacuation Planning	**7**	Test and exercise evacuation routes with community to increase preparedness.	Accommodate
	8	Test and exercise flood response procedures with multi-agency input to ensure better outcomes during future flood events.	Accommodate
Community Flood Resilience	**9**	Community flood awareness and preparation education covering weather forecasts, community resilience, evacuation planning for individual households and the community together. Individual plans can include which doors to exit your own home. Community plans can include "don't use X road as it is prone to flooding", and identify if certain people require help evacuating first.	Accommodate
Insurance pay outs / agricultural insurance	**10**	Council to facilitate discussions with insurers to understand insurance options moving forward for residents and landowners.	Retreat
	11	Consider purchase and lease back, and / or purchase and covenant in line with planning control options below.	Retreat
Emergency works	**12**	Repair river groyne training structures to design level and / or current standards.	Protect
	13	Riparian vegetation management (clear vegetation clogging streams, reinstate riparian vegetation that provides appropriate room for the streams and rivers, while also protecting banks)	Protect
Building controls	**14**	Identify and apply minimum floor heights for at-risk habitable dwellings (as identified through flood hazard mapping, or at least using the maximum historical flood height with appropriate freeboard).	Accommodate
	15	Property flood resilience measures (alterations). These provide a cost-effective approach to managing existing flood risk, e.g. rebuilding with materials less impacted by flood waters.	Accommodate
Planning controls (long term, strategic)	**16**	Provide planning rules that allow people who want to stay in their houses and on their land to acknowledge the flood risks.	Accommodate
	17	Re-zoning undeveloped floodplain land to prevent future development of properties, and limit subdividing of land already in the floodable zones, e.g. prevent development on the paper road land on the true left lower Waiotu Stream floodplain. Generally, people do not want to leave the land under direction of anyone else. They want to stay on their land and adapt to the flood risks, until they themselves are no longer comfortable with the risks.	Avoid
	18	Review of drainage systems within Anaura Bay to ensure any proposed future development will not exacerbate, and ideally will reduce flood risk (i.e. adequate stormwater drainage).	Protect & Accommodate
	19	Planning for managed retreat. Engagement with communities to understand and develop a strategy that meets the needs of communities whilst managing flood risk into the future. This could include changes to zoning, redevelopment restrictions, and Council buy-back options.	Retreat

Option Group	No.	Option Description	PARA Category
		Further assessment of areas at risk of flooding to establish key land areas that could be retreated from to enable rest of community to remain (e.g. pockets of highest risk).	
	20	Planning for catchment land use change in areas of high hazard. Particularly relevant for catchments with significant landslide risks and potential high sediment loads.	Retreat
Hard engineering	**21**	Reassess, redesign and potentially reinstate damaged groynes that are still connected to the river banks to manage lateral river erosion. Consider options to replace outflanked groynes with alternative management structures, e.g. timber pile training fields, or living groynes/willow pole groynes.	Protect
	22	Increase protection height of Mangahauini stopbanks to 0.1% AEP standard (1 in 1,000 year flood return period). Note that rivers are aggrading outflanking defences, requiring high capital investment in this option.	Protect
	23	Upgrade Arthur Street stormwater drainage capacity to drain flood waters faster (reduce the ponding time of flood water).	Accommodate
	24	Re-grade the southern Tokomaru SH35 road to provide flood storage, and to direct flooding back into the stream.	Accommodate
	25	Upgrade road culverts to limit gravel build up and blockages.	Accommodate
	26	Design and rebuild Waiotu stopbank to protect from fluvial flooding.	Protect
	27	Upgrade the Hawai Stream culvert to a bridge or larger culvert that will convey flood flows.	Accommodate
Soft engineering/ natural flood management	**28**	Construct flood detention storage in line with water-sensitive urban drainage techniques.	Accommodate
	29	Develop the paper road on Waiotu Stream below South SH35 bridge as flood flow path.	Accommodate
	30	Provide space for streams and rivers to freely move.	Retreat
	31	Manage / create / maintain a permanent woody riparian vegetation buffer along the river floodplain to stabilise banks. Willows should be avoided as they may cause channel infilling, and therefore reduce channel capacity.	Protect
	32	Identify sustainable sediment management options tailored to the sediment loads of the systems.	Accommodate
Asset management	**33**	Create an asset management plan for the flood protection assets in these catchments including groynes, stopbanks, and riparian vegetation.	Protect
	34	Identify ownership of low head gravel detention weirs on the Mangahauini River and create a combined asset management plan.	Protect
	35	Develop Emergency Action Plans (EAP)[9] for key assets and infrastructure within flood prone areas, including Transfer Station (to enable clearance of waste ahead of event), School (to ensure safe evacuation of students and staff), etc.	Accommodate

[9] Also referred to as Trigger Action Response Plan (TARP)

Option Group	No.	Option Description	PARA Category
	36	Ensure timely and regular roading culvert maintenance, inspections and pre-storm clearance (e.g. added to Council emergency planning procedures).	Accommodate
	37	Review of maintenance contractor contract for this part of the region to ensure capability and capacity for flood events.	Accommodate
	38	Review of historic landfills at risk to erosion to ascertain effective management strategy to avoid waste exposure.	Avoid
Do nothing	**39**	Accept all flood and erosion risks.	Accept

Note that spatial planning has not been included in this PARA assessment

8 Summary

The March 2022 flood event across Tolaga, Tokomaru and Anaura Bays resulted in personal safety risk to the communities, and damaged property and infrastructure. No lives were directly lost during this flood event. In the context of the requirements of national legislation and Tairāwhiti Plan, the recent flood impacts indicate that some objectives in relation to flood hazard risk management are not being fully met.

Flooding is not uncommon to these communities, and there are records from the early 1900s reporting “phenomenal”, “extraordinary”, “terrific”, and “improbable” “rainstorm deluges”, causing flash flooding, surface flooding and landslides. Rainfall that causes disruptive flooding is generally either at an intensity greater than 40 mm / hour, or with 24 hour totals greater than 200 mm. There have been at least eight storm events that met these criteria in Tolaga, Anaura or Tokomaru Bays reported in the last 100 years.

The March 2022 event resulted in fluvial flooding from the Uawa, Hikurangi, and Mangahauini Rivers and from Waiotu Stream. There was evidence of pluvial (surface water) flooding in Tolaga, Tokomaru and Anaura Bays. It is likely that there was coastal inundation and erosion to some extent at the river mouths of the Uawa and Mangahauini Rivers, and Waiotu, Hawai, Anaura, Waipare and Nuhiti Streams.

In Anaura and Tokomaru Bays, flooding was likely caused by, and in some instances exacerbated, by limited culvert capacity. Woody debris, or log jams against bridges in Anaura Bay caused flooding. In Tolaga Bay, debris blockage may have caused or exacerbated some flooding to land adjacent to the tributary rivers within the Uawa catchment. There were many landslips during the March 2022 event across all three catchments, impeding or blocking culverts and drainage paths. Landslips in Anaura Bay appeared to cause the most disruptive effects for the community based on anecdotal reports.

Severe Weather Warnings were communicated to communities through various public information channels, but no further proactive measures were taken ahead of the March 2022 flood event. Recovery efforts focused on supporting residents with properties served with building notices.

The communities are located in catchments without flood forecasting systems. Catchments elsewhere in the region have emergency management planning in place, such as warnings and evacuation planning. The lack of formalised flood forecasting systems should not prevent further preparation and planning for flood events across Council, Risk Management Agencies and the community.

GDC recognises the need for further understanding and investigation into options for these communities. This report has identified high-level options framed within the **PARA** framework, which identifies flood risk treatment options within four broad categories: **Protect**, **Accommodate**, **Retreat**, **Avoid** (explained in Table 7.1). Priority options with associated timeframes for realisation of

benefits are identified in Table 7.2. A further list of key options is identified in Table 7.3. These options cover:

- Natural Hazards research;
- Early warning systems;
- CDEM planning / evacuation planning;
- Community flood resilience;
- Insurance pay outs / agricultural insurance;
- Emergency works;
- Building controls;
- Planning controls (long term, strategic);
- Hard engineering;
- Soft engineering / natural flood management;
- Asset management, and
- Do nothing.

9 Next steps

The March 2022 flood event has highlighted areas of improvement for Council, Risk Management Agencies, and the community. This report identifies key flood risk management options with benefits that could be realised in the short, medium and longer term.

It is recommended that the next steps to address and manage the flood risk for the Tolaga Bay, Tokomaru Bay and Anaura Bay communities include, inter alia:

a Review, identify and prioritise key management options through appropriate business case processes. This could include coordination of appropriate funding mechanisms across parties.

b Early consideration of short term 'quick wins', including:
  - Targeted emergency planning at community and Council level, establishing Emergency Action Plans covering flood warning triggers and associated actions (e.g. communications) along with evacuation plans for communities
  - Increased awareness of flood risk within all communities across GDC, be they within a modelled catchment or not.
  - Increased flood risk asset management to identify drainage and flood management assets, their associated ownership, condition and expected performance to inform maintenance and future potential capital works.

c Review flood response procedures, including associated training and exercising across GDC, TCDEM and other Risk Management Agencies to enhance coordination and communication during readiness, response and recovery.

d Coordinate within GDC regarding prioritised policy and management options.

e Engage with Risk Management Agencies to identify and coordinate responsibilities to reduce and/or manage flood risk

f Engage with communities to understand preferred options to manage future flood risk.

10 Applicability

This report has been prepared for the exclusive use of our client Gisborne District Council , with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

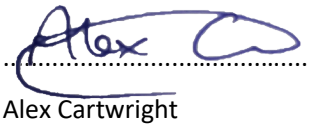
Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

.....

Michelle Hitchcock
Water Resources Consultant

Technical review by:



.....

Alex Cartwright
Chartered Water and Environmental Manager

Authorised for Tonkin & Taylor Ltd by:

P.P.

.....

Tom Bassett
Project Director

This version of the report has been approved per procurationem Jon Rix (Project Director).

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Appendix B Legislation

Table 10.1: New Zealand Legislation for flood hazards directed under four categories in relation to flooding: Flood hazard Identification and control, Flood information and education, Flood hazard preparedness, response and recovery, Hazard financial loss.

Category	Description	Acts	Action
Hazard control	Measures such as the provision of stopbanks, channel maintenance and clearance, dams.	Local Govt act 2002	Avoidance and mitigation of natural hazards that councils must pay particular regard to, includes specific mechanisms for stormwater control and flood protection works. Obligations are discharged through Long Term Plans, Annual Plans and Asset Management Plans. Set rules in local bylaws for managing land drainage.
		Soil Conservation and River Control Act 1941	Conservation of soil resources, prevent damage by erosion, make better provision for the protection of property from damage by floods.
		Rivers Board Act 1908	Largely repealed unless River district is constituted under the Act.
		Land drainage act 1908	Now largely repealed. Any drains must be constructed and maintained so as to not cause a nuisance (section 25).
		Building Code Act 2004	Refuses building consent for construction on land subject to or likely to be subject to a natural hazard Allows building if hazard is listed but subject to conditions (section 72).
		Resource Management Act 1991	To carry out functions of the act, a regional authority must produce Regional policy statement. Also has provisions to avoid property damage through the control of resources through resource consenting, requiring activity to avoid or mitigation adverse effects on the environment. Collate records of hazards.
		Public Works Act, 1981	Authorization of local authority to undertake, establish, operate or maintain works as identifies as *public works*. Also, empowers local authority to acquire land to undertake *public works.*

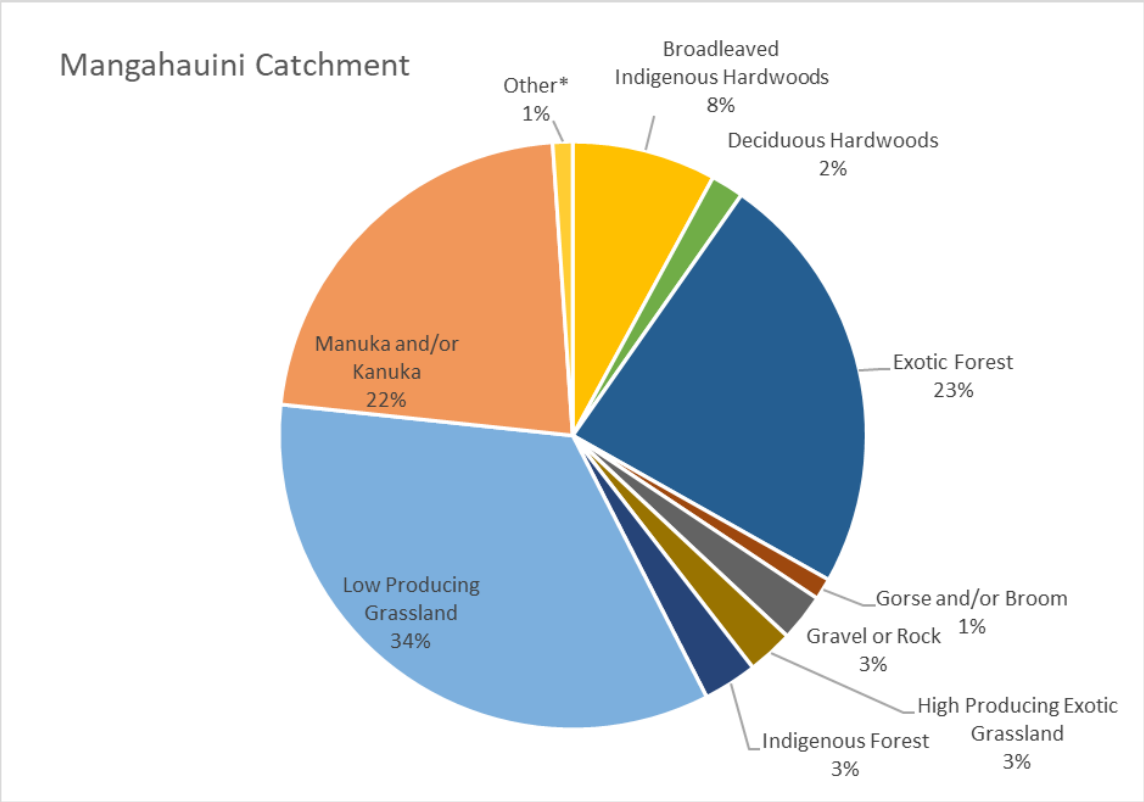
Category	Description	Acts	Action
Flooding information and education	Scientific and practical information about flooding and ways to minimise the impacts of flood events.	Local Govt Official Information and Meetings Act 1987	A Land Information Memoranda (LIM) is required to list hazards on a property title, or provide ways in which public can access site specific hazard information.
Flood Hazard Preparedness, response and recovery	Legislative framework for national regional and local committees to prepare for and respond to flooding.	CDEM Act 2002	Encourage and enable communities to achieve acceptable levels of risk by, among other things, identifying, assessing and managing risks. i.e Communicate hazards to public Act requires some level of hazard identification to allow for appropriate risk management. Provides review of tools to manage natural hazards.
Flood loss insurance and financial assistance	EQC, govt can also provide disaster relief funding	EQC Earthquake Commission Act 1993	Compensation for residential buildings, land, personal property in event of natural disaster. EQC can put hazards on titles, if council has not.

Appendix C Catchment land use

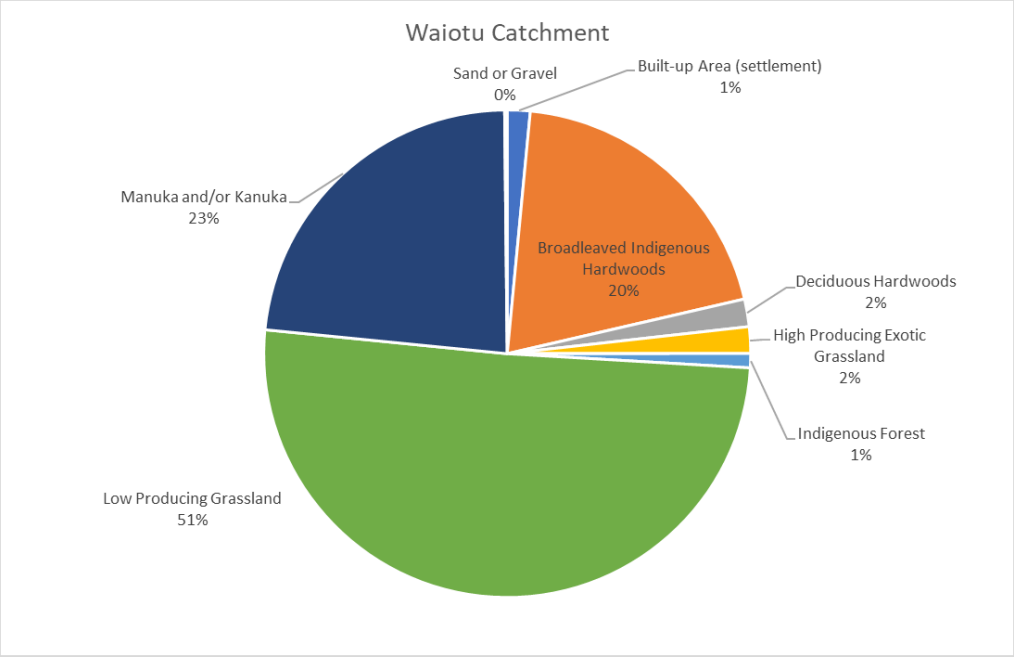
Catchment land cover as classified as 2018 reported from Land Cover data Base (LCDB) V5: LCDB v5.0 - Land Cover Database version 5.0, Mainland, New Zealand - LCDB | | Environment and Land GIS | LRIS Portal (scinfo.org.nz)

C1 Mangahauini Catchment, Tokomaru Bay Land cover database 2018

Other consists of land classification that makes up less than 1% of the total catchment area. For the Mangahauini catchment this was: Fernland, Mixed Exotic Shrubland, Sand or Gravel, Built-up Area (settlement), Urban Parkland / Open Space.

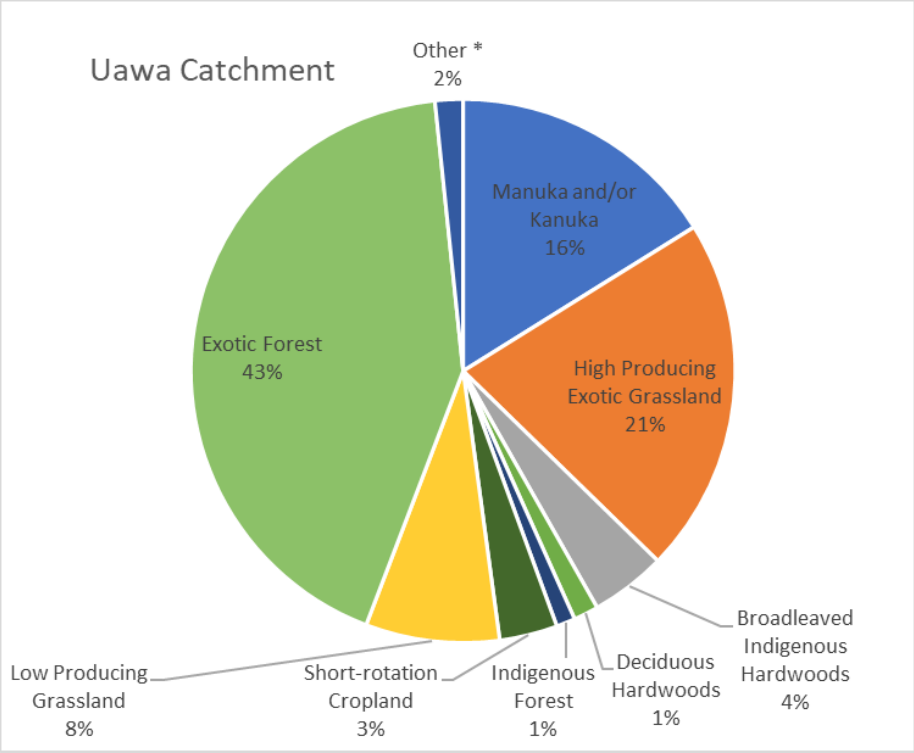


C2 Waiotu Catchment, Tokomaru Bay Land cover database 2018



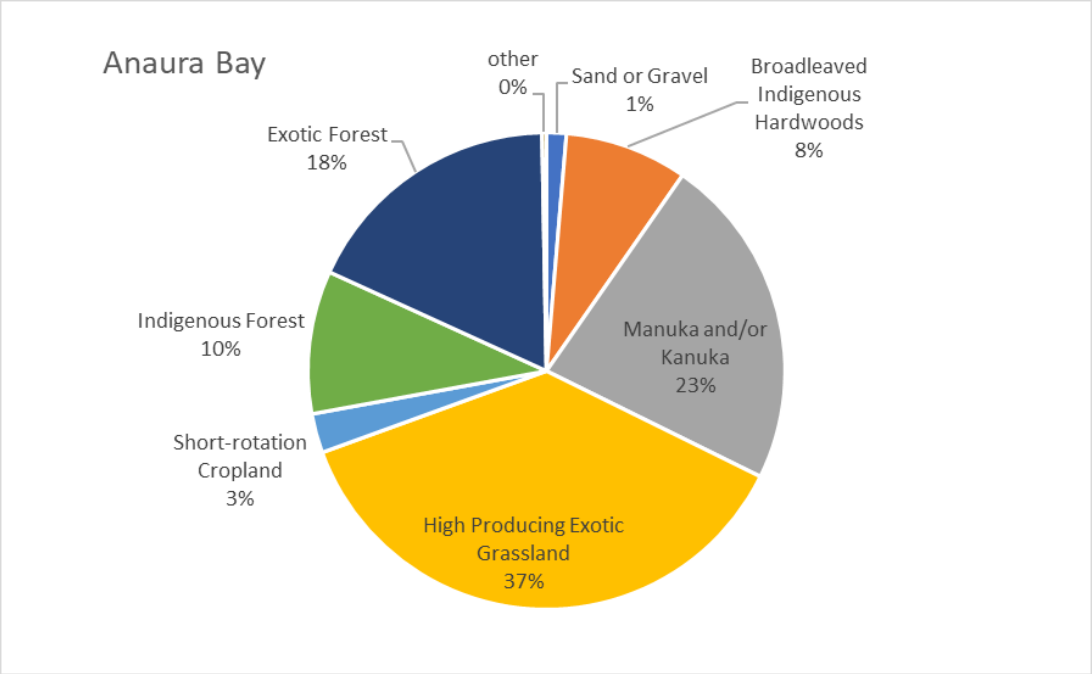
C3 Uawa Catchment, Tolaga Bay Land cover database 2018

Other consists of land classification that makes up less than 1% of the total catchment area. For the Uawa Catchment this was: Landslide, Fernland, River, Herbaceous Freshwater Vegetation, Gravel or Rock, Mixed Exotic Shrubland, Gorse and/or Broom.



C4 Anaura Bay Land cover database 2018

Other consists of land classification that makes up less than 1% of the total catchment area. For the Anaura Bay catchments, this was Landslide and Built up area (settlement)



Appendix D Summary of Historic Flood Events

Table 10.2: Table of historic floods and rainfall recorded

Date	Rainfall recorded	Rainfall totals	Comments
1800s	Gisborne Region		Records of floods in Poverty Bay through the 1800s mostly around Gisborne but some likely to cross over up the coast. Nature in Freakish Mood | NZETC (victoria.ac.nz)
1916-1917		483 mm in 18 hours	Flood wash out or caused damage to bridges Tolaga and Tokomaru Bay. 21 22 January 1917 Mangahauini River rose to record level in a few hours.
19/02/1938	Tolaga Bay	194 mm 24 hours	https://hwe.niwa.co.nz/event/February_1938_Eastern_North_Island_Flooding
23/04/1938	Waima	208 mm in 24 hours	https://hwe.niwa.co.nz/event/April_1938_Gisborne_and_Hawkes_Bay_Flooding
July or August 1963		101 mm in 3 hours	East Coast Page - Gisborne Photo News - No 110 : August 8, 1963
Nov-64	Tokomaru	89 mm in 4 hours	Flash Flood - Gisborne Photo News - No 126 : December 3, 1964 East Coast Page - - No 121 : July 16, 1964 (photonews.org.nz)
December 1980		580 mm over 8 days	Phillips, C.J, 1988.
April 1982		220 mm over three days	EX Cyclone Bernie https://hwe.niwa.co.nz/event/April_1982_North_Island_Ex-tropical_Cyclone_Bernie
6-11 /03/1988	Te Puia	419 mm 24 hours, 700 mm over 5 days	Cyclone Bola 300 mm in 24 hours, 900 mm rainfall over three days, declared emergency. Te Puia springs 419 mm / 24 hours (150 year return period) (Pascoe 2012). Total rainfall recorded 700 mm, Hikuwai 490 mm. Tokomaru bay interpolated depths maybe 800 mm from 05/03/1988 to 10/03/1988.
	Hikuwai	490 mm in 24 hours	
	Tokomaru Bay (interpolation)	800 mm over 5 days	
25-28/02/2003	Hikuwai	423 mm 60 hours	
21/10/2005	Hikuwai No4	371.5 mm 36 hours to 11am on 22nd	

Date	Rainfall recorded	Rainfall totals	Comments
	Te Puia	365.5 mm in 36 hours to 10 am 22nd, Intensities of 44 mm / hour	
2/06/2018		80 mm in 3 hours	Cyclone Cook / Tolaga Bay storm. The one with all the forestry slash
19/06/2021	Te Puia	150 mm in 12 hours	Tokomaru Bay storm flooded Arthur street and Toa street
6-8/02/2022	Hikuwai River at No 4 Bridge	134 m min 24 hours	Cyclone Dovi. No flooding
	Te Puia	150 mm in 24 hours	
22-23 /03/2022	**Te Puia**	**184 mm in 6 hours** **528 mm in 72 hours**	**March 2022 flood**
	Puketiti House	**441 mm in 72 hours**	
12-14/4/2022	Hikuwai River at No 4 Bridge	161 mm in 24 hours	Cyclone Fili. No flooding
	Te Puia	174 mm in 24 hours	

Note: data from GDC, reported on Photo News Gisborne Photo News, Extreme Rainfalls (nzextremerainfalls.com), https://hwe.niwa.co.nz

D1 19-20 June 2021 Flood

A severe short storm struck the Gisborne Tairāwhiti region overnight on 19 June 2021 and had cleared the region by mid-morning on the 20 June. The most significant impacts of the flooding occurring in the coastal township of Tokomaru Bay. Flooding occurred within houses and properties on Arthur and Toa Streets, the transfer station inundated by flood waters, surface water ponded on low lying areas of Tokomaru Township and the Waiotu Stream flowed down the south SH35 into Tokomaru (Cave 2021).

The Waiotu Stream overflowing onto SH35 southern approach to Tokomaru Bay early morning 20 June 2021.

Figure Fifteen. *Photograph hosted on the Uawa Live Facebook page credited to Kuipo Saulala and described as taken at approximately 8am.*

D2 20-22 October 2005

20 – 22 October 2005 a deep stalling low to the East of the North Island heavy rainfall on the Tairāwhiti Region causing heavy widespread surface flooding (Chappell, 2016). Rainfall of over 340 mm fell in the Hikuwai catchment, resulting in river flood levels that were 0.6m lower than Bolas levels and 7 houses were inundated by flood waters around Tolaga Bay. SH35 suffered from many slips, blockages and wash outs. Reinitiated gulling and shallow soil flows were the main contributor to sediment load in the Hikuwai River (Beatham and Grant, 2006). The Footbridge over the Waiotu Stream in Tokomaru Bay was reported by residents to have trapped debris from the floodwaters.

D3 6-11 March 1988

6-11 March 1988 Cyclone Bola recorded the highest rainfall numbers (in the north island) since records began in 1876. The intense rainfall fell on steep highly erodible hill country, resulting in lots of erosion, landslides and silt deposition on arable land, causing crop losses. The storm did not cause new environmental problems but exacerbated existing problems. (Borland, 1988). Many houses were raised after this storm and infrastructure made more resilient. E.g. roads bridges that were washed out were rebuilt higher and stronger.

Ariel view of Tolaga Bay Cyclone Bola. Source Gisborne Herald Remembering Cyclone Bola – The Gisborne Herald

D4 1963 and 1964

Reported in the Gisborne Photo News is two reports of Tokomaru bay flooding and the building of the Waiotu stopbank in 1964.

November 1964 (no specific date reported)

A flash flood, the result of a deluge of rain on the Coast last month (three and-a-half inches in four hours), swept through the Tokomaru Bay area. Although the floodwater did not rise to the height of last December's effort, it washed away small bridges, damaged and retarded road works, and left a trail of debris and silt in its wake. Main road traffic reached a dead end north of Tokomaru Bay where a low level bridge was submerged by the floodwaters. Workmen are pictured inspecting the bridge.

Flash Flood

By Frank Wynne-Jones

A flash flood, the result of a deluge of rain on the Coast last month (three and-a-half inches in four hours), swept through the Tokomaru Bay area. Although the flood-water did not rise to the height of last December's effort, it washed away small bridges, damaged and retard-ed road works, and left a trail of debris and silt in its wake.

Above: Main road traffic reached a dead end north of Tokomaru Bay where a low level bridge was submerged by the floodwaters. Workmen are pictured inspecting the bridge.

Two girls hitch up their skirts to wade across a flooded Tokomaru Street..

...while this gentleman decided to try it on his bicycle.

1963

Reported on 8th August 1963 Gisborne photo news edition.

"The improbability if flooding in the East Coast town of Tokomaru Bay were quickly dispelled one day last month, when a cloudburst in the hills overflowed already swollen Streams. The main highway was overrun for a considerable length, also low lying Arthur Street to a depth that penetrated above the floor boards in some houses. On one day four inches of rain fell in three hours causing even more widespread inundations."

This truck stalled trying to get along Arthur Street

86-years-old Mrs H.McGuire of Tokomaru Bay recently painted her own house!

East Coast Page

The improbability of flooding in the East Coast town of Tokomaru Bay was quickly dispelled one day last month, when a cloudburst in the hills overflowed already swollen streams. The main highway was over-run for a considerable length, also low-lying Arthur Street to a depth that penetrated above the floor boards in some houses. On one day, four inches of rain fell in three hours causing even more widespread inundations.

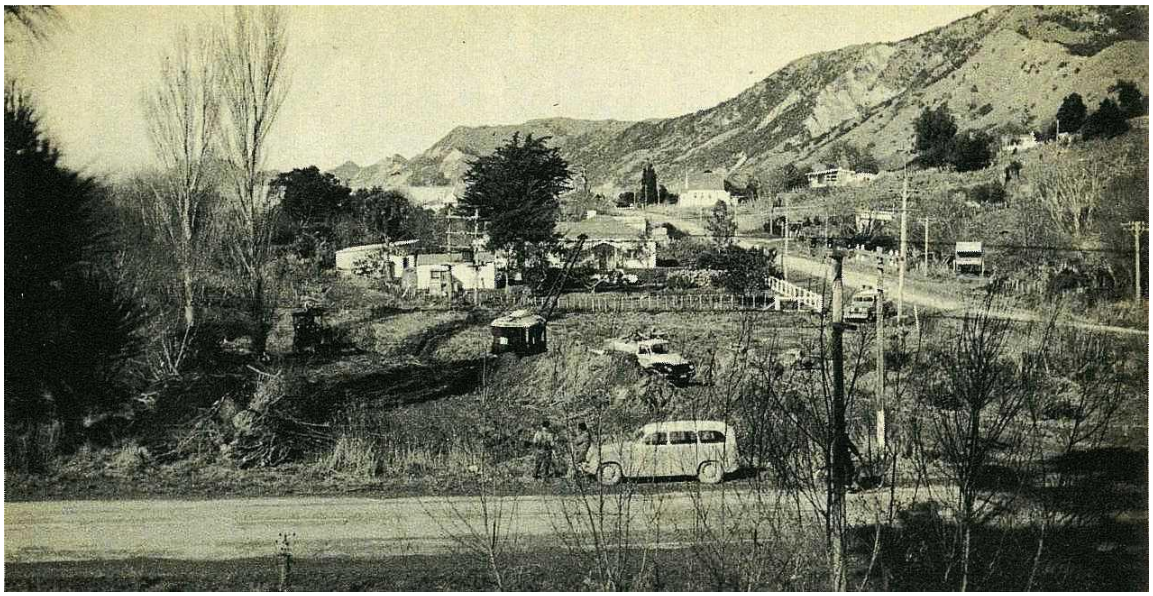
The water penetrated as far as Chaffey's Transport depot

The properties of Thomas Edge, sr, and Colin Peach suffered considerably

Water covered the main road and damaged stock in the Tustini Cafe

46

July 16, 1964 "the poverty bay Catchment board is carrying out flood control work in the Tokomaru Bay area. Pictured is the scene of operations alongside the township where bulldozers and draglines are building stopbanks along the Waiotu Stream."



Mangahauini River gravel dams 13 July 1966 *East Coast Page - Gisborne Photo News - No 145 : July 13, 1966*

East Coast Page

By Frank Wynne-Jones

Above: One of a series of steel and boulder dams which are being built in the Mangahauini stream by the Poverty Bay Catchment Board. This is to control the flow of the stream and prevent erosion.

D5 1938

Two notable storms

A two day storm on the 18, 19 February **1938,** delivered 194 mm in 24 hours.

Pressures were high to the south of New Zealand and low to the north, with north-east flow over the North Island. A mesoscale low developed off Gisborne within this flow, then moved southwards. There was torrential rain from East Cape to Hawkes Bay and southwards to Cook Strait. Electrical activity was a major contributor to heavy rain (McKay, 1949)

Post flood debris from the Hikuwai river suspended in the telephone line indicated the river was 18 m above the normal level. A 40 year old bridge on the Uawa was carried away in flood waters. Silts were deposited on the flats. Tolaga Bay township was isolated.

Three day storm **25 April 1938**

On the 25th a much intensified cyclone centred east of Gisborne and brought prolonged heavy rain to Gisborne and Hawke's Bay districts (McKay, 1949). The main feature was the slow-moving low to the north of the North Island. Extreme rainfalls occurred in a fairly small area – lying in broad convergence zone between humid east northeast flow and cooler east southeasterlies. Distribution of rainfall was similar throughout the three days of the storm.

208 mm in 24 hours

Terrific rain caused extensive flooding in Tokomaru Bay. There was considerable damage in the township. Two bridges were damaged. The approach to Mangahauini bridge washed out and the bridge near Te Puka Hotel collapsed. Silt covered low-lying areas to a depth of one foot (0.3 m) in places. Huge boulders were brought down. The school grounds suffered, about 15 cm of silt was left on the grounds and huge boulders were lying about in many places. Deep deposits of silt were left around houses. The road between Tokomaru Bay and Tolaga Bay was blocked at Arero and Mangatuna with 0.9m depth of water over the road (McKay, 1949).

D6 1916-1917

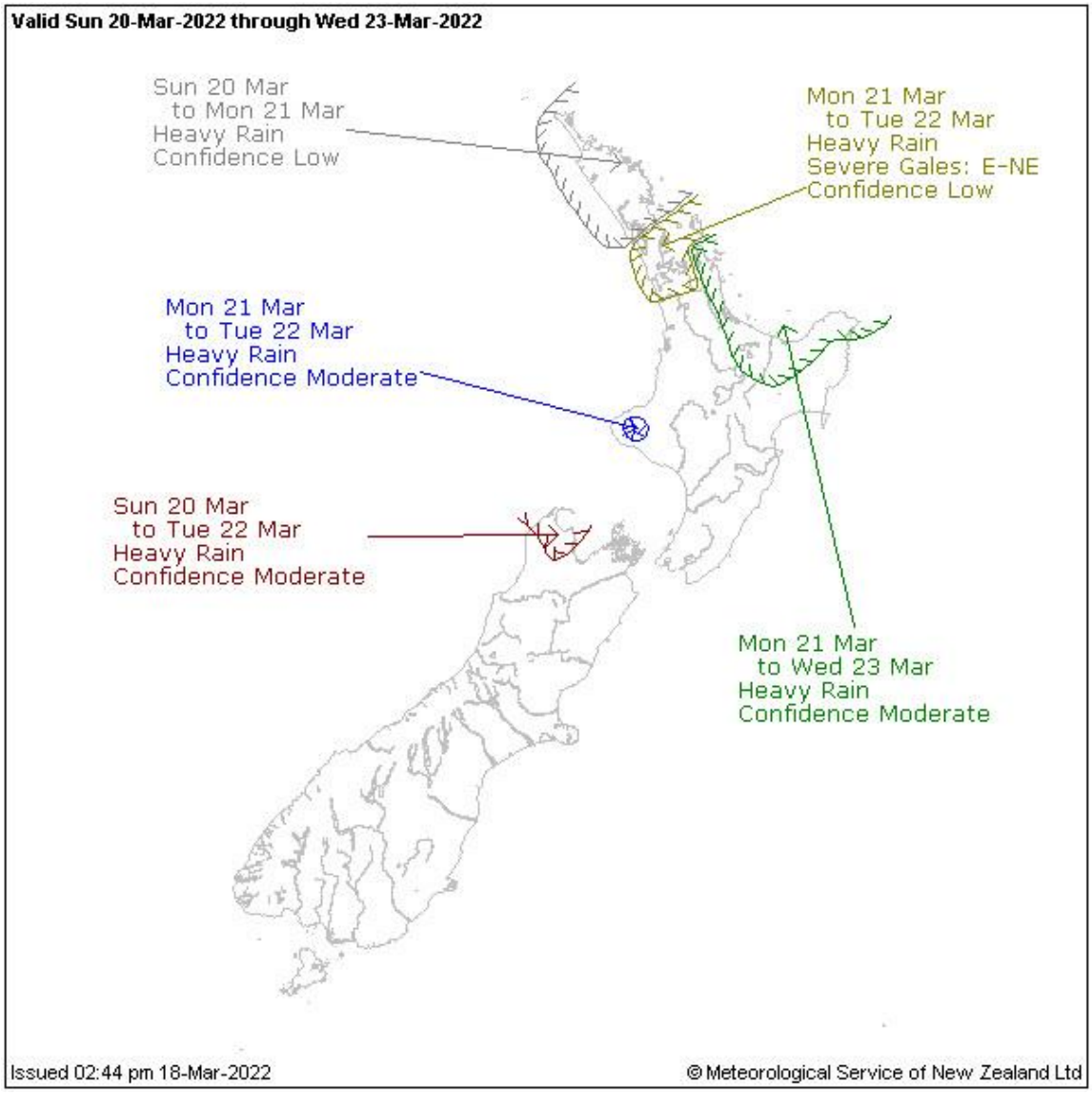
Phenomenal rains at Tokomaru Bay on 21–22 January 1917, caused the Mangahauini Stream to rise to a record level in a few hours (McKay, 1949).

Uawa River, On 12 May 1916, a flood—the first of thirteen in twelve months—caused portion of the bridge to subside. Two more spans were wrecked during a flood in January 1917. Another flood on 4 February 1917, when 19 inches (483 mm) of rain fell in 18 hours, did further damage. May 2016 storm causes damages in Tokomaru Bay to the Tikitiki bridge and Rotokautuku bridge.

Appendix E March 2022 Forecasts

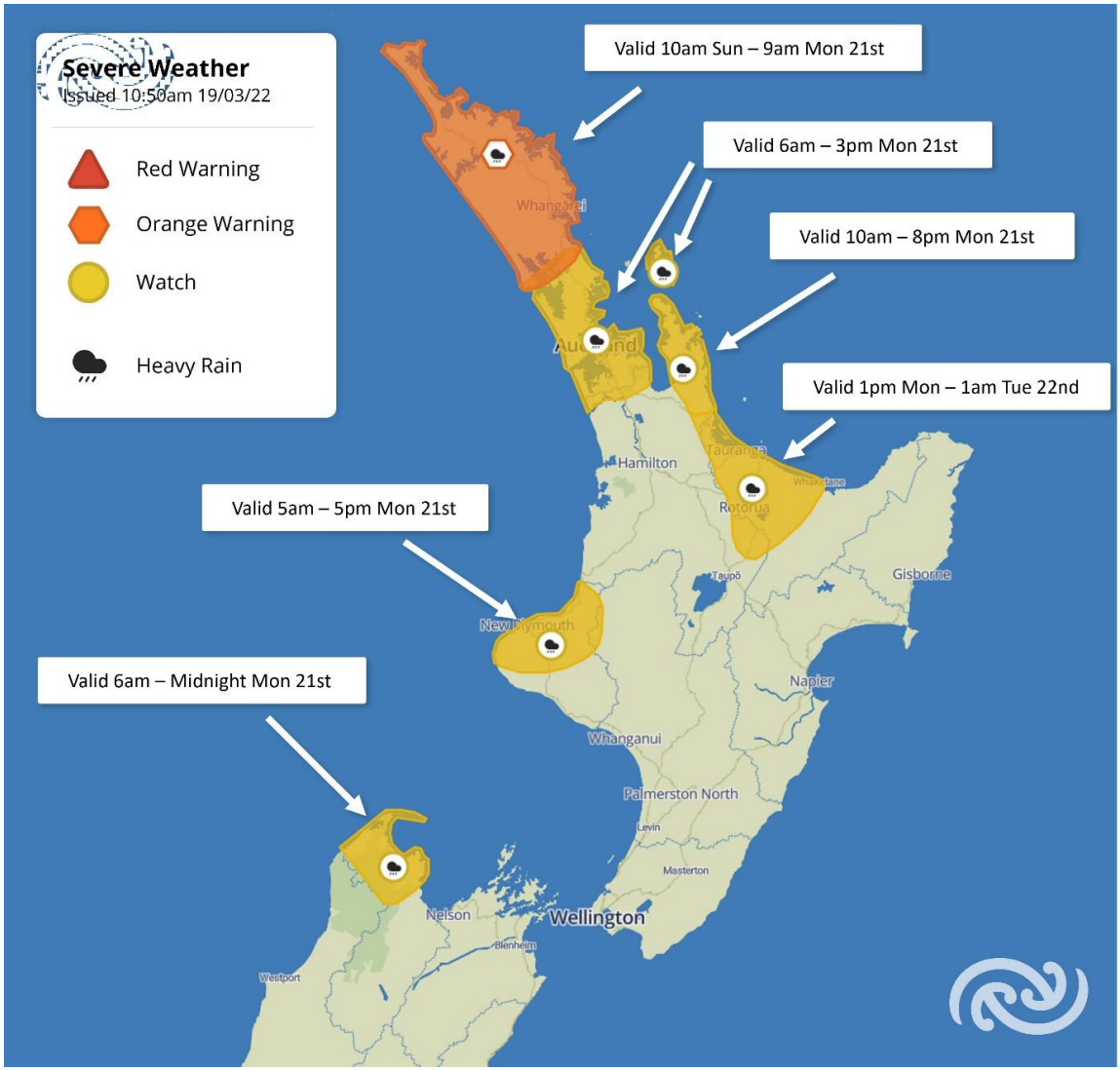
E1.1 Friday 18th March

MetService Tweet: There is a possibility of heavy rain and severe northeast gales across northern and central Aotearoa during the latter half of the weekend and into early next week.



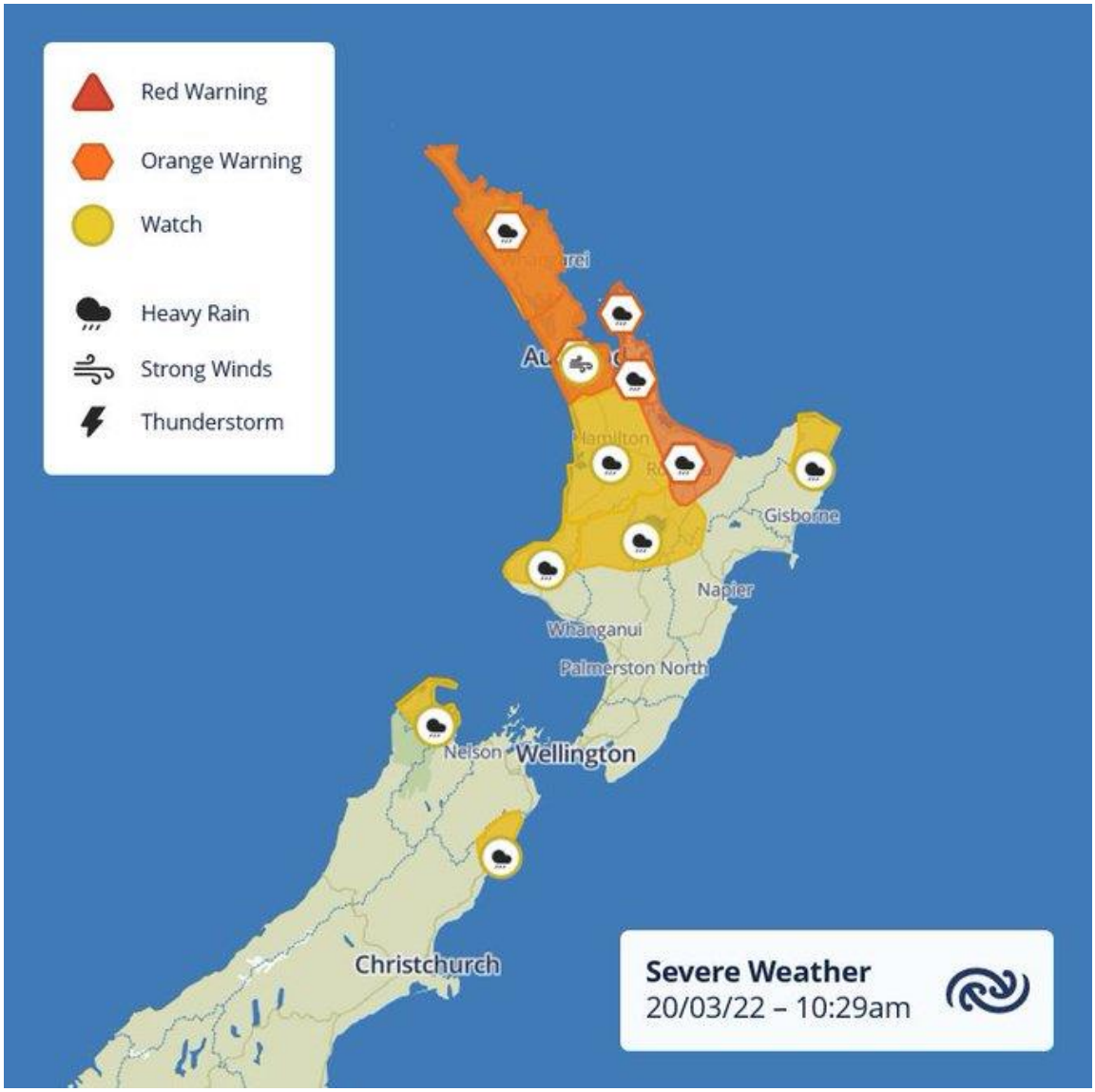
E2 Saturday 19th March

Heavy Rain Warning and Watches issued for parts of the North Island and the top of the South Island



E3 Sunday 20 March

Here are your latest Severe Weather Watches and Warnings http://bit.ly/AllWarnings. A front is expected to move eastwards across northern and central New Zealand today and Monday, delivering a period of heavy rain, possible thunderstorms, and strong NE winds to many places. ^KL



E3.1 Tairāwhiti Civil Defence FB broadcast forecast 10:30 am 20th March

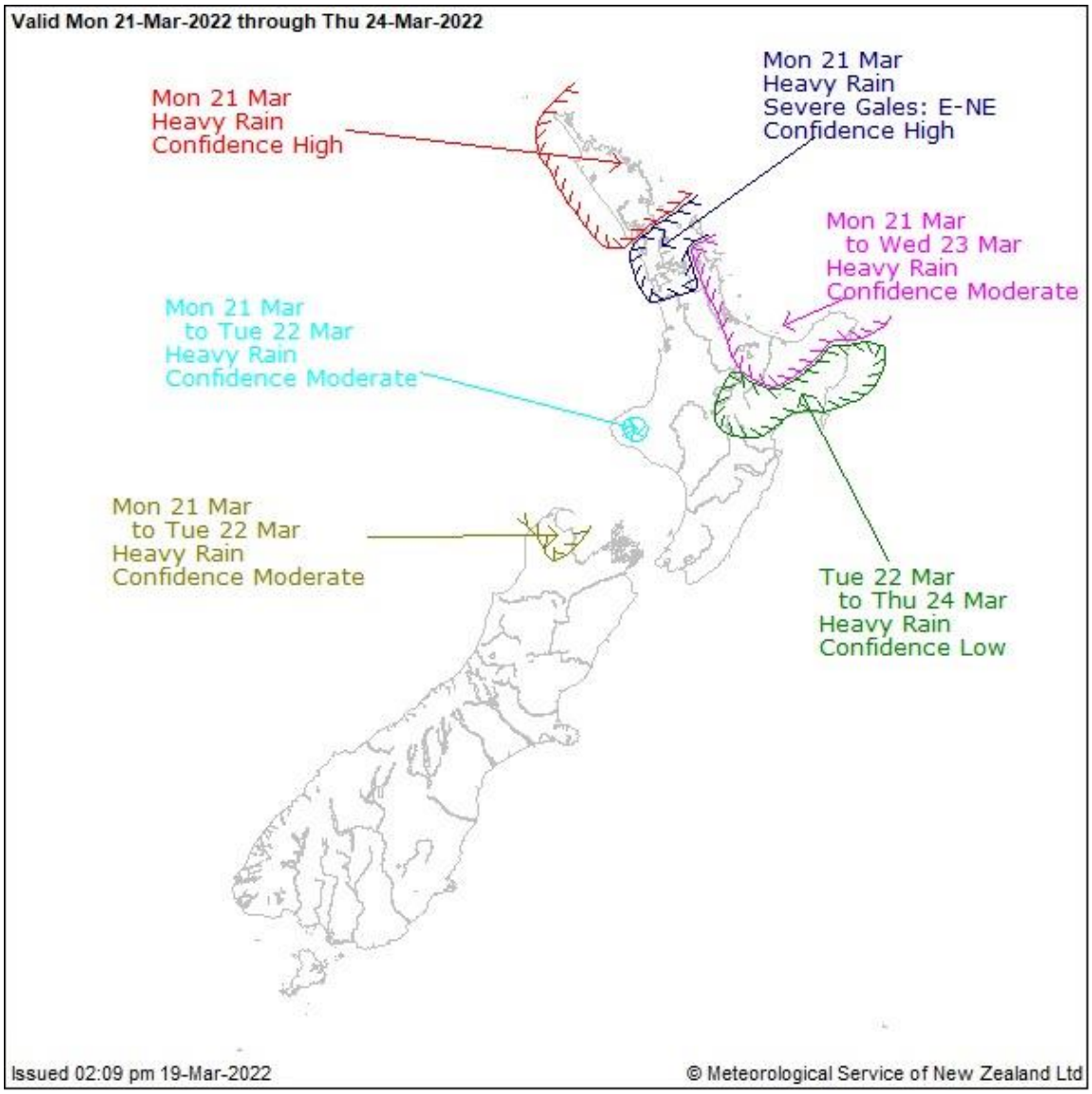
MetService Severe Weather Watch
Issued at: 10:30am Sunday, 20th March 2022
Situation

Heavy Rain Watch for Tologa Bay north including East Cape
Issued: 10:29am Sunday, 20th March 2022
Area: Gisborne north of Tolaga Bay
Valid: 12:00pm Monday to 12:00am Tuesday
Periods of heavy rain and possible thunderstorms. Rainfall amounts may approach warning criteria. Another period of heavy rain is possible on Tuesday, and an associated Watch or Warning may be issued closer to the time.

A slow-moving low pressure system is forecast to lie to the west of New Zealand this week, directing a strong and moist north to northeast flow across the country. A front embedded in this flow is expected to move eastwards across northern and central New Zealand today and Monday, delivering a period of heavy rain, possible thunderstorms, and strong northeasterly winds to many places.

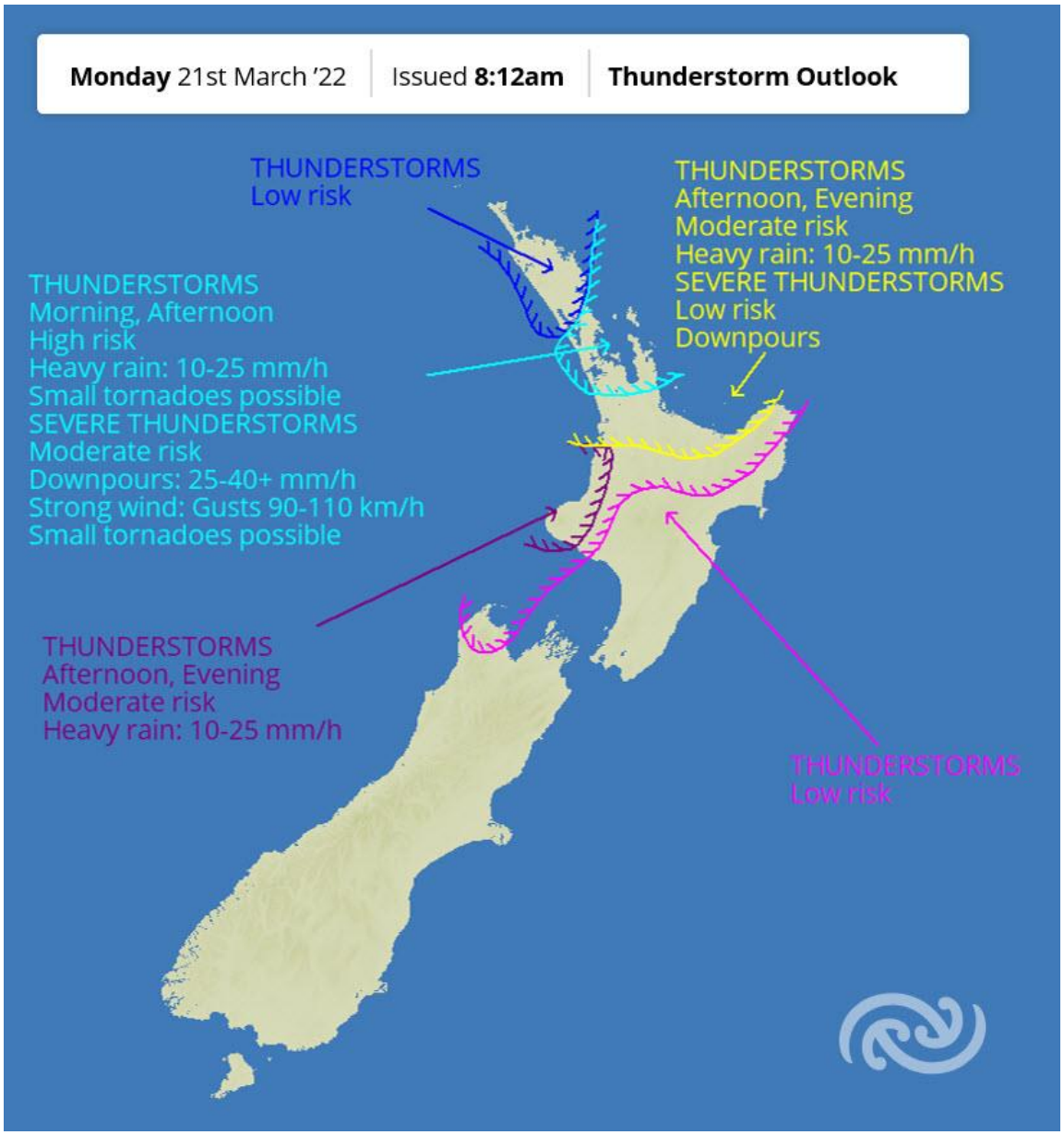
Heavy Rain Warnings and Watches are in force for parts of northern and central New Zealand. People are advised to keep up to date with the latest forecasts in case any changes are made, or further areas added.

Low confidence: a 20% likelihood that the event will actually happen.
Moderate confidence: a 40% likelihood that the event will actually happen.
High confidence: a 60% likelihood that the event will actually happen
Gisborne District CouncilRadio Ngati PorouThe Gisborne HeraldEastland NetworkHinemaurea Marae Ki Wharekahika (Official Page)Waiapu Civil DefenceTe Araroa township
See less


Valid Mon 21-Mar-2022 through Thu 24-Mar-2022
Mon 21 Mar
Heavy Rain
Confidence High
Mon 21 Mar
Heavy Rain
Severe Gales: E-NE
Confidence High
Mon 21 Mar
to Wed 23 Mar
Heavy Rain
Confidence Moderate
Mon 21 Mar
to Tue 22 Mar
Heavy Rain
Confidence Moderate
Mon 21 Mar
to Tue 22 Mar
Heavy Rain
Confidence Moderate
Tue 22 Mar
to Thu 24 Mar
Heavy Rain
Confidence Low
Issued 02:09 pm 19-Mar-2022
© Meteorological Service of New Zealand Ltd

E4 Monday 21 March

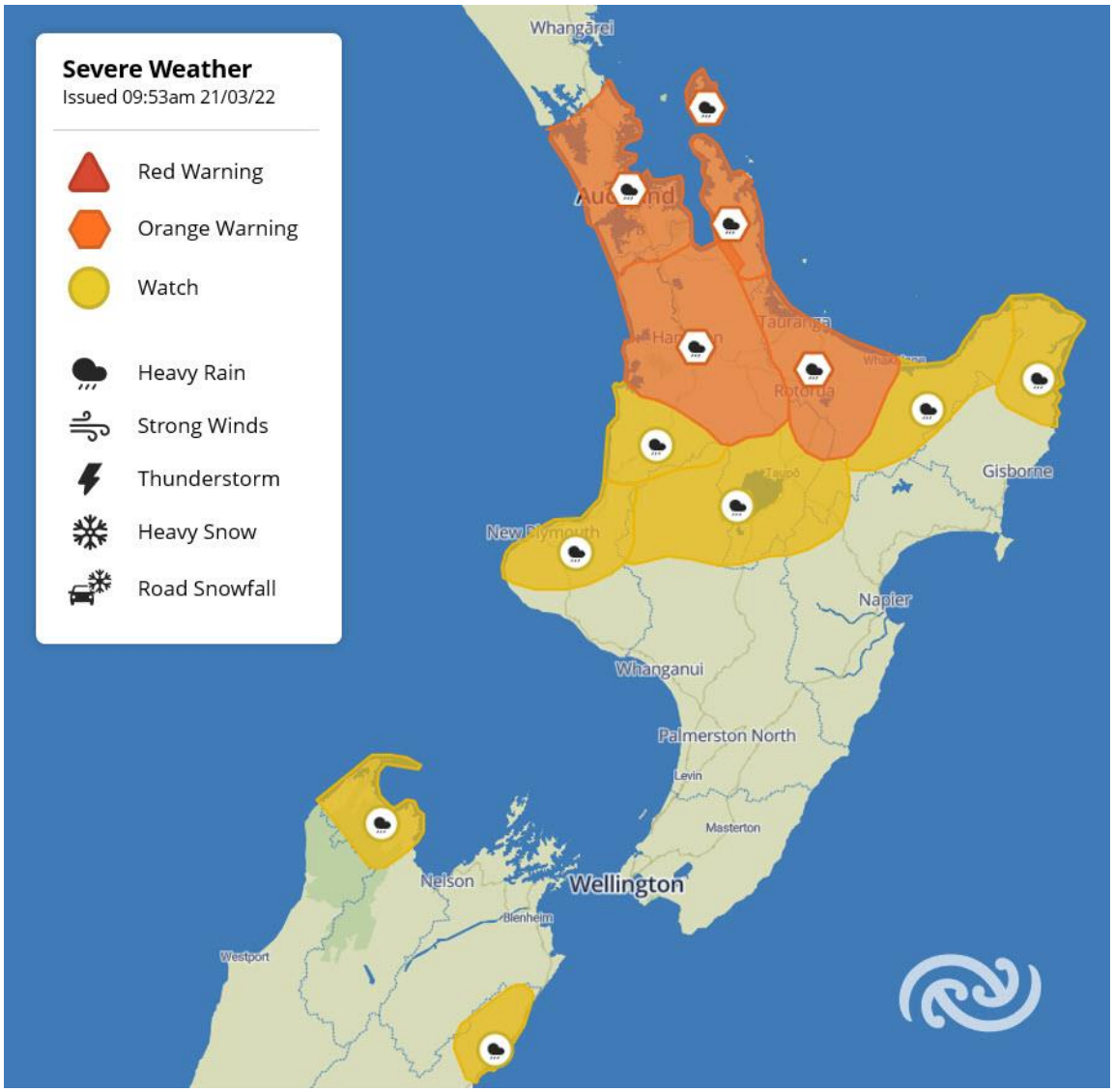
Thunderstorms for Northern and Central North Island Regions ⛈Thunderstorms will continue to spread south today. Full details on what regions may be affected here: http://bit.ly/TSOutlook



1:45pm

The Severe Thunderstorm Watch and Warning has been lifted, but thunderstorm activity may continue for some this afternoon and evening ⛈

There are still Heavy Rain Watches and Warnings valid until later today. Full details on those found here:


Severe Weather
Issued 09:53am 21/03/22
Red Warning
Orange Warning
Watch
Heavy Rain
Strong Winds
Thunderstorm
Heavy Snow
Road Snowfall
Whangārei
Tauranga
Rotorua
Gisborne
New Plymouth
Napier
Whanganui
Palmerston North
Levin
Masterton
Nelson
Wellington
Blenheim
Westport

E4.1 4:30 pm Tairāwhiti Civil Defence FB broadcast forecast 21st March

Severe Weather Outlook for New Zealand (UPDATED)

Issued 04:27pm Monday 21 Mar 2022

Valid from Wednesday 23 Mar 2022 to Saturday 26 Mar 2022

Significant heavy rain possible for Bay of Plenty and northern parts of Gisborne on Wednesday

A slow-moving low-pressure system west of central New Zealand directs a very moist northeast flow over the northern and central areas through to Wednesday. Associated Heavy Rain Warnings and Watches are currently in force. Meanwhile, a second low is expected to develop northeast of the North Island on Wednesday and then may move towards Gisborne on Thursday where it could become slow-moving for a time, before weakening on Saturday. The second low is expected to direct a moist south to southeast flow across central and northern New Zealand from Thursday through to Saturday.

For Bay of Plenty and Gisborne north of about Tolaga Bay, there is HIGH confidence of rainfall amounts exceeding warning criteria on Wednesday. There is the potential for extreme rainfall in these areas, with dangerous River conditions and significant flooding possible. People in Bay of Plenty and northern parts of Gisborne are advised to keep up to date with the latest forecasts as Heavy Rain Warnings are likely to be issued for these areas closer to the time.

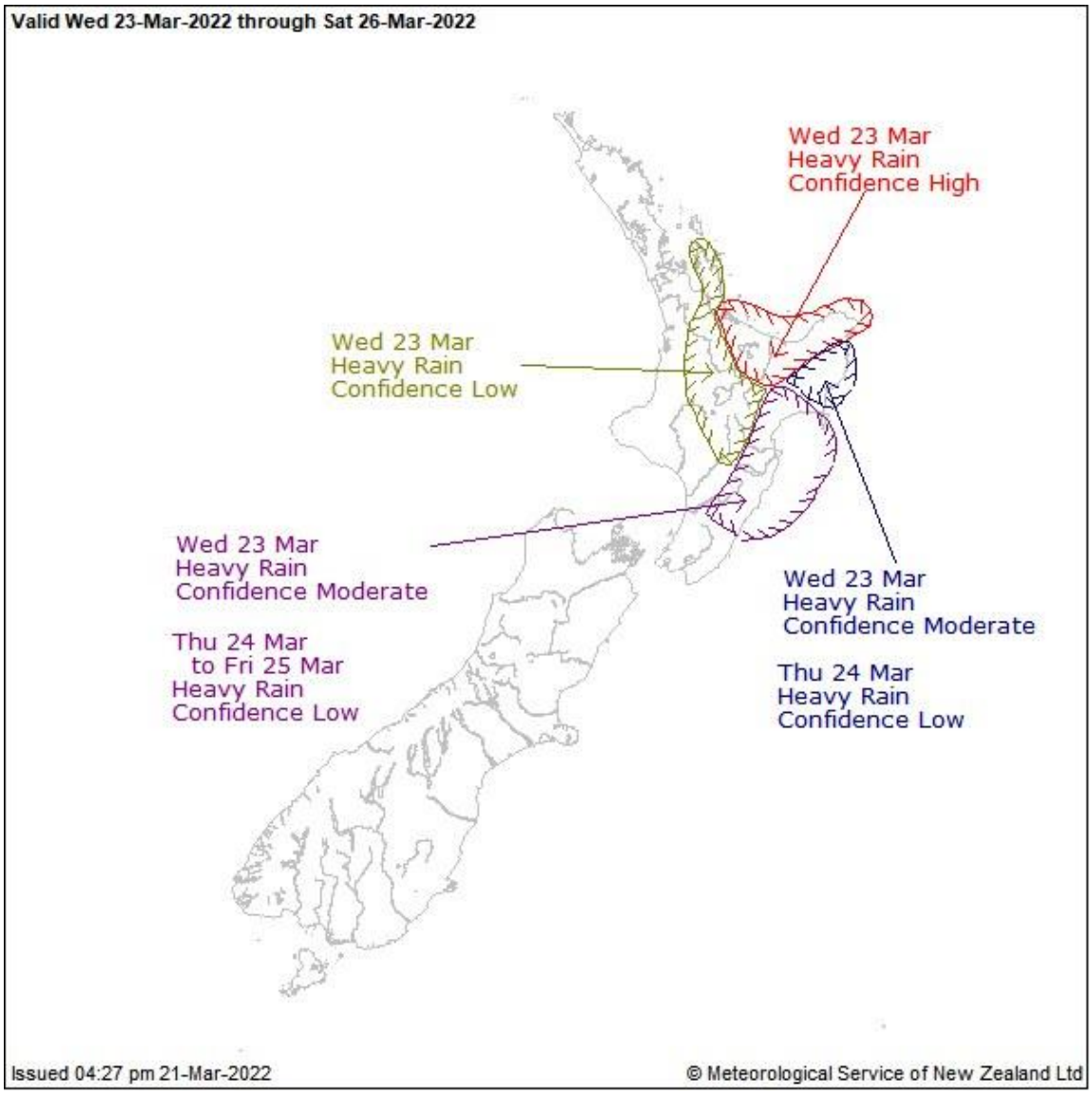
Also on Wednesday, there is MODERATE confidence of warning amounts of rain for the remainder of Gisborne, Hawkes Bay and the Tararua District. The risk then reduces to LOW on Thursday, and on Friday the area of LOW confidence contracts to Hawkes Bay and the Tararua District as depicted on the chart. Finally, there is LOW confidence of rain amounts reaching warning criteria about the Coromandel Peninsula, inland parts of Waikato, Waitomo and Taumarunui, also Taupo and Taihape on Wednesday.

Low confidence: a 20% likelihood (or 1 chance in 5) that the event will actually happen.

Moderate confidence: a 40% likelihood (or 2 chances in 5) that the event will actually happen.

High confidence: a 60% likelihood (or 3 chances in 5) that the event will actually happen

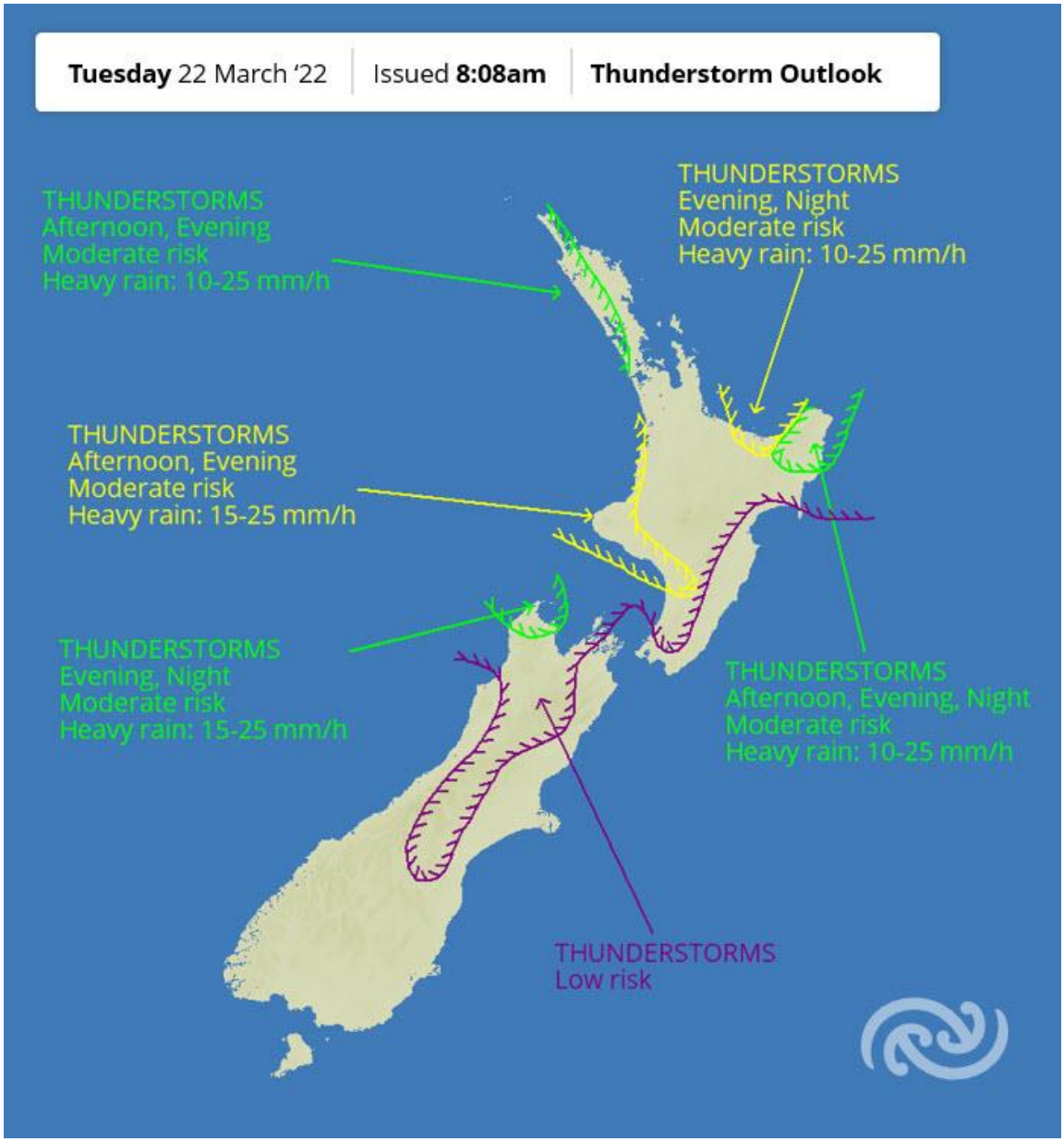
Gisborne District CouncilRadio Ngati PorouThe Gisborne HeraldTuranga FM MediaEastland NetworkSH35 PanuiTe Araroa townshipWaiapu Civil DefenceHinemaurea Marae Ki Wharekahika (Official Page) See less


Valid Wed 23-Mar-2022 through Sat 26-Mar-2022
Wed 23 Mar
Heavy Rain
Confidence High
Wed 23 Mar
Heavy Rain
Confidence Low
Wed 23 Mar
Heavy Rain
Confidence Moderate
Thu 24 Mar
to Fri 25 Mar
Heavy Rain
Confidence Low
Wed 23 Mar
Heavy Rain
Confidence Moderate
Thu 24 Mar
Heavy Rain
Confidence Low
Issued 04:27 pm 21-Mar-2022
© Meteorological Service of New Zealand Ltd

E5 Tuesday 22nd March 9am

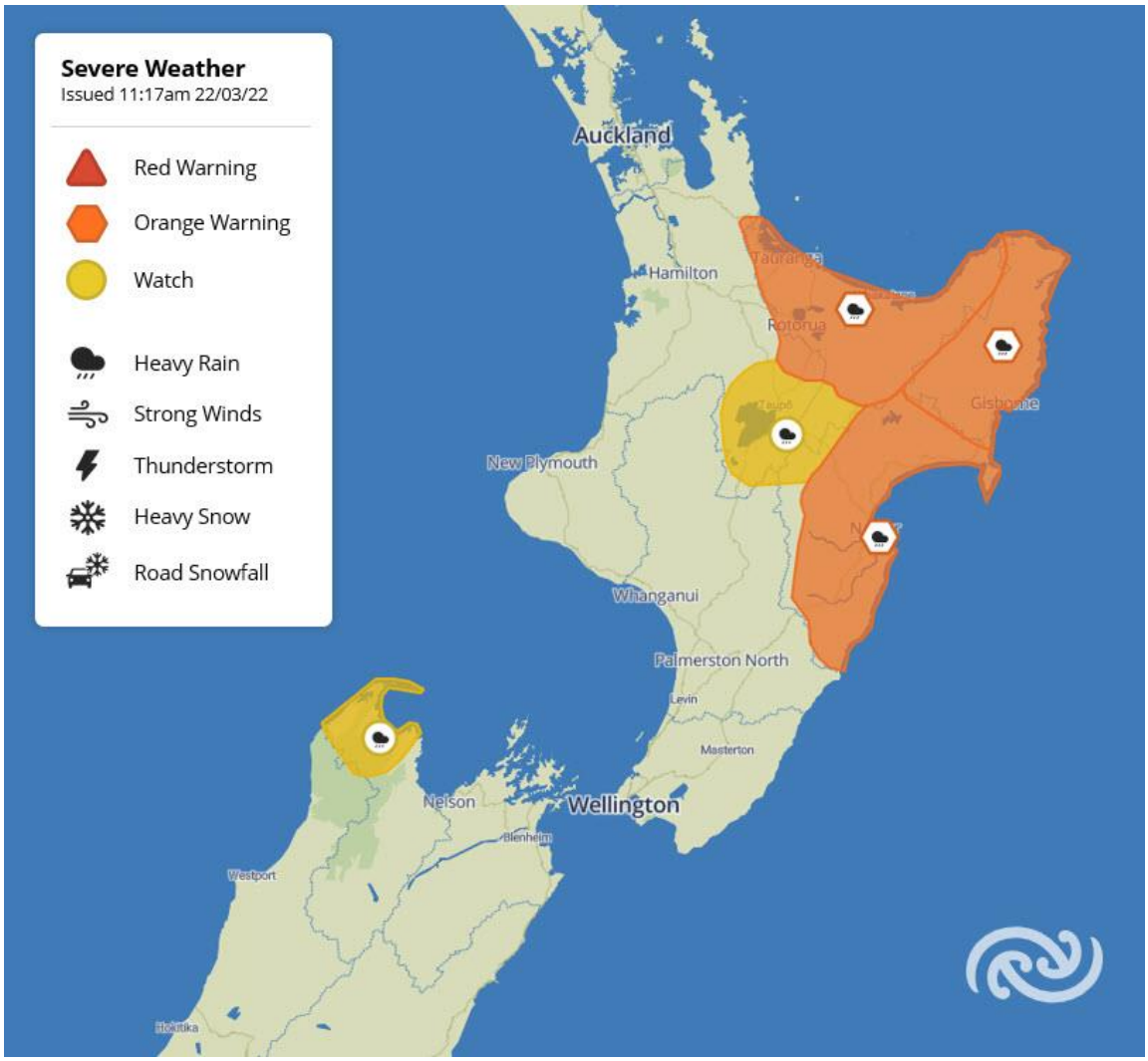
Possible Thunderstorms Today ⛈Showers scattered themselves across much of the country today.

There is a chance of heavy and thundery showers for some.Full details here: http://bit.ly/TSOutlook



E5.1 11:24 am 22nd March

Potentially significant rain event ◆ A band of rain fuelled by warm, subtropical air brings the risk for areas of significant flooding in Bay of Plenty and Gisborne from Wednesday. There is the potential for upgrades to a Red Warning.



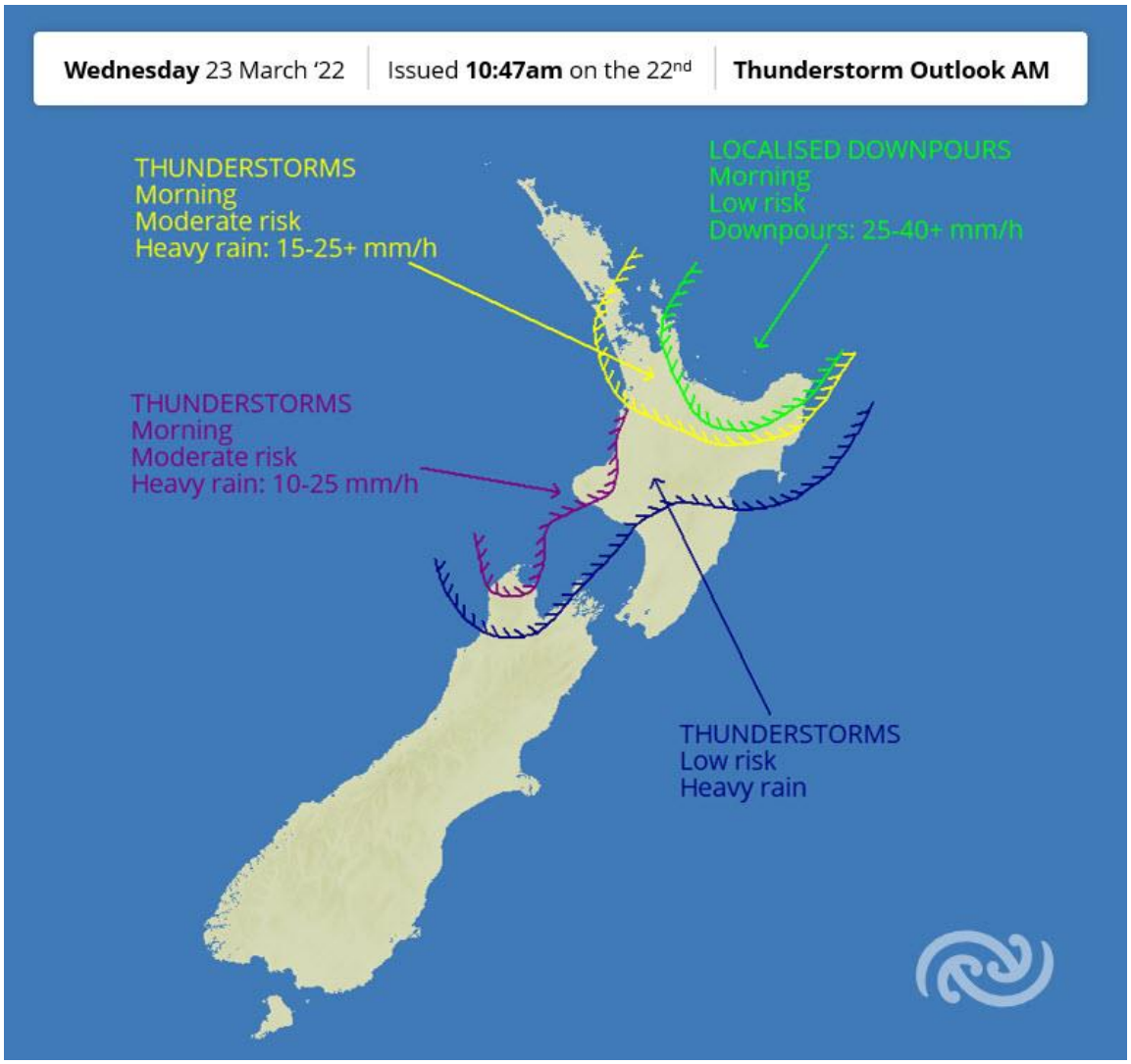
11:29

There is agreement in the models that large accumulations of rain may occur in short time periods but there is disagreement about where exactly those areas will be within BOP and Gisborne.

If your place is prone to flooding this is an event worth keeping an eye on!

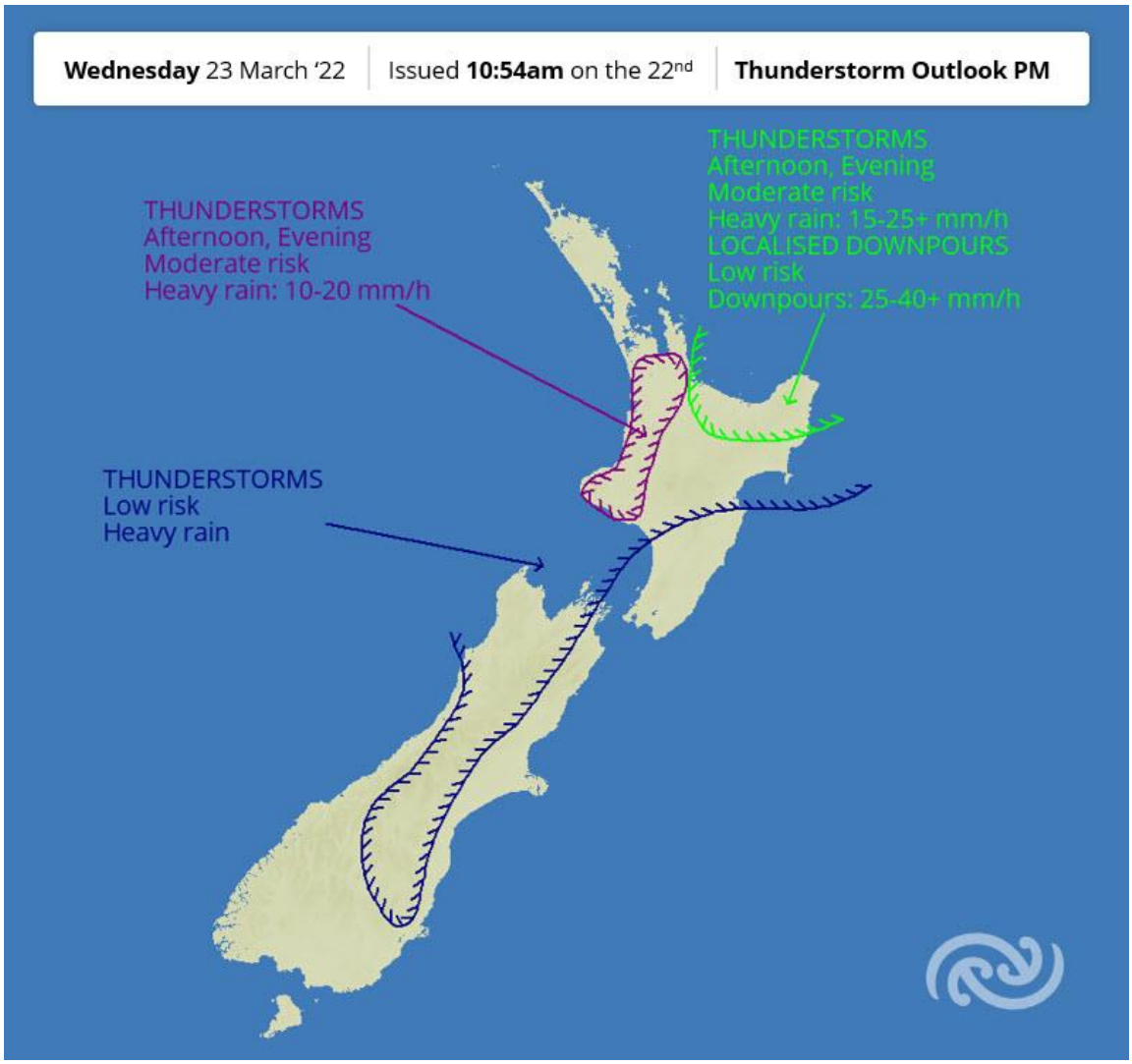
E5.2 12:30 pm 22nd March

Thunderstorms for Wednesday ⚠ Thunderstorms and associated downpours are forecast in Bay of Plenty and Gisborne tomorrow. Hourly rainfall rates of 45mm are possible in these regions, potentially causing flash flooding.



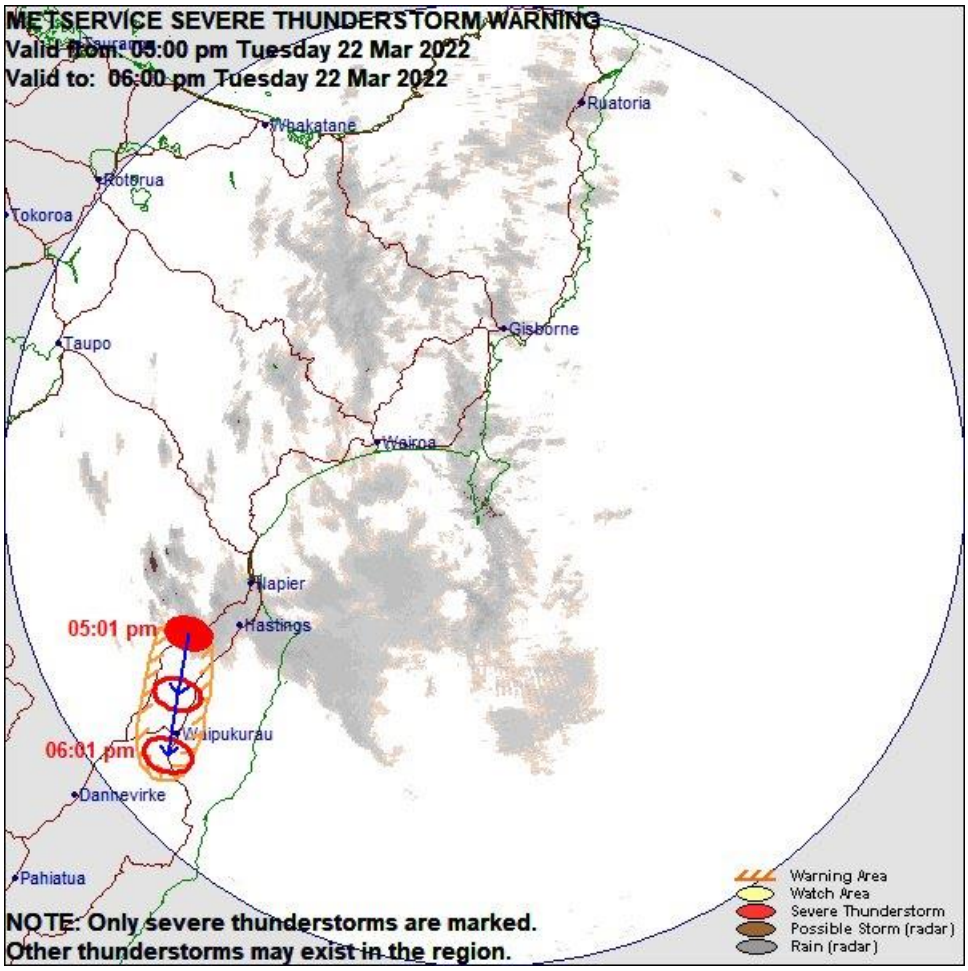
E5.3 Uawa Civil Defence Community Facebook flood preparedness message included in the weather warning update on the 22nd

Uawa Civil Defence Community Facebook flood preparedness message included in the weather warning update on the 22nd



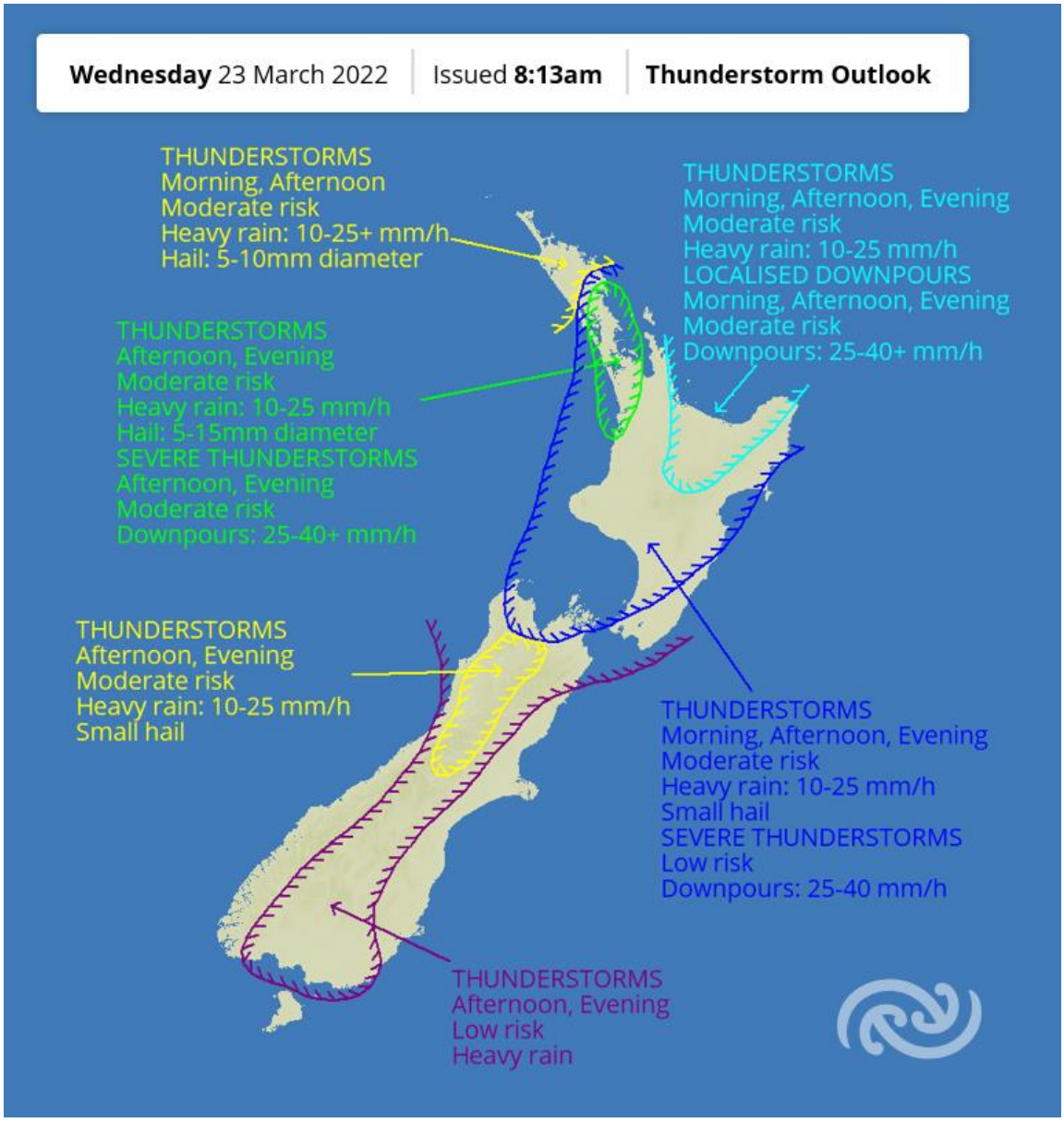
3:15pm shows rain pressure and wind coming in from the east

5:15pm Severe Thunderstorm Warning issued for Gisborne / Hawke's Bay Radar Area
https://zpr.io/jnnkdiLWd7Y6


METSERVICE SEVERE THUNDERSTORM WARNING
Valid from: 05:00 pm Tuesday 22 Mar 2022
Valid to: 06:00 pm Tuesday 22 Mar 2022
Ruatoria
Whakatane
Rotorua
Tokoroa
Gisborne
Taupo
Wairoa
Napier
Hastings
05:01 pm
Waipukurau
06:01 pm
Dannevirke
Pahiatua
NOTE: Only severe thunderstorms are marked.
Other thunderstorms may exist in the region.
Warning Area
Watch Area
Severe Thunderstorm
Possible Storm (radar)
Rain (radar)

E6 Wednesday 23rd March

Thunderstorms and Downpours for Wednesday ⚠ Much of the North Island is at risk of thunderstorm activity today, with a risk of localised downpours for some areas. Full details: http://bit.ly/TSOutlook A Severe Thunderstorm Watch has been issued: http://bit.ly/STSWatch



E6.1 8:21 Metservice- retweet the NEMA TCEDM declaration

9:09 am

Parts of northern Gisborne have recorded between 150-250mm of rain in the 12 hours up to 9am.

The band of rain has moved into Bay of Plenty but is forecast to return eastwards this afternoon.

The current Gisborne warning is being extended

Video of where the storm went https://twitter.com/i/status/1506362549180452866

10am Gisborne Red Warning 🟥

On the back of torrential rain overnight a Red Warning has been issued for the next intense band of rain later today and into Thursday. Downpours of 50mm/hr are possible which will see impacts occur very quickly. Details http://bit.ly/AllWarnings

In consultation with Gisborne Council, the Rain Warning for Gisborne has been upgraded to a Red Warning.

Red Warnings are reserved for the most severe weather events and requires immediate action and to act now!

https://about.metservice.com/.../changes-to-warnings-and.../

Check out https://getready.govt.nz/ for information on what to do in an emergency.

http://bit.ly/AllWarnings for full details on all the warnings active over the country.

E6.2 10:13 Metservice share “get ready info”

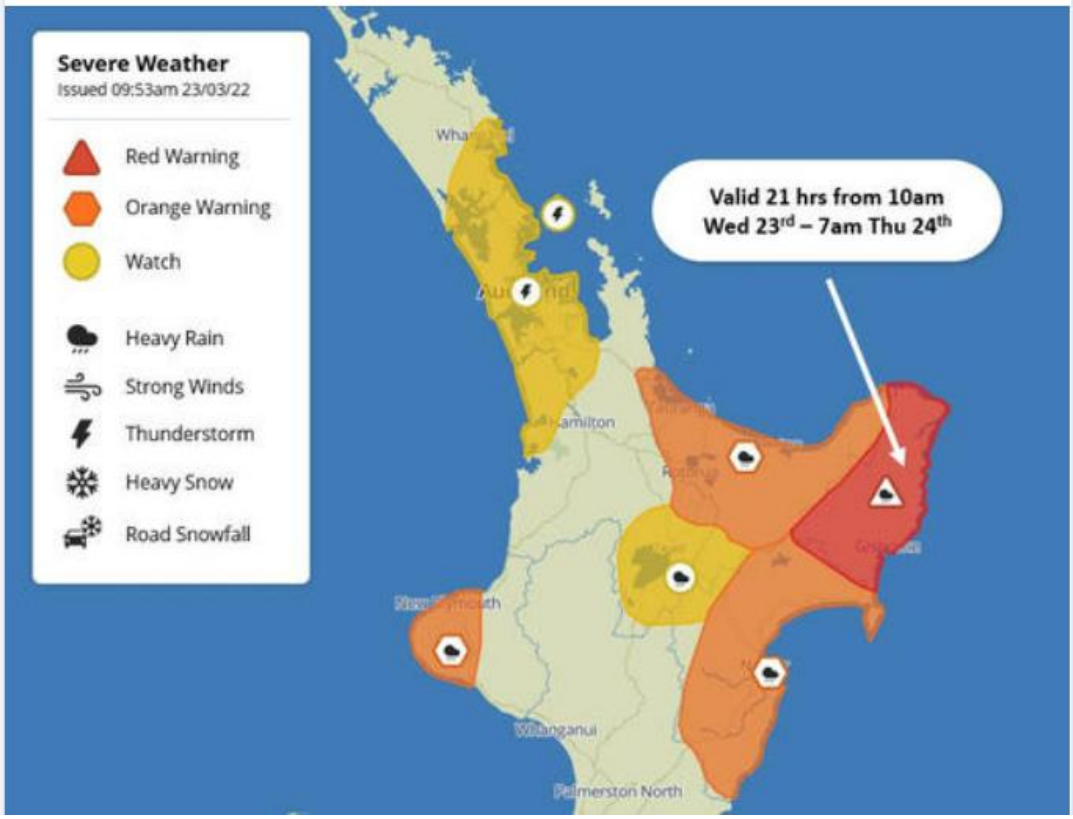
MetService New Zealand
23 March ·

In consultation with Gisborne Council, the Rain Warning for Gisborne has been upgraded to a Red Warning.

Red Warnings are reserved for the most severe weather events and requires immediate action and to act now!
https://about.metservice.com/.../changes-to-warnings-and.../

Check out https://getready.govt.nz/ for information on what to do in an emergency.

http://bit.ly/AllWarnings for full details on all the warnings active over the country.



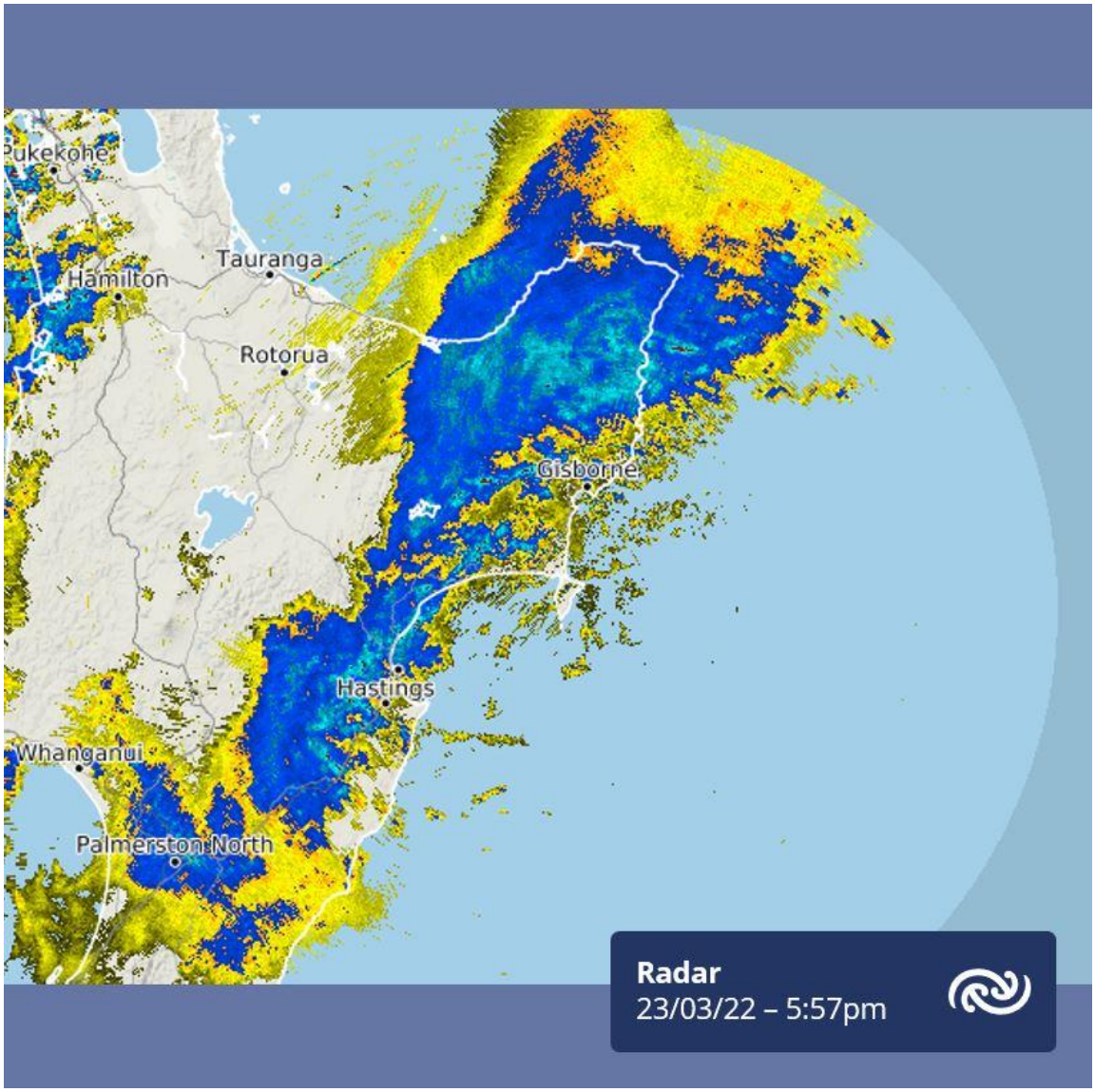
E6.3 10:17 share video of what the warning means

What do the tiers of MetService Heavy Rain warnings look like on the ground? This animation shows some of possible outcomes. We're in the middle of an intense week of weather so follow advice from local authorities and keep up with the forecast at http://metservice.com

https://twitter.com/i/status/1506409667249197061

6:12 pm

Stations in Gisborne in the last 24 hours have received between 250-300mm of rain. Here is the last radar imagery at 6pm, a band of rain well set in over the area. The latest Red Heavy Rain Warning in force will be updated this evening. Get the latest http://bit.ly/AllWarnings ^KL



Appendix F Rainfall summary and return period frequencies

F1 Rainfall

Appendix F Table 1: Three day rainfall totals for the five local rainfall monitoring sites: Fernside Station Telemetry Station, Hikuwai River at No 4 Bridge, Hikuwai River at Willowflat, Te Puia, and Puketiti from midnight 21/03/2022 to 11:59 23/03/2022 (Raw data sourced from GDC 10 June 2020)

3 day rainfall totals (mm)	Fernside Station Telemetry Station	Hikuwai River at No 4 Bridge	Hikuwai River at Willow flat	Te Puia	Puketiti House
00:00 21/03/2022 to 11:59 23/03/2022	355.2	435	436.5	528	441.2

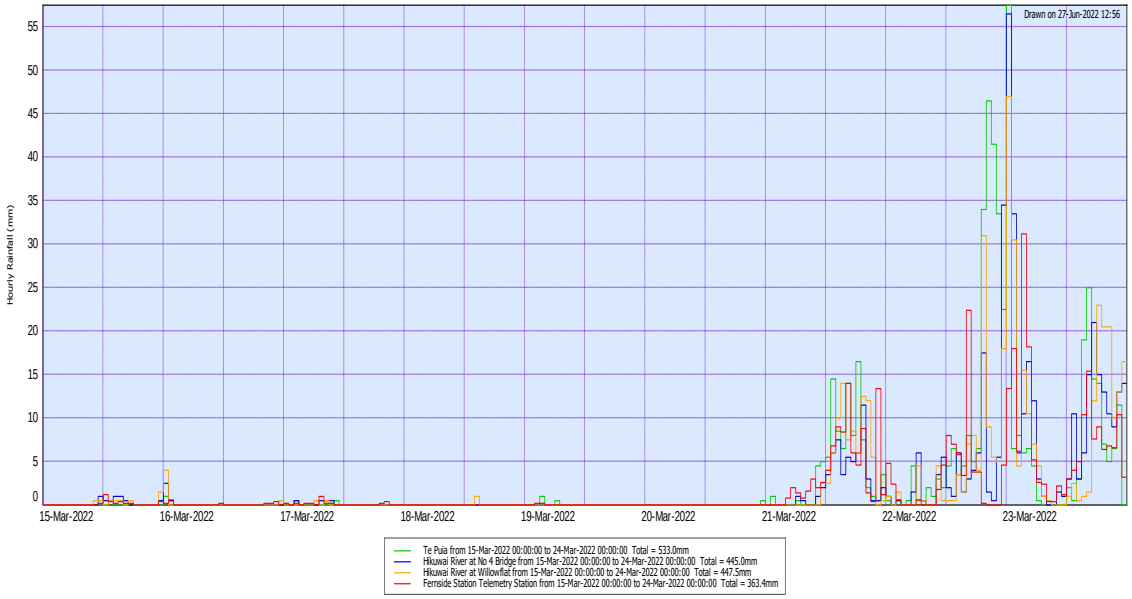


Figure Appendix F.1: The 10 day antecedent condition storm as 1 hour rainfall totals for the four local GDC rainfall monitoring sites: Fernside Station Telemetry Station, Hikuwai River at No 4 Bridge, Hikuwai River at Willow flat, Te Puia

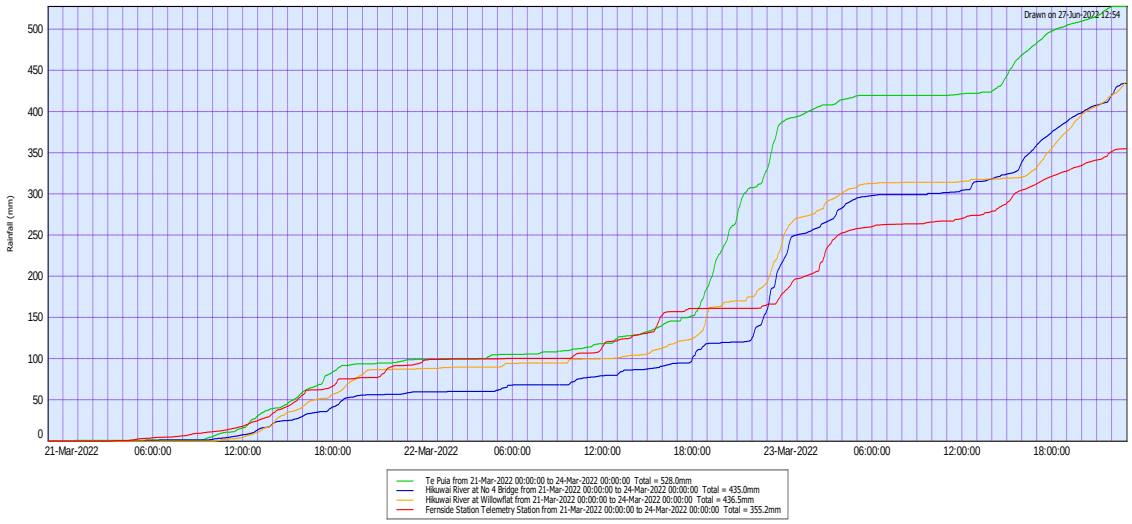


Figure Appendix F.2: 3 day cumulative totals for the four local GDC rainfall monitoring sites: Fernside Station Telemetry Station, Hikuwai River at No 4 Bridge, Hikuwai River at Willow flat, Te Puia.

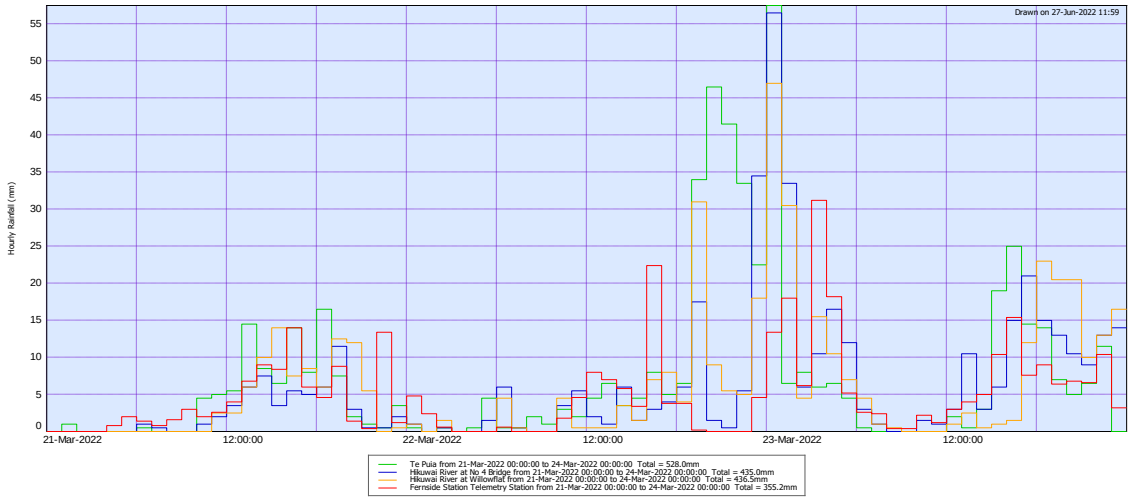


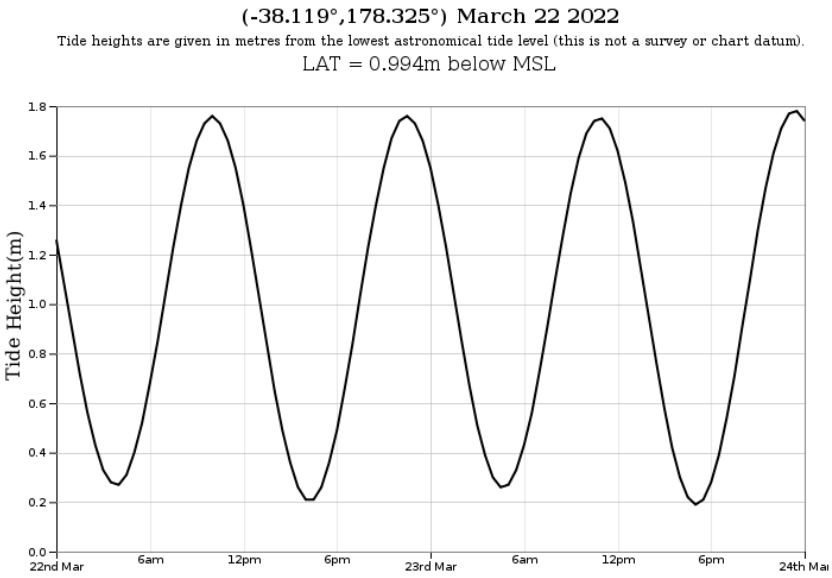
Figure.3: 3 day one hour totals for the four local GDC rainfall monitoring sites: Fernside Station Telemetry Station, Hikuwai River at No 4 Bridge, Hikuwai River at Willow flat, Te Puia.

Table 10.2: Te Puia Rain Gauge depth duration and return period 21-24 March 2022 as identified using HIRDS v4

Te Puia	min	min	min	hour	hour	hour	hour	day	day	day
Duration	**10**	**20**	**30**	**1**	**2**	**6**	**12**	**1**	**2**	**3**
From 22-Mar-2022 12:00:00 to 23-Mar-2022 12:00:00										
RF total (mm) for period	14.5	26	35.5	57.5	88	184	216	306		
Return period (year ARI)	60	50	40	40	30	50	20	30		
From 23-Mar-2022 12:00:00 to 24-Mar-2022 12:00:00										
RF total (mm) for period	6	10.5	15.5	25	39.5	64	108	108		
Return period (year ARI)	2	2	2	2	2	2	2			
From 22-Mar-2022 12:00:00 to 24-Mar-2022 12:00:00										
RF total (mm) for period									414	
Return period (year ARI)									**60**	
From 21-Mar-2022 12:00:00 to 24-Mar-2022 12:00:00										
RF total (mm) for period										528
Return period (year ARI)										**100+**

Appendix G March 2022 Tides

NIWA Tides at Tokomaru Bay from 00:00 on 22 march to 00:00 24 March 2022.



Source NIWA Tides.co.nz

Appendix H Flooding Impacts

Acknowledgement that this list is collated from impacts observed through sites visits, recorded by council staff, documentation supplied, and impacts as recounted by residents spoken to during data capture. Is most likely not an exhaustive list but intends to capture the majority and the range of impacts that occurred as a result of the March 2022 flooding.

H1 Uawa Hikurangi Rivers

Table 10.3: Hikuwai Uawa River and Catchment flooding locations and impacts from the 22 March 2022 rainfall event.

Where	Distance	What	Impact
Hikuwai Uawa SH35 Bridge			
800 m downstream	Mouth of Uawa from Ferneaux st	Left bank Lateral erosion	Uawa River mouth migrating north towards legacy closed landfill
3.3 km Upstream	Waiapu road Pacific coast highway	Hillside slips	Pasture damage
8.5 km upstream	Waiapu road Pacific coast highway	SH 35 road flooding (unsure if River or overland flow source)	Car got stuck on flooded road had to evacuate, abandon car.
15.5 km upstream	Waiapu road Pacific coast highway	Right bank lateral erosion	Eroding further into slip created in July 2021 flooding,
Mangaheia River			
3.6 km upstream Uawa	Paroa Road	Left and right banks River overflow	Floodwater into pasture and horticulture
9.3 km upstream Uawa	Wigram bridge	Left and right banks River overflow	Log jams against bridge, some stop banks being created from woody debris pulled from River
Mangatokerau River			
500 m upstream Hikuwai	Paroa road bridge over Mangatokerau River	Log jam on the bridge River bank slumping	Bank overflow, erosion of river margin
	Hokoroa road		Two families isolated
			Medical supplies delivered to isolated people

H2 Mangahauini River

Table 10.4: Mangahauini River and Catchment flooding locations and impacts March 2022

Where	Distance	What	Impact
Mangahauini River Flooding			
0	At SH 35 Bridge	Bridge right abutment eroded, destabilised and surface span of the bridge was washed away leaving a 16 m gap in the road over the river.	Reduced roading lifelines, disconnecting the communities north and south of the Tokomaru Township. The bridge was closed for 10 days before rebuilt. A temporary road and ford were constructed from Taro Street, cutting through the Taro street stop bank to Paikea Street near the transfer station.
100 m	Te Kura Kaupapa Māori O Nga Taonga Tuturu Ki Tokomaru, Moana Street	Left bank lateral erosion and damage the groyne protection scheme behind the downstream groyne.	Causing loss of land adjacent to the edge of the sports court, exposing the water tank overflow pipe, eroding the end of a surface stormwater drain.
320 m	12 Taro Street	Stopbank overtopped Drain under stopbank may have also not been working and caused surface flooding due to lack of drainage. River overflowed at 19 Taro street and that water likely flowed down Taro street	Flood waters into paddocks and onto Taro Street Access along Taro street cut off isolating residents.
320 m	12 Taro Street	Further Lateral erosion of right bank	Loss of land at property. River groynes detached from bank. Upper groyne now approximately 10 m from the new river bank.
500 m	37 Marotiri St Old Bowling Club	Potential River flooding conveyed up Marotiri Street Or stormwater runoff from SH35 blockages	Flood water and sediment over old bowling club. Transfer station waste strewn across bowling club

Where	Distance	What	Impact
Mangahauini River Flooding			
			and River riparian scrub downstream
600 m	27,29,33 Toa St	Right bank lateral erosion	Detachment of groynes from the River bank.
650 m	Through river linking Taro street to Paikea Street	Temporary road and ford constructed through River	Cut stop bank on Toa street to create road
830 m	19 Taro	Left bank lateral erosion	Loss of land at property. River flow over bank into paddock and drained down driveway to Taro Street. Isolated residents.
1 km	Paikea Street Transfer Station	Right bank lateral erosion	further erosion and slumping in the toe of the slip.
1 km	Paikea Street Transfer Station	Left bank river overflow	Flood flows through transfer station entrained waste at the site into the flood flows.
1.4 km	40 Toa Street	Left bank river overflow and bank lateral erosion	Property inundation below floor level
1.7 km	Waiapu road SH35	Right bank lateral erosion	Existing slip cut further back to the road, reducing the road to one lane
1.7 km	River flat true right	River right bank overflow	River flow over the whole River flat on the true right
2 km	Eastland tower	Right bank lateral erosion	Loss of land
2.1 km	River flat true left	River left bank overflow	River flow over half the river flat on the true left
4.1 km	In river	Deposition zone	Dollices and River training structures deposited on gravel islands
4.5 km	River left bank	left bank lateral scour	SH35 road protection undercut, dislodging some of the protection structures
5 km	River left bank	Left bank lateral erosion	Slump and loss of road margin
5.6 km	In Stream drop structures or grade control structures	Right bank lateral erosion	Detachment of structures from the right bank
Catchment flooding			

Where	Distance	What	Impact
Mangahauini River Flooding			
1km west up SH35 from Tokomaru bridge	SH35 culvert	Blocked culvert limiting flow downstream, resulting in overland flow	Water flowing down SH35, flowed into properties on Toa street, depositing silt and debris around and under houses. No known reports of water above the floor level.
1.1 km west up SH35 from Tokomaru bridge	SH35 culvert	Blocked culvert limiting flow downstream, resulting in overland flow	Water flowing up SH35. Road fully submerged by ponding of on the next bend up the road. Overland flow over the road and to the properties off Te Wehi Road
Tokomaru town south of River	True right of River, around town	Surface water ponding	Silt deposition, standing water
Beach road	Beach road	Land slips	Landslide damage or unsafe risk to properties
800 m north of SH35 bridge on beach road	81 Beach Road	Waikoko Stream overflow and erosion	Waikoko Stream brought down lots of boulders, silt, papa material, inundated property

H3 Waiotu Stream

Table 10.5: Waiotu Stream and Catchment flooding locations and impacts from the 22 March 2022 rainfall event

Where	Location	What	Impact
Waiotu Stream Flooding **Distance upstream from footbridge**			
0	Mangahauini Street footbridge	Left bank lateral erosion	Undermined the left abutment of the footbridge
250-500 m	11,13,19,21,16, Arthur Street	Stream overflow right bank of Stream	Flood waters inundated 5 houses above the floor levels
300 m	6 School Road, School	Stream overflow left bank of Stream	Flood waters inundated school buildings above the floor levels
640 m	3553 Waiapu Road	Stream overflow right bank of Stream	Flood water inundated and isolated property
1 km	3527 Waiapu Road	Stream overflow right bank of Stream	Washed away walk bridge access to house. Flood flows over paddocks

Where	Location	What	Impact
Waiotu Stream Flooding Distance upstream from footbridge			
1.2 km	SH35	Stream overflow right bank of Stream	Road become flood conveyance. Cut off road access to Tokomaru Bay
2 km	52 Kaiawha Road	Stream overflow right bank of Stream	Flood water inundated property below floor boards
2.3 km	66 Kaiawha Road	Kaiawha Stream high flow	Ford would have been unpassable
Waiotu Catchment flooding			
70 m upstream SH35 bridge over Waiotu Stream	3558 Waiapu Road	Blocked culvert that flows under Sh35	Limiting surface runoff flow through the pipe, backing up and overflowing down the road
500 m	New house	Blocked culvert that flows under Sh35	Limiting ephemeral stream and surface runoff flow through the pipe, backing up flow and overflowing down the road
3km up SH35	SH35	Land slumping	SH35 has been redirected due to continual slipping of the upper catchment

H4 Anaura Bay

Table 10.6: Anaura Bay Stream and Catchment flooding locations and impacts from the 22 March 2022 rainfall event

Where	Location	What	Impact
Anaura Stream			
10 m	Anaura Stream	Downstream bridge	Stream overflow left and right banks
30 m	Anaura Stream	Downstream neighbouring property	Left bank lateral erosion
80 m	Anaura Stream	True right downstream campground beach front	Right bank erosion
Hawai Stream			
0 from Lockwood road	Hawai Stream	Lockwood road Culvert	Stormwater culvert capacity exceeded
Hawai Stream Catchment flooding			

Where	Location	What	Impact
Anaura Stream			
430 m	south down Lockwood Road	Drain overflow and coastal inundation	Farm drain overflow, Road culvert exceeded, Coastal erosion
Catchment flooding			
0	Bottom of Anaura Road	Drain overflow	Surface water ponding
75 m	North along Anaura Road	Drain overflow	Surface water ponding
0	Anaura Bay Road drain to sea	Coastal Inundation	Water ponding
240 m	North along Anaura Road Under road culvert	Culvert Capacity exceeded	Surface water ponding
730 m	North along Anaura Road	Roadside drain and under road culvert capacity exceeded	Surface water ponding
730 m	North along Anaura Road	Coastal Inundation	Water ponding
1100 m	North along Anaura Road	Hillside slump	Surface runoff exceeded roadside drains
2 km	North along Anaura road	Bridge debris build up	Stream overflow surface runoff
2 km	North along Anaura road	Bank overflow	Stream overflow surface runoff
2.2 km	North along Anaura road	Culverts blocked by landslides	Surface runoff overland flow and ponding
2.3 km	North along Anaura road ~900 Anaura road	Culverts blocked by landslides	Surface runoff saturated land

Appendix I General Flood Hazard Vulnerability Curves

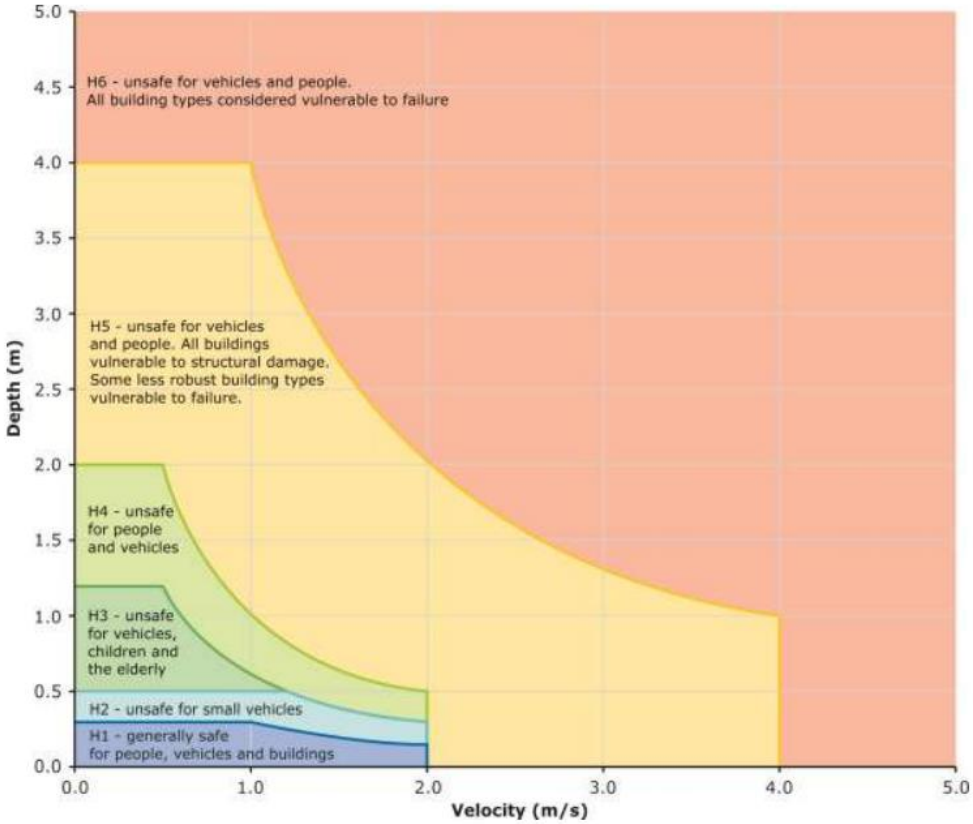


Figure.1: General classification of flood hazard on a flood plain. Source: Australian Rainfall and Runoff Guidelines 2019: Flood Hazard guideline-7-3-technical-flood-risk-management.pdf (aidr.org.au)

Appendix J 10 Golden Rules to Flood Management

Te Kaunihera o Te Tairāwhiti
GISBORNE
DISTRICT COUNCIL

23-40

Title:	**Tokomaru Bay Transfer Station update**
Section:	Community Lifelines Solid Waste
Prepared by:	Chloe Howard-Lloyd - Solid Waste Advisor
Meeting Date:	Thursday 2 March 2023

Legal: No | Financial: No | Significance: **Low**

Report to OPERATIONS - INFRASTRUCTURE/NGĀ WHAKAMAHI - TE HANGANGA Committee for information

PURPOSE - TE TAKE

The purpose of this report is to inform the Operations Committee of the progress of the Tokomaru Bay Transfer Station relocation and construction.

SUMMARY - HE WHAKARĀPOPOTOTANGA

Work is currently being undertaken to relocate the Tokomaru Bay Transfer Station to the adjacent paddock located to the front of the transfer station along Paikea Road. The decision to relocate the transfer station was due to the severe damage caused from previous flood events and the existing site becoming increasingly vulnerable to future flooding.

This report provides the estimated timeline for completing the relocation and construction of the transfer station and identifies risks that could impact the final date of completion of 30 June 2023.

The project is in the early stages and preliminary work is being undertaken before the physical works can commence. The project is currently on budget.

Risks include delays in preliminary work occurring should the resource consent require further information for the positive management of the new site. It is likely there will be delays in the completion of the transfer station due to contractors' commitments to emergency works following Ex Cyclone Hale. Further risk of future weather events could also adversely impact the timeline. There is possible financial risk, if the detailed site investigation and consenting requires more work than forecasted in our current prices. An additional risk is the increasing cost of material/s. These identified risks are being mitigated by careful consideration in managing the budget and the use of existing resources.

RECOMMENDATIONS - NGĀ TŪTOHUNGA

That the Operations - Infrastructure/Ngā Whakamahi - Te Hanganga Committee:

1. Notes the contents of this report.

Authorised by:

David Wilson - Director Lifelines

Keywords: Tokomaru Bay transfer Station update, operations infrastructure.

BACKGROUND - HE WHAKAMĀRAMA

1. **Report 22-175** Tokomaru Bay Transfer Station Relocation **(Attachment 1)** was presented to Council at a Workshop on 10 November 2022 for decision on the relocation of the Tokomaru Bay Transfer Station and request for unbudgeted funds of $880,000 for this work. The report recommended relocating the transfer station due to the severity of ongoing flooding after weather events as the best option for the environment and community. Work is under way and we aim to have the project completed this financial year.

DISCUSSION and OPTIONS - WHAKAWHITINGA KŌRERO me ngā KŌWHIRINGA

2. Figure 1 – Map of transfer station sites – shows the current site (indicated in red) where the river flows during high periods of rain and in flood. In July part of SH 35 Mangahauini bridge was washed away and a temporary road was established by Waka Kotahi on the new transfer station site. Material from the temporary road is being utilised as fill to increase the height of the land at the new site to mitigate flooding in future events.

3. The current site, which is located within the Mangahauini riverbed, will be decommissioned and all above-ground infrastructure will be moved to the new site.

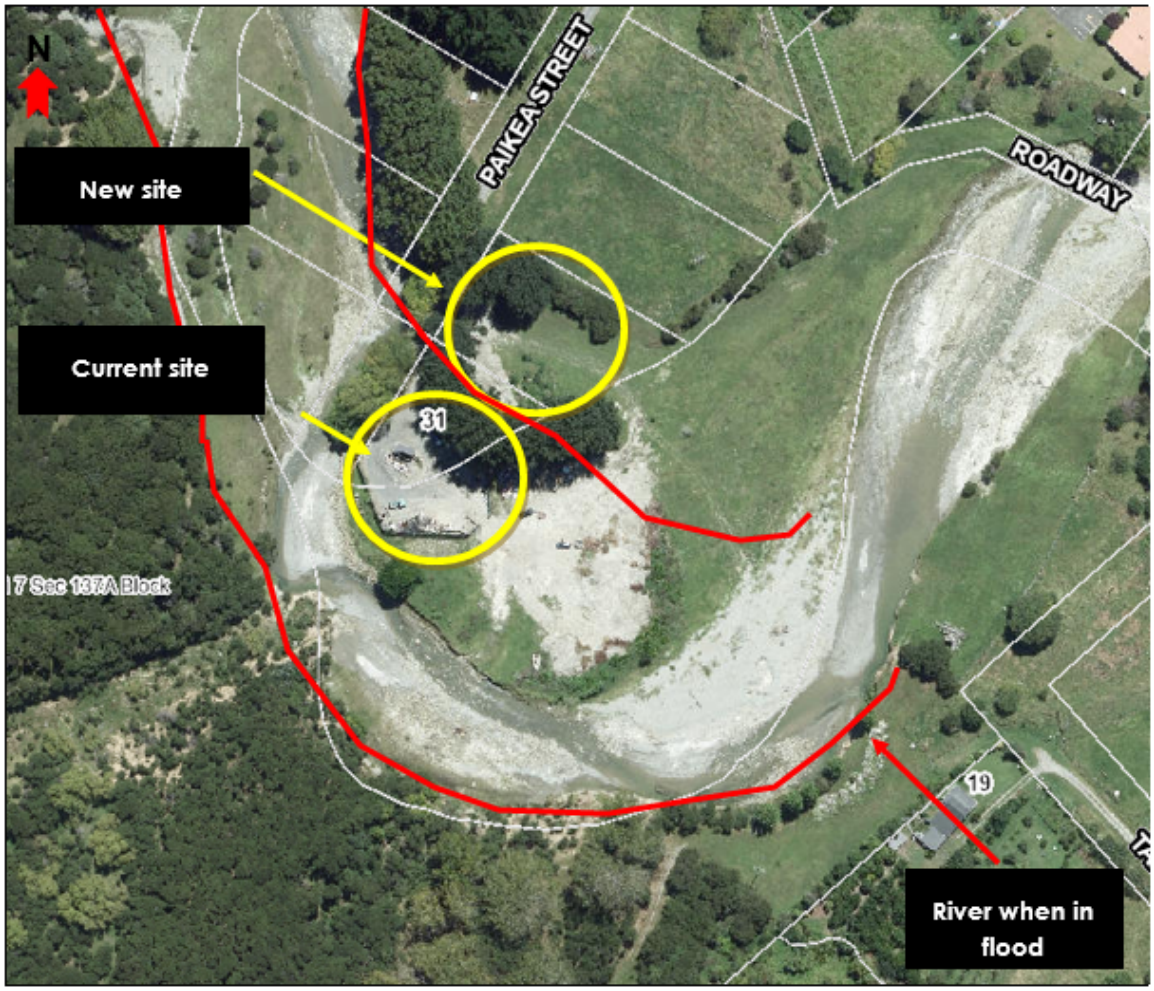


Figure 1, Map of transfer station sites

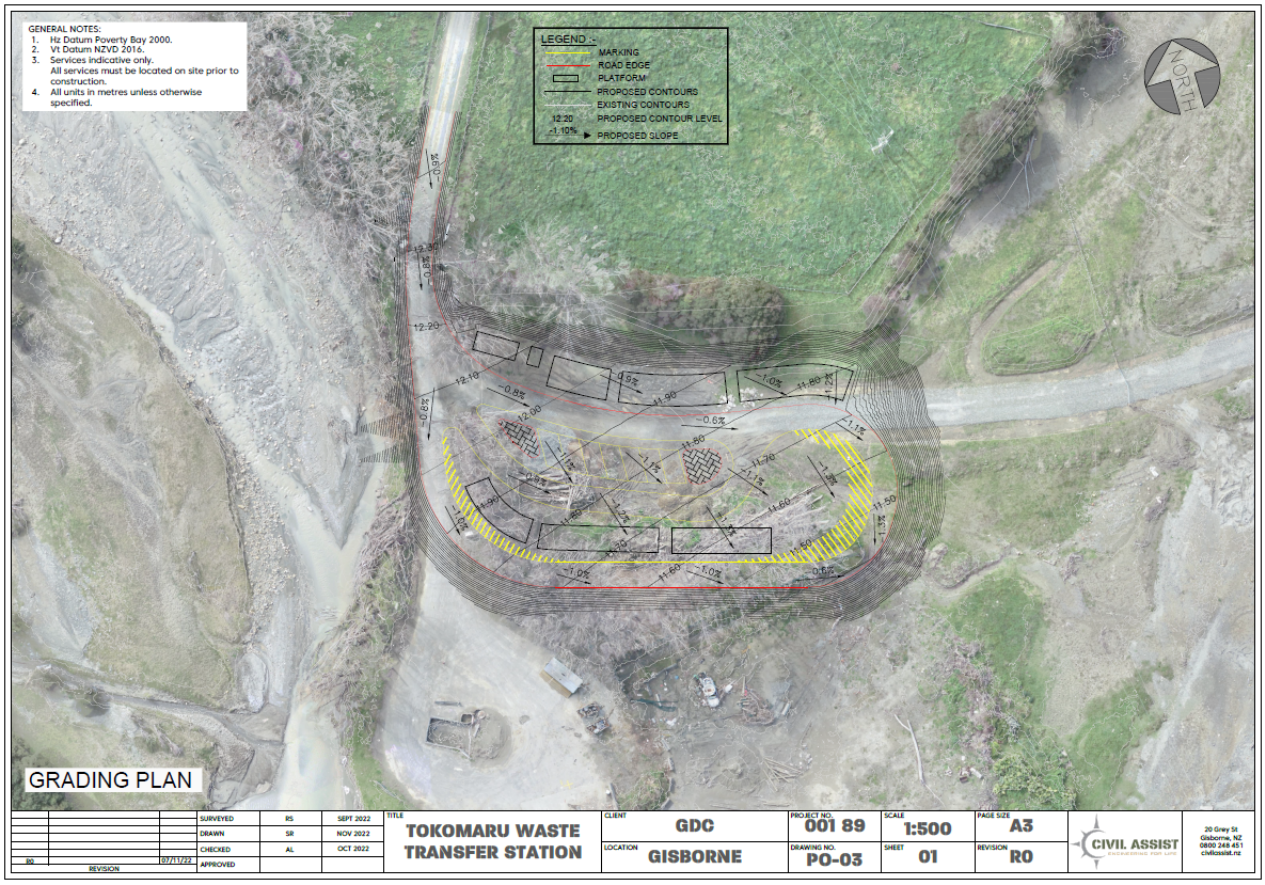


Figure 2, Transfer station layout

4. The current transfer station uses a deep concrete pit for general rubbish and has surrounding infrastructure that accepts our separated recycling, whiteware, metals and green waste. The intention for the new site is to move away from the pit and utilise bins and segregated areas for the waste streams. Bins will enable us to reduce our footprint and maintain a cleaner site. We will need to maintain regular transfer of different waste streams. The team is working with other organisations on recyclable waste streams such as farm plastics, e-waste and tyres. These will be implemented as they become viable across our rural transfer stations.

5. The solid waste team has engaged Civil Assist for the scope of the work and a detailed timeline has been provided in **Attachment 2**. An approved Offer of Service from Civil Assist was accepted in August 2022 and the final design for earthworks, stormwater and final site layout were completed in November. The next milestones are:

   - Completion of enabling works – 28 February 2023
   - Approval of the earthworks consents – 31 March 2023
   - Preparation of Contract, procurement and award of contract – 31 March 2023
   - Completion of construction works – 30 June 2023

6. The project is in the early stages and the table below indicates the status of the preliminary work before the physical works can commence.

Preliminary work	Status
Consent	*In progress*
Detailed Site Investigation (DSI)	*Completed and awaiting a report*
Procurement memo	*For approval by the solid waste team*

ASSESSMENT of SIGNIFICANCE - AROTAKENGA o NGĀ HIRANGA

Consideration of consistency with and impact on the Regional Land Transport Plan and its implementation
This Report: **Low** Significance

Impacts on Council's delivery of its Financial Strategy and Long Term Plan
Overall Process: **Low** Significance

Inconsistency with Council's current strategy and policy
Overall Process: **Low** Significance

The effects on all or a large part of the Gisborne district
Overall Process: **Low** Significance

The effects on individuals or specific communities
This Report: **Medium** Significance

The level or history of public interest in the matter or issue
This Report: **Medium** Significance

7. The decisions or matters in this report are considered to be of **Low** significance in accordance with Council's Significance and Engagement Policy.

TANGATA WHENUA/MĀORI ENGAGEMENT - TŪTAKITANGA TANGATA WHENUA

8. A community hui was held at the Tokomaru Bay Rugby clubrooms in November 2022. Plans for relocation and reasoning were discussed with residents in attendance.

COMMUNITY ENGAGEMENT - TŪTAKITANGA HAPORI

9. A community hui was held at the Tokomaru Bay Rugby clubrooms in November 2022. Plans for relocation and reasoning were discussed with residents in attendance.

CLIMATE CHANGE – Impacts / Implications - NGĀ REREKĒTANGA ĀHUARANGI – ngā whakaaweawe / ngā ritenga

10. There are no climate change implications from this update.

CONSIDERATIONS - HEI WHAKAARO

Financial/Budget

11. This project is currently on budget. However it is possible that the consent requirements and detailed site investigation (DSI) could result in further works that have not been budgeted for.

Legal

12. There are no legal implications from this update

POLICY and PLANNING IMPLICATIONS - KAUPAPA HERE me ngā RITENGA WHAKAMAHERE

13. There are no policy and planning implications from this update.

RISKS - NGĀ TŪRARU

14. The transfer station is scheduled to be completed by 30 June 2023. However it is possible that construction will not be completed within the financial year due to contractor availability and commitments to current emergency works after the recent weather events. It is likely that any future weather events will also further slow progress.

15. Resource Consent has not been granted and it is possible that this could adversely impact the completion date, as consent may require further preliminary work to be completed. A DSI has been conducted and we are waiting for a report of the findings. There is a possibility of unforeseen costs dependent on the findings.

NEXT STEPS - NGĀ MAHI E WHAI AKE

Date	Action/Milestone	Comments
31 March 2023	Resource Consent approval	It is estimated that six weeks is required for the consent to be granted once it is lodged.
27 March 2023	Procurement for physical works	The Solid Waste team is currently reviewing the procurement memo.
1 April 2023	Physical works commences	This date is an estimate as delays could occur due to contactor availability and weather.
30 June 2023	Expected completion	This may be delayed as noted in above risks.

WORKSHOP AGENDA

GISBORNE DISTRICT COUNCIL

P O Box 747, Gisborne, Ph 06 867 2049 Fax 06 867 8076
Email service@gdc.govt.nz Web www.gdc.govt.nz

MEMBERSHIP: Her Worship the Mayor Rehette Stoltz, Deputy Mayor Josh Wharehinga, Meredith Akuhata-Brown, Bill Burdett, Andy Cranston, Shannon Dowsing, Sandra Faulkner, Larry Foster, Debbie Gregory, Isaac Hughes, Tony Robinson, Pat Seymour, Terry Sheldrake and Kerry Worsnop.

WORKSHOP – Tokomaru Bay Transfer Station Relocation

DATE: Wednesday 10 November 2021

TIME: Following the Finance & Performance Committee

AT: Te Ruma Kaunihera (Council Chambers), Awarua, Fitzherbert Street, Gisborne.

AGENDA – OPEN SECTION

4. Reports of the Chief Executive and Staff for WORKSHOPPING

GISBORNE DISTRICT COUNCIL

21-175

Title: **Tokomaru Bay Transfer Station Relocation**

Section: Community Lifelines Solid Waste
Te Kai Arataki Tuia Whakapakari
Principal Scientist Dr Murry Cave

Prepared by: Chloe Howard-Lloyd - Solid Waste Advisor

Meeting Date: Wednesday 10 November 2021

Legal: No	Financial: Yes	Significance: **High**

Report for Workshopping

PURPOSE

The purpose of this report is to workshop the issues associated with the Tokomaru Bay Transfer Station and discuss the associated cost estimate for the relocation and establishment of the rubbish and recycling transfer station in Tokomaru Bay.

SUMMARY

The Tokomaru Bay Transfer Station located on Paikea Street has a series of issues. These include a landslip on the left bank, erosion of the right bank, subsequent protection of the legacy landfill and the site location being in a low-lying area susceptible to flooding. Four floods have been recorded over the past six years, the largest event occurring on 20 June 2021. This severe flood event caused damage to the Tokomaru Bay Legacy Landfill and extensive damage to the transfer station which resulted in rubbish being beached and swept into the Pacific Ocean. The transfer station and the legacy landfill it sits on will be increasingly vulnerable to flooding in the future.

The proposal is to relocate the transfer station to the adjacent paddock located to the front of the transfer station along Paikea Road. This will reduce environmental risks, further damage to our current transfer station and non-compliance issues. Relocating the transfer station will enable the transfer station to continue to operate during future flood events allowing the response and recovery time to be reduced. The relocation enables Council to prepare for the potential removal of the legacy landfill in the future, reducing further risk to the environment and aligning our mission with the government intent to reduce waste.

The Solid Waste Team propose that Council consider the options and the cost implications.

The decisions or matters in this report are considered to be of **High** significance in accordance with the Council's Significance and Engagement Policy.

Authorised by:

David Wilson - Director Lifelines

Keywords: Tokomaru Bay, transfer station, landfill

BACKGROUND

1. The Tokomaru Bay Transfer Station is located at 31 Paikea Street and was established in 1992, consented in 1999 and sits upon the pre-existing landfill that was built out onto the riverbed.

2. Section 15(1)(b) (RMA) 1991 states:

   discharging a contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating because of natural processes from that contaminant) entering water is prohibited unless expressly allowed by a national environmental standard or other regulations, or resource consent.

3. In accordance with 15 (2A) (a and b) of the (RMA) 1991:

   a contaminant into the air, or onto the land, from a place or any other source, whether moveable or not, in a manner that contravenes a regional rule is prohibited unless the discharge is expressly allowed by a national environmental standard, other regulations or by resource consent.

4. Two site assessments were conducted establishing that severe erosion of the left bank is causing contamination from the Tokomaru Bay Legacy Landfill into the Mangahauini River. A 'Cease Abatement Notice' and a 'To Do Abatement Notice' were issued on 15 October 2020, followed by a formal warning issued on 16 October 2020 for a breach of the RMA section 15 (1)(b), 15 (2A) (a and b). Compliance work under these notices had to be completed on the legacy landfill by 30 October 2020. Emergency works were conducted to achieve compliance.

5. Three options to prevent further contamination into the waterway and a risk assessment matrix (*Figure 1*) show the removal of the landfill as the recommendation and is a consideration for future planning, (Reference **Attachment 1)** *Tokomaru Bay Legacy Landfill Urgent Work Assessment Report*. Council is applying to the Ministry for the Environment Contaminated Sites Remediation Fund for assistance to remove the legacy landfill in the future.

Risk Assessment	Gabion Basket	Rock Revetment	Removal of Landfill
Structural lifetime	20–30 years	50–100 years	VERY LOW
Risk Structure	HIGH	LOW	VERY LOW
Risk to environment	LOW	LOW	LOW

***Figure 1 - Risk* Assessment Summary**

6. Weather warnings for heavy rain north of Tolaga Bay were issued for 19–20 June 2021.

   "*Heavy rain may cause streams and rivers to rise rapidly. Surface flooding and slips are also possible and driving conditions may be hazardous. Expect 100 to 150mm of rain. Peak intensities of 20 to 30mm/hr this evening, and again tomorrow morning with thunderstorms*".

7. This weather event resulted in flash flooding of Tokomaru Bay on Sunday 20 June 2021 when an estimated 70–75mm fell within a one hour period equating to a storm with an average recurrence interval of 100 years. A site inspection was carried out on 21 June to assess the flood damage to the Tokomaru Bay Transfer Station. The perimeter fence failed to contain some of the contents. Compounding the issue were large plastic containers and other items stored outside the perimeter fence that were washed out to sea and along the shoreline. This required redeployment of teams from other areas within the community to clean-up the beach stretching resources during the Tokomaru Bay flood response.
8. The transfer station suffered considerable damage, and there was a large volume of silt deposited on the site from the flooding. Willow trees that were previously planted to help stabilise the left bank and circumference of the landfill were uprooted and scattered across the transfer station.
9. The Tokomaru Bay Legacy Landfill requires an extension of the existing revetment by approximately 70m for which the Solid Waste Team is currently seeking consent. The transfer station has been repaired and is operational, however, it is at substantial risk of failure in future flooding events.

DISCUSSION and OPTIONS

10. A landslip is located on the right bank opposite the rock revetment. Previous data shows the slip began as early as 1945. Monitoring by Land, Rivers and Coastal (LRC) began in 2020 and a project has been initiated reviewing the erosion and the impacts of removing the landfill and what erosion risk will be caused downstream. This is being funded through EnviroLink.
11. The current rate of movement is assessed to be 0.2m annually, but the results are inconclusive until further data can be collected. During the recent flood event approximately 15m fell into the Mangahauini Stream and a further 10m since the initial event. This resulted in the widening of the stream allowing a larger area for the river to flow high. The slip is currently moving towards the left bank putting increasing pressure on the existing revetment protecting the legacy landfill. In flood events the stream is redirected across the river, transfer station and landfill.
12. A 70m rock revetment was established in 2020 after erosion of the legacy landfill exposed the contents. The rock revetment has been weakened by the recent flood event, and the upstream end has been eroded exposing the geotextile paper which prevents leachate discharging into the stream. The rock revetment needs ongoing monitoring and maintenance after heavy rain and flooding, and after every winter (reference **Attachment 2** - Monitoring and Maintenance Plan). It is highly likely that further damage to the revetment will occur, potentially exposing the landfill contents if strict ongoing assessment is not conducted. LRC have an allocated budget in the Long Term Plan to conduct further works on the right bank to help slow the erosion rate along the riverbanks.

13. Historical flooding has been identified. Chaffey's Contracting Ltd have operated the Tokomaru Bay Transfer Station since 2016. They have been responsible for the clean-up of the medium-scale flood events in 2016 and 2017, and the large-scale floods in 2020 and 2021. The 20 June 2021 flood event required a team of people to clean-up the area to allow the transfer station to become operational for the community to dispose of their flood damaged household contents. A secondary team was established to clean the plastics and rubbish on the beach, with volunteers cleaning up the beach before high tide. Both the transfer station and beach clean-up required a considerable effort from the community and external volunteers. This restricted the ability for the community to attend to their personal situations, stretched community resources and hindered the response time.

14. The current transfer station is divided into two parts indicated in *Figure 2 - Transfer Station Outlay (Section 1 and Section 2)*. Section 1 consists of a pit for general rubbish and recycling, with a perimeter fence and entrance gate located to the north. Section 2 stores large plastic containers, old cars and green waste with a gate located to the southwest. When in flood the river spreads across the flood plain on which the transfer station sits, as indicated in *Figure 2 (River in flood)*.

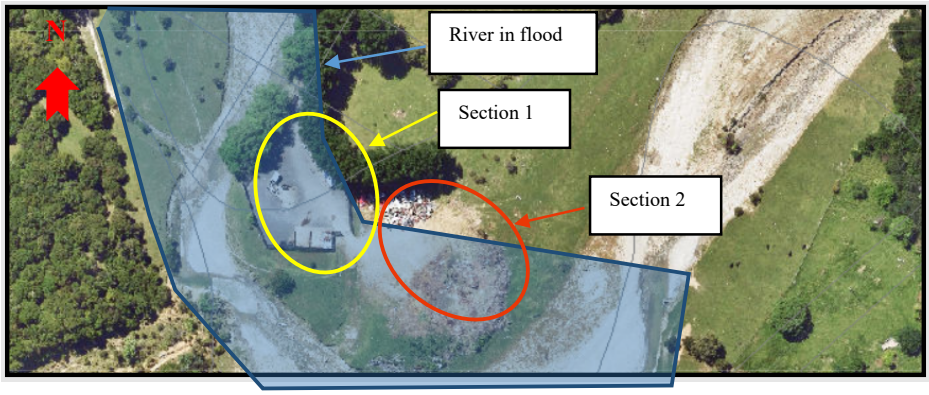


Figure 2 - Transfer Station Outlay

OPTIONS

Option Summary

Option 1 - Relocate and establish a new transfer station	The Solid Waste Team and Dr Murry Cave **recommend Option 1** as being the most cost-effective long-term option that meets the needs of the community and reduces harm to the environment.	**Costs** **$874,245** (Plus additional decommissioning fees) **Preferred**
Option 2 - Continue to operate the existing transfer station and remove Section 2	This is a continuation of the current operation and accepted collateral costs from clean-ups that are future forecasted, due to climate change. This option requires a robust revetment to be constructed to maximise protection of the legacy landfill and leaching of contaminates into the stream.	**Costs** **$405,000** **Not Preferred**

Option 3 - Close the transfer station and utilise Te Puia Springs transfer station	Closure of the Tokomaru Bay transfer station and utilising the Te Puia Springs transfer station as the primary option for Tokomaru Bay. This requires a robust revetment proposed in Option 2 for the protection of legacy landfill.	**Costs** **$367,000** Plus additional decommissioning fees **Not Preferred**

Option 1 – Relocate and Establish a New Transfer Station

15. Relocate and establish a new transfer station to the section located forward of the current station. Use river run and slip material to elevate the height of the section. This will mitigate the site's risk of flooding.

16. The Solid Waste Team's goal is to reduce, reuse, repurpose and recycle the region's waste to minimise our footprint on the environment and align ourselves with the government in diminishing waste going to landfill. The Solid Waste Team proposes a new site and design shown in Figure 3 - Conceptual Proposed Transfer Station Design to reduce our impact on the environment (this design is subject to change following community and iwi consultation). The transfer station size and design will reflect the current population of approximately 444 and potential future growth. The design is a roundabout system with bins appropriately sized for their contents. A crossing is to be located on the left-hand side so people can park and safely carry their recycling to the bins during high traffic periods. Both sides of the roundabout design have large bypass areas, sized for a car and trailer allowing for the disposal of waste and not impeding traffic flow. A cage with painted lines on the concrete would allow the division of plastic containers, gas bottles and whiteware. The Solid Waste Team has assessed the existing seven transfer stations within the region and identified issues with the current designs and have addressed these issues with this new design.

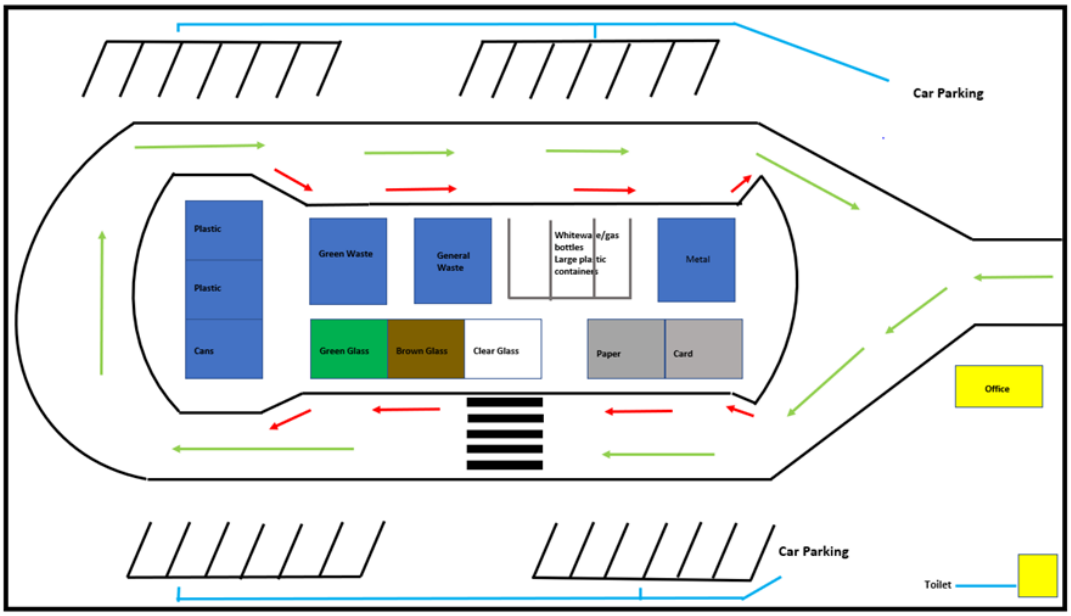


Figure 3 – Conceptual Proposed Transfer Station Design

17. Two locations were considered when assessing a site relocation (reference **Attachment 3** - Tokomaru Relocation of Transfer Station). This option is the most cost-effective option and addresses the difficulties presented by the current location. The proposed site for the transfer station is the land located immediately north of the existing transfer station indicated in *Figure 4 - Site Location*. The site is currently consented to operate a transfer station. This consent was granted when the transfer station was primarily constructed. This proposed site suffered minimal damage during the 20 July 2021 flood event and is positioned outside the assessed flood zone. To mitigate and decrease the risk of future flood events affecting the operational ability and reduce the impact on the environment, it is recommended the land be built up in height to approximately 2.5m with river run material and the new transfer station positioned on top, with the entry located on the left-hand side of the paddock adjoining the current road indicated by *Figure 4 - Site Location (Entry)*.

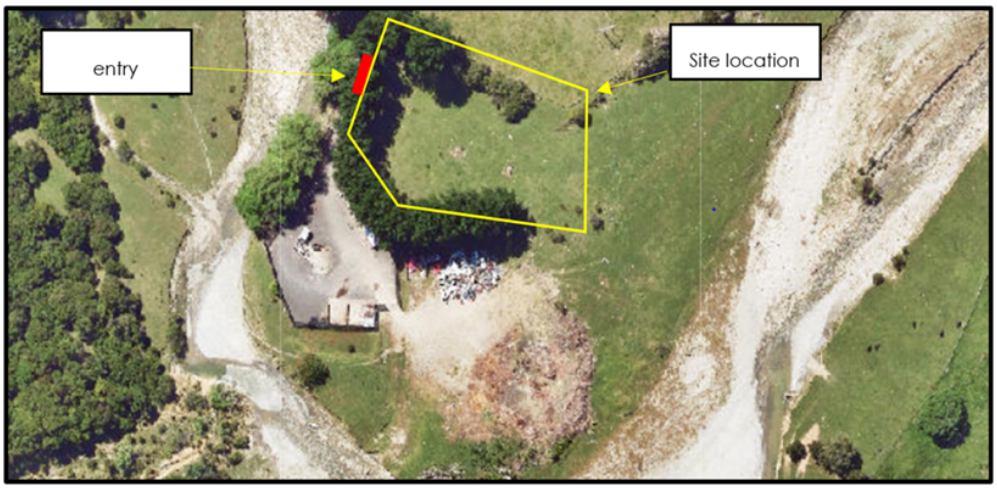


Figure 4 - Site Entry and Location

18. The Solid Waste Team proposes a short revetment or gabion basket design to be used for addressing the current issue of the exposed legacy landfill. This will allow for the removal of the legacy landfill in the future.

Option 2 - Continue to Operate the Existing Transfer Station and Remove Section 2

19. This option proposes the removal of section 2 and all contents be permitted to be stored on the paddock forward of the transfer station, indicated by Figure 2 - Transfer Station Outlay, section 2. This will reduce the risk of some contents being swept into the river during a weather event. The station would operate as usual and expected clean-ups after weather events are forecasted. A revetment was established in 2020 under emergency works. An extension of the revetment protecting the legacy landfill is required to become compliant. The existing revetment was damaged during the flood event.

20. An assessment from Mangala Wickramanayake, Team Leader Land Rivers & Coastal (LRC), has established that the construction of the revetment was done under emergency works provisions of the RMA to stop further scouring of the closed landfill under the transfer station and was not a permanent fix, it was always envisioned that further works would be required. LRC have provided plans for a robust revetment indicated by Figure 4 - Revetment Plans, appropriate for the forecasted weather events up to a 1 in 100-year flood event. (The 2021 flood event was assessed as a 1 in 100-year flood event). The Solid Waste Team will monitor and ensure the constant work on repairs is conducted yearly to not compromise the integrity of the revetment. The plans for a revetment propose a 105m revetment in length indicated by Figure 5 - Revetment Location and Length and is estimated to cost around $405,000.

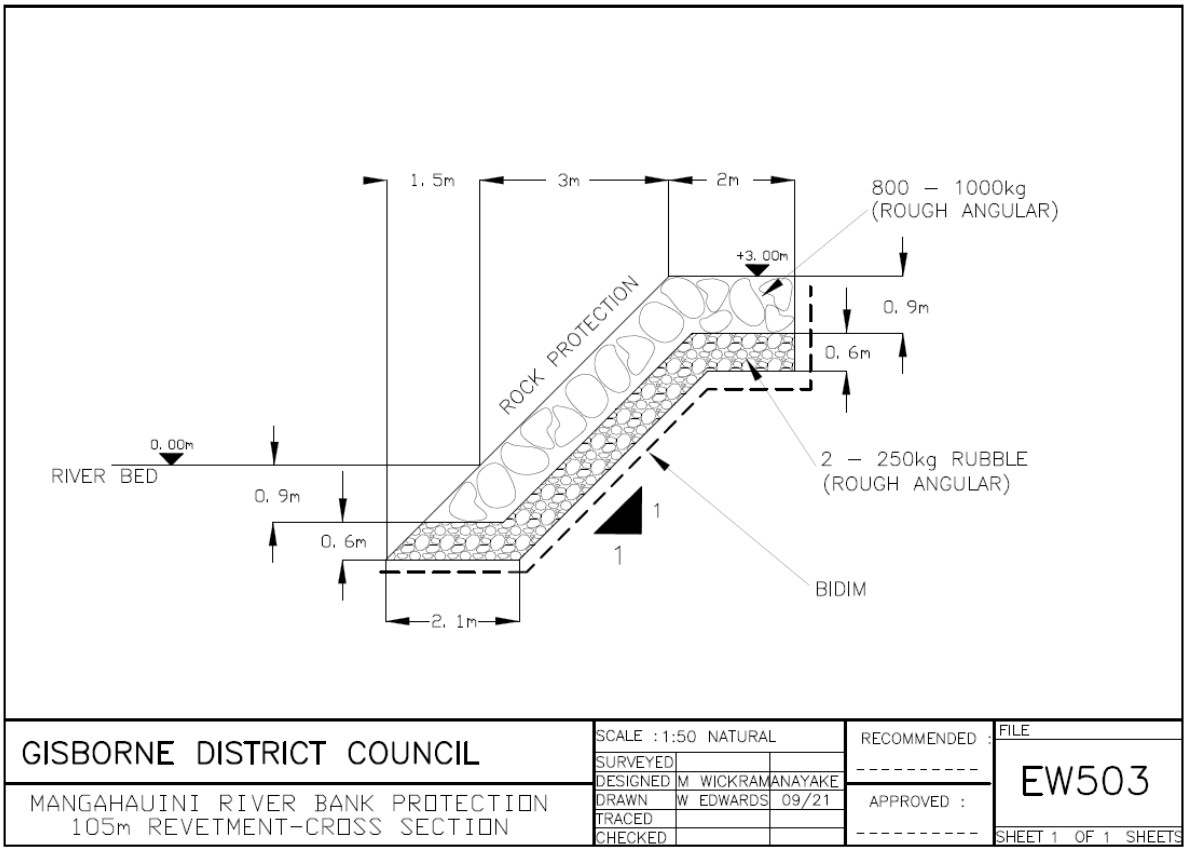


Figure 4 – Revetment Plans

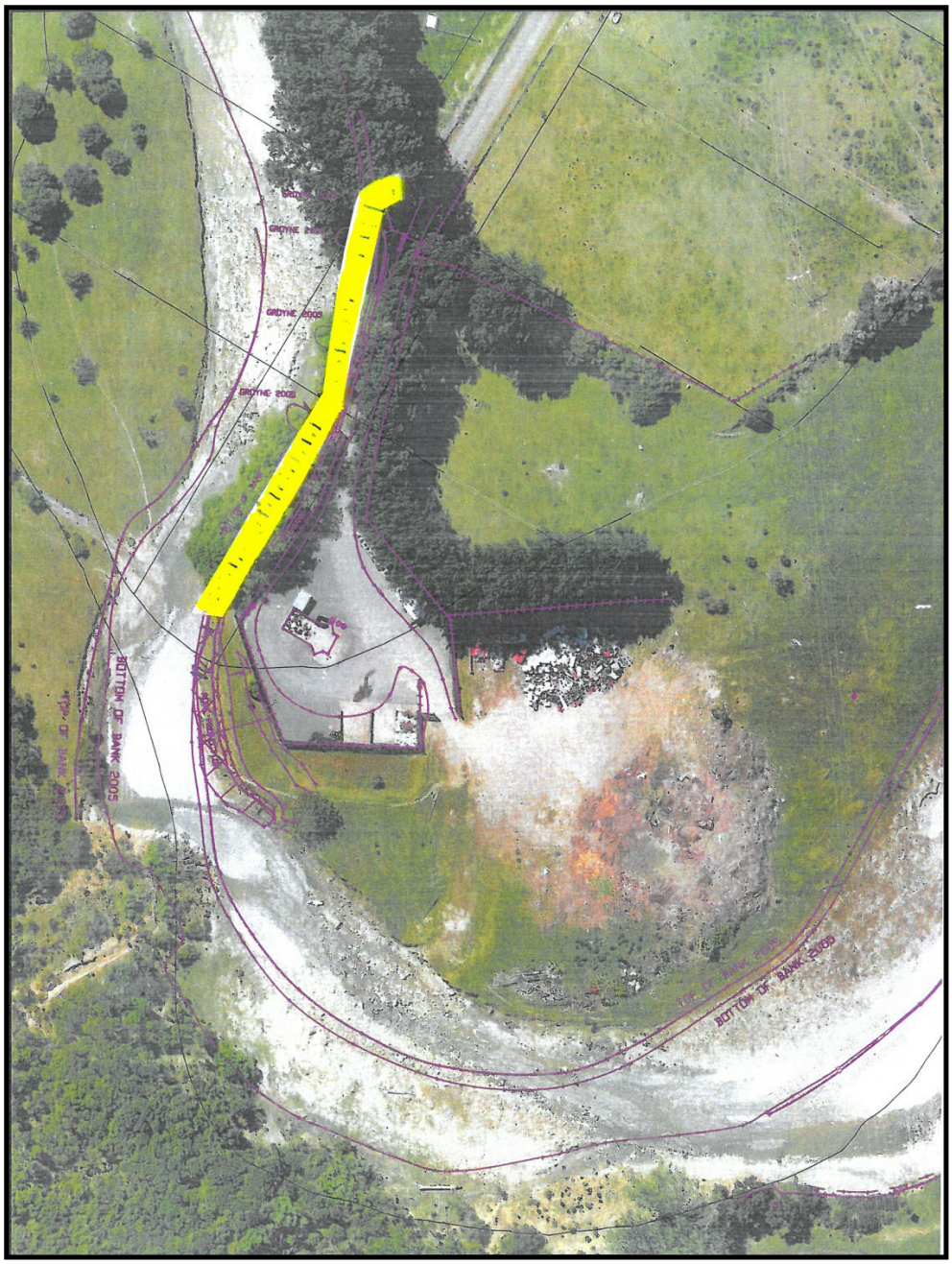


Figure 5 - Revetment Location and Length

Option 3 – Close the Transfer Station and Utilise Te Puia Springs Transfer Station

21. This option proposes the closure of the Tokomaru Bay Transfer Station and the primary use of the Te Puia Springs Transfer Station. Residents from Tokomaru Bay will be required to travel 12km to dispose of their household rubbish. The combined population of Tokomaru Bay and Te Puia Springs is 844. The Te Puia Springs Transfer Station will need to be emptied more than once a week and further planning will be needed for this. Good traffic management will need to be established by the caretakers to ensure the process of recycling and dumping of rubbish is safe.

22. Closing the Tokomaru Bay Transfer Station will reduce the risk of rubbish being washed into the Pacific Ocean and prevent action plans and teams been deployed for clean-ups in future weather events. It is highly likely this option will affect the community adversely and result in illegal dumping reflecting poorly on GDC.

23. There will still be a requirement for the revetment proposed in Option 2 to ensure contents from the legacy landfill will not be washed into the stream.

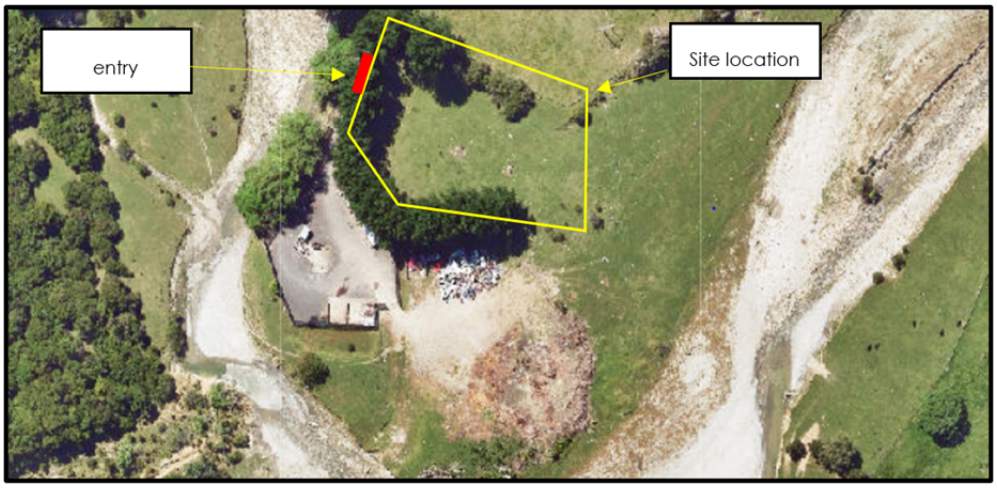


Figure 6 – Site Location

ASSESSMENT of SIGNIFICANCE

Consideration of consistency with and impact on the Regional Land Transport Plan and its implementation
Overall Process: **Low** Significance
This Report: **Low** Significance

Impacts on Council's delivery of its Financial Strategy and Long-Term Plan
Overall Process: **Medium** Significance
This Report: **Medium** Significance

Inconsistency with Council's current strategy and policy
Overall Process: **Low** Significance
This Report: **Low** Significance

The effects on all or a large part of the Gisborne district
Overall Process: **Low** Significance
This Report: **Low** Significance

The effects on individuals or specific communities
Overall Process: **High** Significance
This Report: **High** Significance

The level or history of public interest in the matter or issue
Overall Process: **High** Significance
This Report: **High** Significance

MĀORI ENGAGEMENT/COMMUNITY ENGAGEMENT

24. A meeting was held with Gene Takurua, Te Kai Arataki - Tuia Whakapakari, Lillian Ward, Area Liaison Officer and Errol Clarke, Journeys Capital Projects Officer to discuss the Tokomaru Bay Transfer Station relocation. Iwi and community consultation was to be conducted on 11 September 2021 to introduce the conceptual and design ideas to relocate the Tokomaru Bay Transfer Station. The Solid Waste Team's intent is to seek and consider all feedback from the community. Due to COVID-19 this has been delayed.

CLIMATE CHANGE – Impacts / Implications

25. Council undertook a detailed assessment of climate change in 2019/20 using National Institute of Water and Atmospheric Research (NIWA). This assessment was based on two of the Inter-government panels on climate change (IPCC) Representative Concentration pathways (RCP 4.5 "middle path" and RCP 8.5 "do nothing"). Potential changes to rainfall and flooding are the key factors for the Tokomaru Bay landfill/transfer station.

26. Under RCP 4.5 there will only be a minor change to annual rainfall by 2040 but annual rainfall may decrease by 2090. The situation is similar under RCP 8.5 but with more areas will see annual rainfall decreases. There will be an increase in seasonality of rainfalls under both scenarios with summers drier than at present but north-eastern parts of Tairāwhiti including Tokomaru Bay are expected to see 5–15% seasonal increases of rainfall, particularly in autumn.

27. In contrast it is expected that the maximum one day rainfall will increase and will be higher in coastal areas in the northern half of Tairāwhiti and this will include the Mangahauini catchment where the transfer station is located. NIWA modelling suggests that the rainfall depths for an event with a 50-year annual recurrence interval (ARI) at Te Puia Springs would increase from 330mm of rain over 24 hours to 351mm by mid-century and 364mm by the end of the century under RCP 4.5, and to 354mm and 402mm respectively under RCP 8.5. Rainfall depths for a 100-year ARI event would be correspondingly higher. An alternative way of looking at this is to say that an event with a 50-year ARI now will have a 40-year ARI under RCP 4.5 and a 100-year ARI event would have an 80-year ARI.

28. By comparison with the recent event at Tokomaru Bay, the short-term high intensity storm on the morning of 20 June had a 1½ hour ARI of 35 years, or if it fell within an hour, an ARI of 100 years. Under RCP the 35-year ARI would become a 15-year ARI and the 100-year ARI would become a 75-year ARI under the worst-case scenario.

29. The implications for the Mangahauini River at Tokomaru Bay are that severe storms causing floods of a scale that would threaten the legacy landfill will become more frequent under even a more favourable climate change scenario and the impacts significantly worse under the RCP 8.5 "do nothing" scenario.

CONSIDERATIONS

Financial/Budget

30. The relocation of the Tokomaru Bay Transfer Station is forecast to just under $880,000 – see Table 1. There was no provision made for this expenditure in the 2021–2031 Long Term Plan (LTP). It is almost certain that the rough order cost for "works including prepping and supply of backfill" will be able to be done significantly cheaper than quoted by reusing roading wastes and other materials to significantly bringing the cost down. The Solid Waste Team plans to use slip material for the backfill, therefore only incurring costs for cartage.

31. There will be a financial loss of $172,000 on the disposal of the old site. This is not a cash loss and represents the current book value of the assets being disposed. Funding for this project is expected to be 100% loan funded.

32. Overall costs are expected to increase around $35k per annum (interest and slightly higher operation costs). This equates to around $6.78 per ratepayer or per each of the 2,359 connections

33. Overall external debt will increase by $880k from what was planned for in the 2021–2031 LTP. However, with this additional debt Council will not breach the Financial Strategy 130% Debt to revenue threshold.

34. It should be noted that in years 3–5 of the 2021-2031 LTP, the debt to revenue was forecast to be approaching the 130% threshold (i.e. 122%), and the additional $880k debt reduces the headroom for further borrowing. It terms of dollars, this "head room" now amounts to around $13m.

Table 1: Cost to Relocate Tokomaru Bay Transfer Station	
Earthworks	**$**
• Establishment and disestablishment	3,960
• Remove all vegetation including obstacles and rubbish	33,000
• Works including prepping and supply of backfill	531,905
Transfer Station	
• Concrete Pad	120,000
• Mesh	30,000
• Cartage	24,000
Fencing	
• Posts	12,583
• Netting Wire 465	2,400
• Windbreak	2,397
• Concrete	10,000
• Miscellaneous	8,000
• Labour	16,000
• Contingency fees @10%	80,000
Total	**$874,245**

LEGAL

35. Relocating the transfer station will make it easier to manage and eventually remove the pre-existing legacy landfill in which the transfer station sits and reduce the likelihood of further abatement notices in the future. No other legal implications are envisaged as the replacement site is already consented for this purpose.

POLICY and PLANNING IMPLICATIONS

36. The proposal was not planned for in the 2021–2031 LTP despite the vulnerability of the site having been recognised for at least the last five years. Legacy landfills like the transfer station sits on are now recognised as a national issue and there is funding available to support the remediation of such sites. The recent climate change adaptation study has identified that there is likely to be an increase in extreme weather events in the future and addressing such legacy landfills is a matter that needs consideration in the review of the Tairāwhiti Regional Management Plan.

RISKS

37. The Tokomaru Bay community are aware of the flooding issues with the transfer station. The Solid Waste Team's proactive approach to this issue will reflect positively on Council. Risk of the community being unhappy with the recommendation is a possibility.

38. If the unbudgeted amount is approved by Council, the Solid Waste Team would make plans to commence work this summer. If this cannot be achieved work would be planned for next summer. The risk if funds are not approved for the project to proceed will be costs are incurred to fix the existing transfer station which will remain high risk because of the location.

39. The Tokomaru Bay Transfer Station is the most vulnerable transfer station site within the region and there is a need to consider the implications for the other transfer stations within the district which are also poorly designed for efficient collection of refuse. There is a risk of accelerated demand from other coastal communities to improve or relocate their transfer stations away from waterways.

NEXT STEPS

Date	Action/Milestone	Comments
TBC	Iwi/community consultation	

ATTACHMENTS

1. Attachment 1 - Tokomaru Landfill [**21-175.1** - 10 pages]
2. Attachment 2 - Tokomaru Monitoring and Maintenance Plan [**21-175.2** - 12 pages]
3. Attachment 3 - Tokomaru Relocation of Transfer Station [**21-175.3** - 10 pages]

GISBORNE DISTRICT COUNCIL

28/05/21

Subject: **Tokomaru Bay Legacy Landfill Urgent Work Assessment Report**

Prepared by: Chloe Howard-Lloyd – Solid Waste Advisor

Executive summary

Risk Assessment Summary

Risk Assessment	Gabion Basket	Rock Revetment	Removal of Landfill
Structural lifetime	20-30 years	50- 100 years	VERY LOW
Risk Structure	HIGH	LOW	VERY LOW
Risk to environment	LOW	LOW	LOW
Cost			

Key
Very Low
Low
medium
High

The two site visits established severe erosion of the left bank (LB) causing contamination from the Tokomaru Bay Legacy Landfill into the Mangahauini River. One abatement notice- To Do, one abatement to- cease and one formal warning were issued in 2020 for breaching section 15(1)(b) and (2A) of the Resource Management Act (RMA) 1991. Current issues identified are in breach of the RMA. Three recommendations have been proposed to prevent further contamination into the waterway and a risk assessment matrix shows the removal of the landfill as priority one, rock revetment priority two and Gabion Basket priority three.

The purpose

1. The purpose of this report is to establish what urgent compliance work is required for the Tokomaru Bay Legacy Landfill to prevent further hazardous contaminants from entering the environment, land air and water.

Background

2. The Tokomaru Bay Legacy Landfill is located at GPS coordinates X2065533 Y5766756, 31 Paikea Street Tokomaru Bay next to the Mangahauini River. The Landfill was established in the 1900's and closed in 1992, a few months later the Tokomaru Bay Transfer Station was constructed on top of the landfill and consented in 1999. Emergency works were conducted June and July 2020 to establish a rock revetment on the left bank (LB) to stop further erosion of landfill into the Mangahauini River. Previous reporting shows erosion began in the early 1990's, over the past 30 years works has been conducted and Dolosses were placed as groynes downstream of the landfill to prevent further erosion.

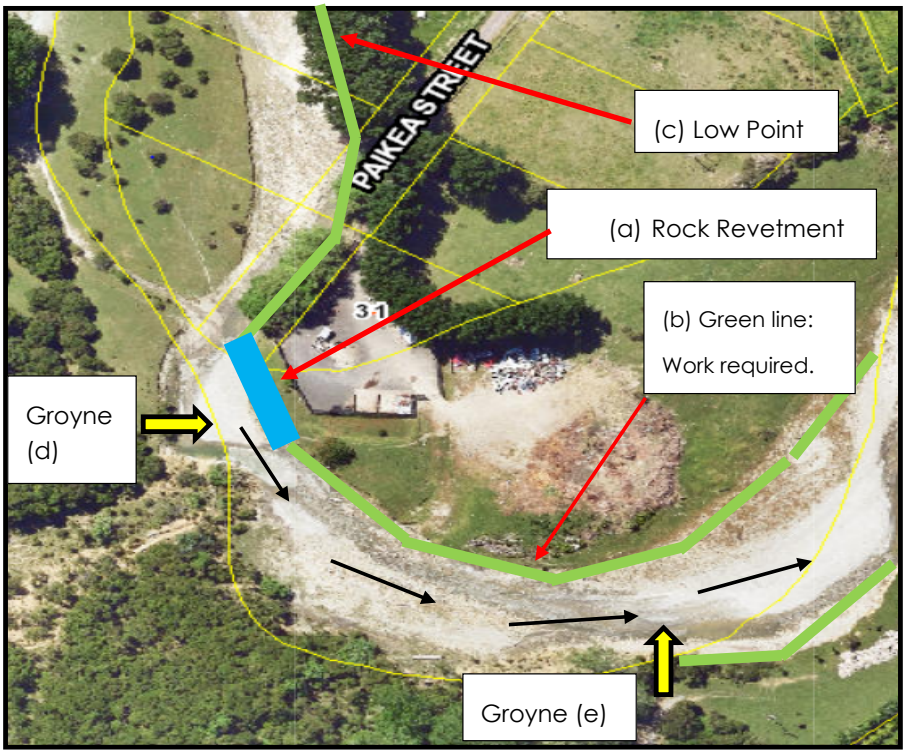


Figure 1: Tokomaru Landfill

Introduction

3. A site visit was conducted 05 MAY 2021 and further erosion of the landfill was identified. Located front of the landfill is a 1.5-meter escapement, the Mangahauini river has caused erosion of the left bank (LB) exposing general rubbish, shoes, and metal.

4. Section 15(1)(b) (RMA) 1991 states; discharging a contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating because of natural processes from that contaminant) entering water is prohibited unless expressly allowed by a national environmental standard or other regulations, or resource consent.

5. In accordance with 15 (2A) (a and b) of the (RMA) 1991, a contaminant into the air, or onto the land, from a place or any other source, whether moveable or not, in a manner that contravenes a regional rule is prohibited unless the discharge is expressly allowed by national environmental standard, other regulations or by resource consent.

6. There is no record of consent being granted allowing discharge of contamination into the water.

7. One 'Cease Abatement notice' and a second 'To Do Abatement Notice' was issued 15 Oct 2020, followed by a formal warning issued 16th Oct 2020, compliance work had to be completed by 30th Oct 2020. Emergency works was conducted to achieve compliance, further works need to be completed to reduce additional non-compliance.

8. The Mangahauini River runs high in the winter months, historically when the river is in flood it runs across the transfer station. In 2020 the transfer station was closed due to flooding. It is HIGHLY LIKELY during winter, erosion on the LB will spike; it is ALMOST CERTAIN contamination will leak into the Mangahauini River over June to August.

Considerations

Landslip

a. There is a slip (attached appendix A) located on the RB opposite the rock revetment. Previous reporting shows the slip began as early as 1945 and the rate of movement is 0.2m per year. The slip has resulted in the narrowing of the Manganui river increasing the rate of erosion of the LB protecting the Landfill. The slip material which is impeding the waterway must be removed to avoid the impediment of the water flow. A stability slope needs to be established to prevent further slipping to mitigate the rate of erosion on the LB where the landfill is located. This issue is being monitored annually by LRC.

Iwi

b. On 28 May 2021 a hui with the Engagement and Maori Responsiveness Manager was conducted to discuss the iwi engagement process regarding work on the Landfill and Mangahauini River. A secondary Hui would be conducted with the Maori Responsiveness Manager to discuss the appropriate way to disseminate information about the current issues with the landfill and recommendations to remedy the issues. A hui will be organised with the local iwi and neighbouring properties.

Consent

c. Consent is currently being processed for the emergency works conducted in 2020, the solid waste team will need to provide a monitoring plan for maintenance of the revetment wall. A consideration into bundling the consents will be a future discussion.

Cost

d. Quotes will be obtained once proposed recommendations have been agreed. A work plan aligned with a budget plan will be established to fix the landfill in priority areas, this plan could span over our next LTP. Further research into funding options is required. Liaison will need to happen with LRC as they have budgeted funds for the RB.

Secondary site visit

9. On 24 May 2021, a secondary site visit was attended by Solid waste, LRC and monitoring and compliance. The purpose of the site visit was to establish recommendations to prevent further contamination into the Mangahauini River. Photos (attached Appendix B) were taken to capture the threat of contamination into the Mangahauini River, it is ALMOST CERTAIN contamination is leeching into the waterway.

Recommendations

Recommendation One

10. The top (LB) has a low point indicated *on figure1 Tokomaru Landfill (c)* in flood the river runs across the Transfer station. It is recommended that the LB is raised, and a Geo paper lining is placed along the LB indicated by *Figure 2, gabion basket design*, gabion baskets are then positioned to the front, *Geo textile prevents the earth and silt from washing out from behind the Gabion wall.* The continuation of Gabion basket along the LB indicated by Figure 1B, Tokomaru bay Landfill, will wrap around the Landfill preventing further leachate and contamination. Rock can be outsourced or existing rock from the Mangahauini riverbed can be use inside the gabion baskets. Groynes *shown by figure 4,* are installed indicated on *figure 5 and 4E.* Groynes are positioned before impact areas to

reduce the erosion of the riverbank. Groynes will direct water flow to the centre of the river indicated on *figure 4G, Groyne placement*.

Strengths

11. Gabion basket are best used in areas with restricted space resulting in limited effects on river flow capacity. When gabion baskets are placed on an angle it offers additional stability and diminishes the backfill erosion indicated *by Figure 3, Gabion basket.*

Weaknesses

12. Maccaferri gabion basket are recommended and have a lifespan of 20-30 years, monitoring and maintenance is required. Gabion baskets are vulnerable to failure, there are wire ties connecting each basket, if one basket fails the entire gabion wall will collapse. Workmanship is key to the success of the Gabion wall for the lifetime of the structure. Groynes were previously placed in the Mangahauini River and were proven ineffective overtime.

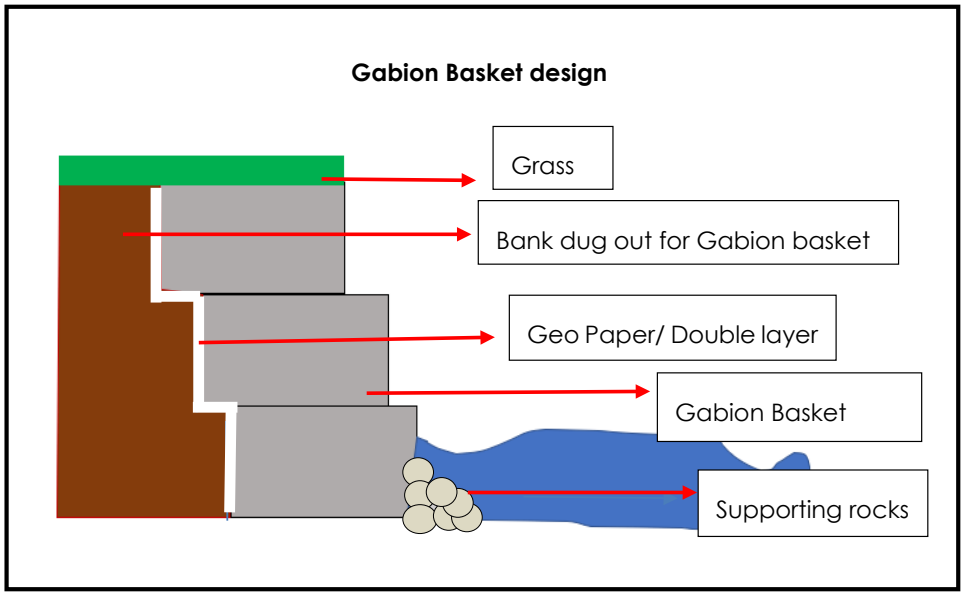


Figure 2, Gabion Basket Design

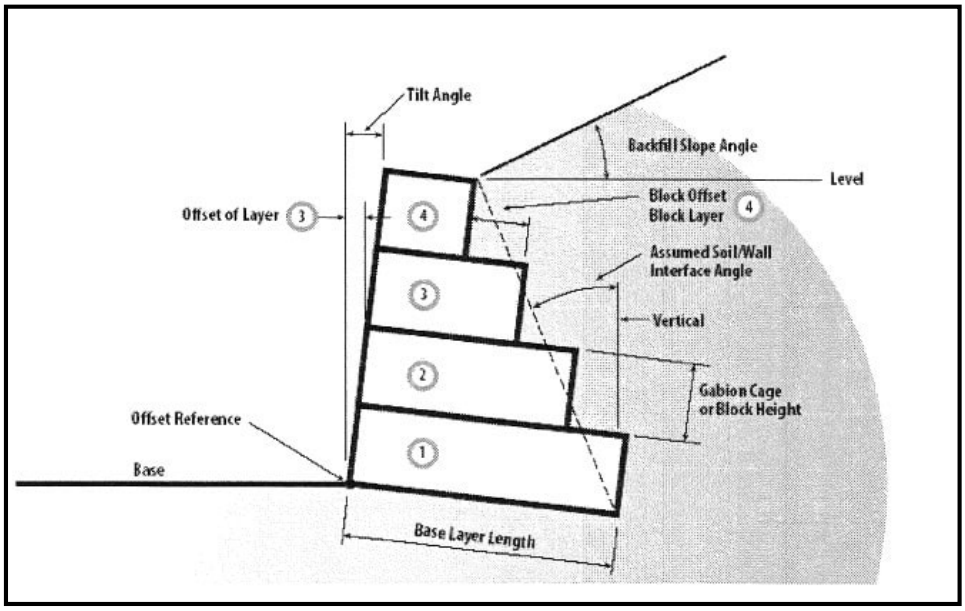


Figure 3, Strengthen Design

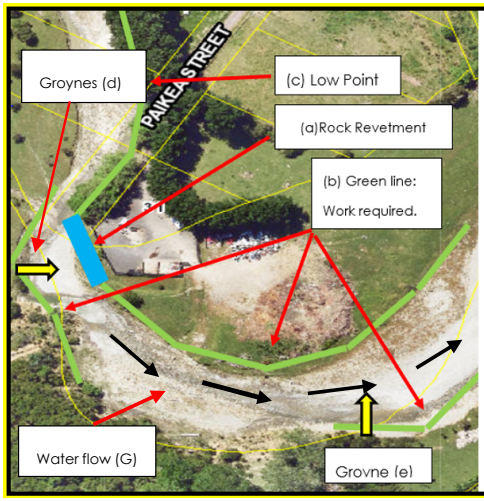


Figure 4, Landfill

Figure 5, Groynes

Recommendation Two

13. A rock Revetment has already been established indicated by *figure 1 Tokomaru landfill (a)*. A continuation of the existing rock revetment will allow for the bank to be shaped. A Polyethylene sheet is laid against the LB to prevent leachate into the Mangahauini River, geo textile is placed on top and the rock is packed with well graded material to fill any cavities, forming the revetment wall.

Strengths

14. Rock revetment has a lifespan of 50-100 years if monitoring and regular maintenance is completed. In the event of significant damage repairs can be conducted without compromising the entire rock revetment.

Weaknesses

15. The Rock Revetment has limited vulnerabilities, after large scale event it is HIGHLY LIKELY the rock revetment will only require repairs not replacement.

Recommendation Three

16. Removal of Tokomaru Bay Legacy Landfill.

Strengths

17. The river will gain more flood plains and reduce the pressure on the banks, reducing the rate of erosion during flow velocity. Removal of the legacy Landfill will result in no further threat of contamination and leachate into the Mangahauini river and Pacific Ocean in the future.

Weaknesses

18. It is HIGHLY UNLIKLEY that contamination during the removal process will happen if the work is conducted during our driest months. The removal of the Landfill will result in a cavity that will need to be filled with rock material, from the riverbed or outsourced. It is HIGHLY LIKLEY the eco system will be affected during the excavation process and is HIGHLY LIKELY the eco system will recover within 12months. The landfill content will need to be relocated, the current Waiapu landfill is due to close in 2024 and does not have the capacity to receive the contents. It is HIGHLY LIKELY air pollution will be affected during the removal of the Tokomaru Landfill. A new location for the transfer station will have to be established.

REMOTE/HIGHLY UNLIKELY	**LESS THAN 10%**
IMPROBABLE/UNLIKELY	**20-25%**
REALISTIC POSSIBILITY	**25-50%**
LIKELY	**55-70%**
HIGHLY LIKELY	**75-80%**
ALMOST CERTAIN	**GREATER THAN 90%**

Appendix A - Aerial Imagery

Figure 1: Slip into the Mangahauini River forcing erosion on the left bank when the river is high.

Appendix B - Photographs

Figure 2: Metal obtruding from the landfill. The Mangahauini River located to the immediate front.

Figure 3: Further metal protruding from the landfill. The Mangahauini River located to the immediate front.

Figure 4: Further along the left bank metal continues to protrude. The Mangahauini River located to the immediate front.

Figure 5: Close up of a tarp from the legacy landfill. The Mangahauini River located to the immediate front.

GISBORNE DISTRICT COUNCIL

TOKOMARU BAY HISTORIC LANDFILL ROCK REVETMENT EMERGENCY WORKS

For Gisborne District Council

Monitoring and Maintenance Plan

August 2021

REPORT INFORMATION AND QUALITY CONTROL

Prepared for:	Chloe Howard-Lloyd Solid Waste Adviser Gisborne District Council

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Reviewer:	Sam Morgan Principal Coastal Consultant	
Approved for Release:	Karl Baldwin Regional Manager	

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1 INTRODUCTION

This document outlines a Monitoring and Maintenance Plan (MMP) which has been developed for Gisborne District Council (GDC) associated with the emergency rock revetment protection works undertaken on the true left bank of the Mangahauini River (**Figure 1**) to stabilise an exposed area of the Tokomaru Bay historic landfill and prevent further erosion issues. The intent is to provide guidance as to how the monitoring and conditions of the resource consent shall be met. The monitoring actions outlined in this MMP are to be implemented as required by Conditions 33 and 34 of the resource consent (LR-2020-109906-00).

Figure 1: Rock revetment protection sealing the landfill in August 2020. *Source: GDC.*

2 MONITORING SCHEDULE

The following outlines the key components of the MMP for the first five years of the consent period, after which the monitoring methods and site requirements will be reviewed (and updated as required). Monitoring at the site includes photographic monitoring of the revetment structure and adjacent unprotected riverbank sections on a biannual basis, as well as more detailed monitoring on an annual basis using an Unmanned Aerial Vehicle. The purpose of the monitoring is to help assess and determine the current state and rate of erosion occurring within the vicinity of the structure and of the inner bank immediately downstream of the structure. Observations of any changes to the integrity of the structure, including movement or displacement of rock members within the revetment, made during site walkovers will also feed into any repair or remediation recommendations.

2.1 Quarterly Site Walkovers and Photographic Monitoring

A site walkover including photographic monitoring shall be undertaken within 48 hours or as soon as practicable after a heavy rainfall warning weather event from the Metservice resulting in significant rainfall in the area, and at least on a quarterly basis to be consistent with Condition 33 (1) of the resource consent.

The photographic monitoring points that have been established at the site are noted in **Table 1** which relate to Condition 33 (2) a – e of the resource consent. Representative photographs shall be taken from these monitoring points during each site inspection to capture both the top and bottom of the revetment at various locations along the length of the structure. Beyond the structure, additional photos will be taken approximately every 10m along the 80m of unprotected riverbank downstream of the revetment on the true left bank. Photos of the true right bank will also be taken at the locations noted in the table below to capture any changes downstream on the outer bank.

The locations of all the photographic monitoring points are indicated on the aerial image in **Figure 2** (below). The date and details of each inspection will be recorded in the accompanying spreadsheet checklist (e.g. **Appendix A**). The photographic monitoring is proposed to take place twice a year in the first five years of the consent period while the structure "settles in", and then once a year from then (subject to review after the initial five years).

Table 1: Description and NZTM coordinates of the photographic monitoring points.

Point ID	Photograph Description	NZTM Coordinates
1	Revetment crest (a) and toe (b)	NZTM 2065485 5766816
2		NZTM 2065487 5766803
3	Revetment ends	NZTM 2065495 5766793
4		NZTM 2065484 5766831
5	Every 10m along the true left-bank extending 80m downstream of the revetment	NZTM 2065501 5766784
6		NZTM 2065508 5766777
7		NZTM 2065515 5766770
8		NZTM 2065521 5766762
9		NZTM 2065529 5766755
10		NZTM 2065540 5766750
11		NZTM 2065553 5766750
12		NZTM 2065563 5766749
13	True left-bank - upstream	NZTM 2065489 5766845
14	True right bank - downstream	NZTM 2065561 5766725
15		NZTM 2065592 5766727
16		NZTM 2065620 5766725
17		NZTM 2065643 5766743
18		NZTM 2065651 5766763
19		NZTM 2065657 5766779

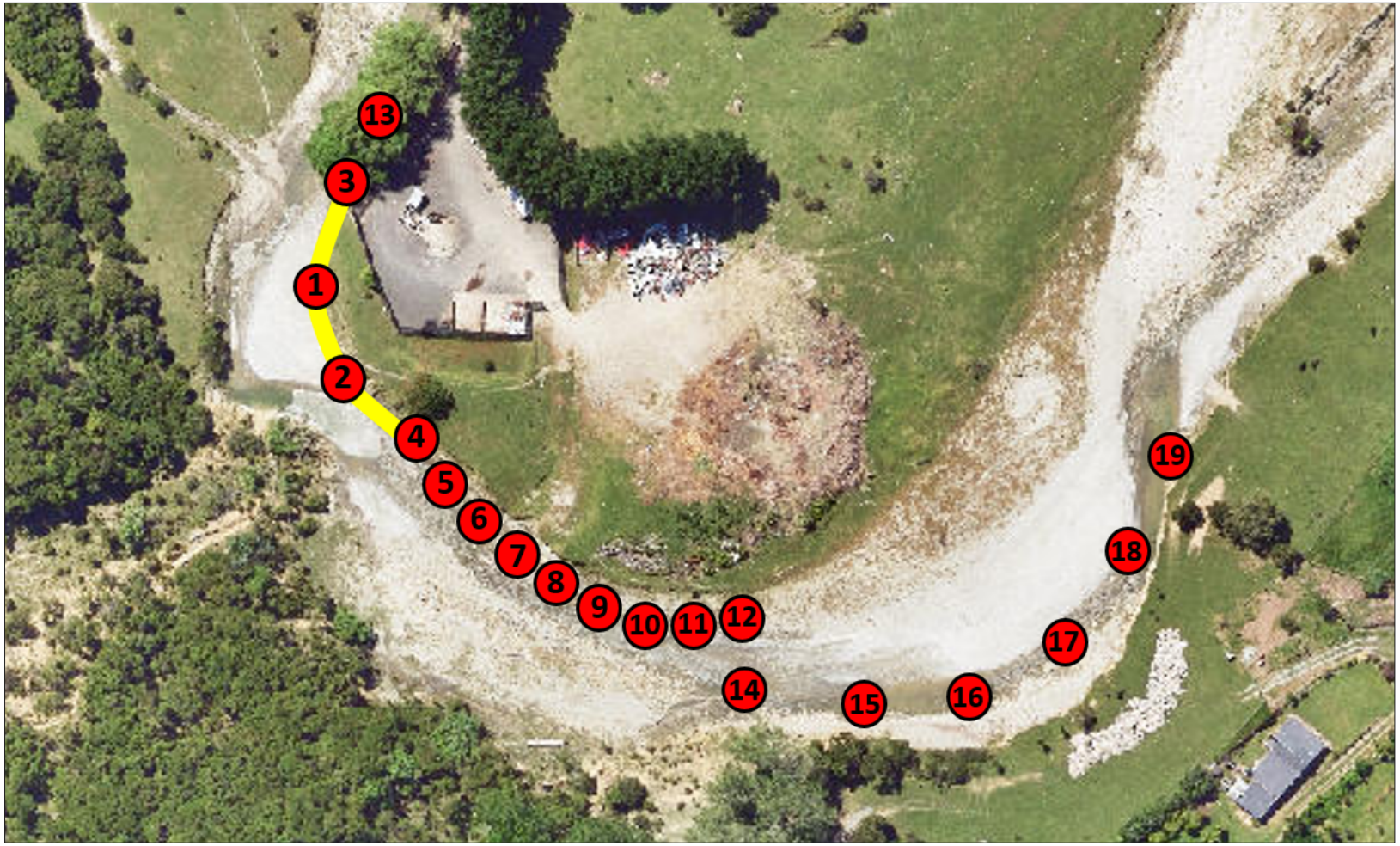

Figure 2: Photographic monitoring points (red). The yellow line indicates approximate extents of the rock revetment erosion protection.

2.1.1 Other General Observations

During each site inspection, any erosion that is noted on the unprotected sections of riverbank shall be measured with an inclinometer to determine the slope. There are a number of apps available which can be downloaded to complete this task using a smartphone. It is recognised that there are two clear slope angles present along the unprotected riverbank sections, as illustrated in **Figure 3**. To help prevent inconsistencies in measurements, it is suggested that two measurements be undertaken at each monitoring point to capture both the more vertical slope near the top of the bank and the gentler slope towards the base.

Further, the person(s) undertaking the site inspection should take along a measuring wheel (or similar) to enable measurements to be taken of any sections of revetment which are failing and/or where the erosion is occurring.

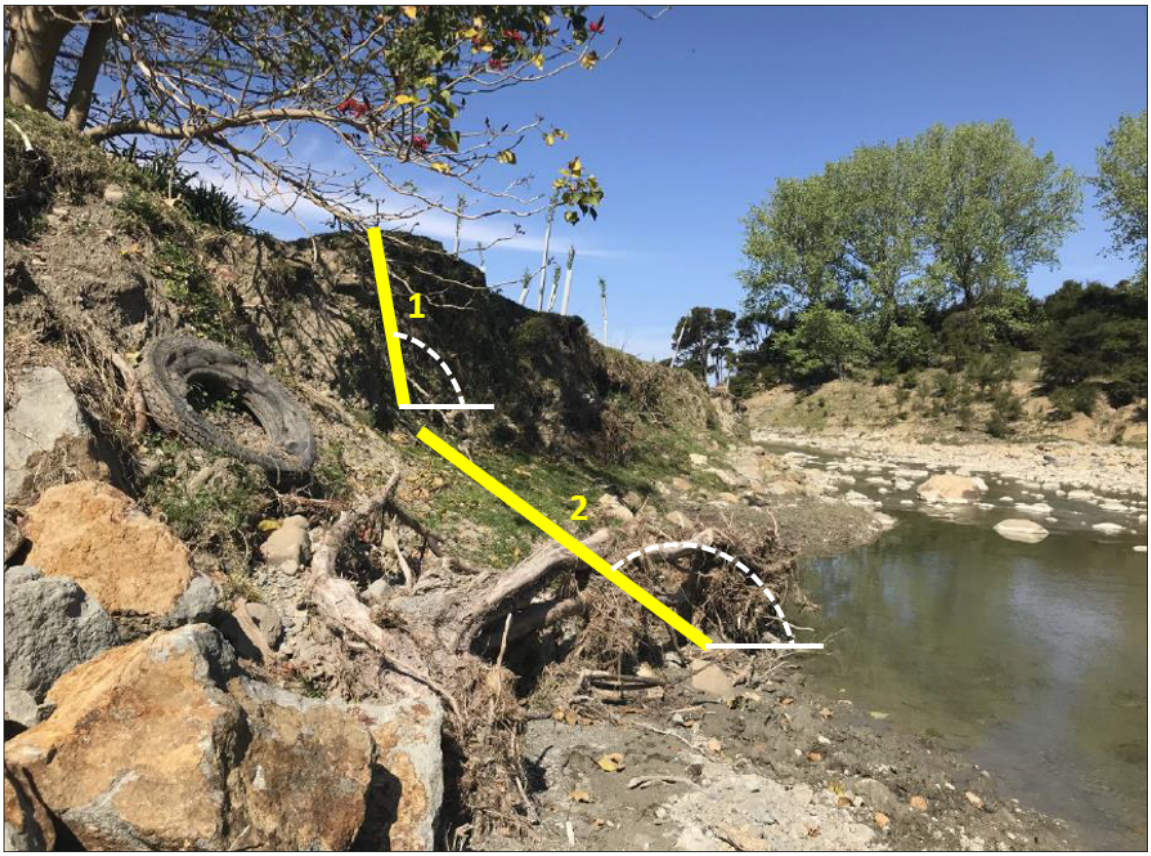

Figure 3: Photograph of the true left bank immediately downstream of the rock revetment structure indicating the two slope angles to be measured during monitoring.

2.2 Annual UAV Monitoring

In addition to the biannual photographic monitoring outlined above, more detailed monitoring will be undertaken on an annual basis using an Unmanned Aerial Vehicle (UAV or "drone"). This is considered to be the most efficient means of capturing high-resolution aerial photography over the system and any potential changes. **Figure 4** identifies the intended area of capture by the annual UAV surveys. Other benefits are that a UAV can be deployed at short notice with little lead in time and it only requires a single operator to safely deploy in the field.

The aerial imagery obtained during each UAV survey will be provided to GDC within 15 working days of the UAV flight taking place. The aerial imagery captured can be geo-rectified for use in the Council's GIS software to allow measurements of erosion to be undertaken at appropriate times. From the footage collected, comparisons can be made over time to allow for the erosion rate to be better quantified. This should be compared to analysis of erosion rates prior to the installation of the structure utilising GIS analysis of aerial and satellite imagery.

Prior to undertaking the UAV survey, it will be necessary to monitor local weather conditions in the days leading up to a chosen survey date. The position of the sun must be right to provide good lighting and to avoid sun glare to enable a clearer picture; generally, early in the morning or a few hours before sunset are the best times to take photos/videos from an aircraft[1]. Another operational issue to consider is the inability of the UAV to fly in excessive wind.

The UAV survey is required to be undertaken once a year for the first five years, after which the frequency of surveys can be reviewed.

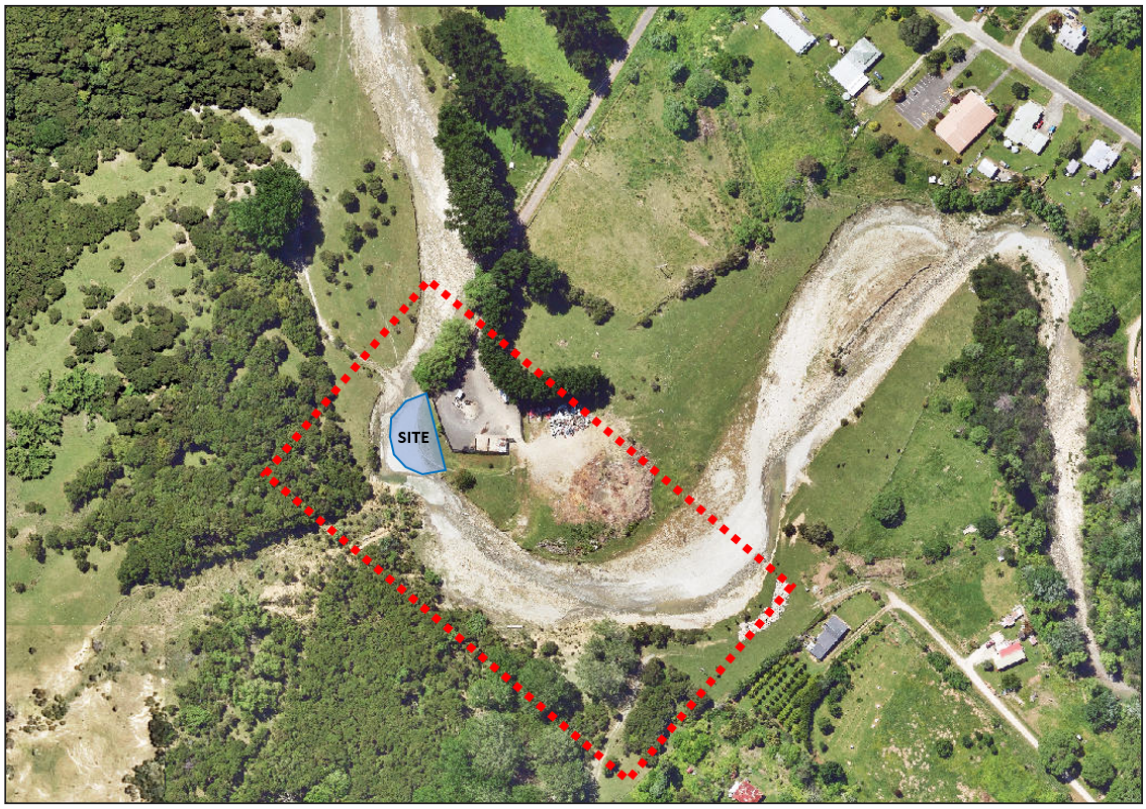

Figure 4: Aerial view of the site showing the approximate UAV survey area (red).

[1] Adobe (2020). https://www.adobe.com/nz/creativecloud/photography/discover/aerial-photography.html

2.3 Reporting and Plan Review

Baseline reporting will be provided to GDC within 15 working days of each site inspection being completed, as required by Condition 34 of the resource consent. This will comprise of the completed spreadsheet checklist (as detailed in Section 2.1 above) and will include a copy of all of the photographs taken during the site inspection.

More comprehensive reporting will be provided every two years. Using the information collected during the site inspections to date, the detailed monitoring report will quantify the current state and rate of erosion occurring:

1. at either end of the revetment;
2. along the crest of the revetment;
3. along the true left-hand bank for 80m extending from the downstream end of the revetment; and
4. along the true right-hand bank extending downstream from NZTM 2065561 5766725 to NZTM 2065657 5766779.

Commentary will also be provided regarding the integrity of the rock revetment, including any observed movement or displacement of rock members from within the structure (some guidance on this is provided within the spreadsheet checklist). A description of any recommended repair or remediation works to alleviate erosion processes caused by the revetment or to maintain the structural integrity of the revetment will also be provided within the monitoring report, including recommended timeframes for any proposed remediation that is to be carried out.

The monitoring methods and requirements for the site as detailed within this MMP will be reviewed after the first five years to confirm whether or not they remain fit for purpose.

Appendix A:

Site Inspection Checklist

Monitoring and Maintenance Plan

Survey date:	
Completed by:	
Checked by:	

Photographic Monitoring of the Rock Structure

Monitoring Point	NZTM Coordinates	Photo Taken (check)	Erosion extent along crest of structure	Description of the rock wall*
1	NZTM 2065485 5766816			
2	NZTM 2065487 5766803			
3	NZTM 2065495 5766793			
4	NZTM 2065484 5766831			

*Make note of any displacement of rock members from the structure (including the size and location of rock members displaced

Photographic Monitoring Downstream of the Rock Structure

Monitoring Point	NZTM Coordinates	Photo Taken (check)	Erosion extent downstream of structure at monitoring points 5-12
5	NZTM 2065501 5766784		
6	NZTM 2065508 5766777		
7	NZTM 2065515 5766770		
8	NZTM 2065521 5766762		
9	NZTM 2065529 5766755		
10	NZTM 2065540 5766750		
11	NZTM 2065553 5766750		
12	NZTM 2065563 5766749		

Photographic Monitoring Upstream of the Rock Structure on the True Left Bank

Monitoring Point	NZTM Coordinates	Photo Taken (check)	Erosion extent upstream of structure at Monitoring Point 13
13	NZTM 2065489 5766845		

Photographic Monitoring Downstream of the Rock Structure on the True Right Bank

Monitoring Point	NZTM Coordinates	Photo Taken (check)	Erosion on the true-right bank downstream at Monitoring Points 14-19
14	NZTM 2065561 5766725		
15	NZTM 2065592 5766727		
16	NZTM 2065620 5766725		
17	NZTM 2065643 5766743		
18	NZTM 2065651 5766763		
19	NZTM 2065657 5766779		

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GISBORNE DISTRICT COUNCIL

06/07/21

Subject: **Tokomaru Bay Transfer Station Relocation**

Prepared by: Chloe Howard-Lloyd – Solid Waste Advisor

Executive summary

Executive Summary

Severed flooding caused damaged to the Tokomaru Bay Legacy Landfill exposing compressed cars and metal materials. The Tokomaru Transfer Station perimeter fencing failed to retain the surface rubbish and contents were beached, It is HIGHLY LIKELY surface rubbish was swept into the Pacific Ocean. It is ALMOST CERTAIN that a new site and design see para 13, for a transfer station needs to be established to support the population of approx. 444.

Removal of Tokomaru Landfill

Removal of the Tokomaru Legacy Landfill is the primary option to mitigate further breaches of the consent. Further researching into the funding is needed, see recommendations from the previous report.

The purpose

1. The purpose of this report is to assess new locations for the relocation of the Tokomaru Bay Transfer Station after the flood Event that occurred 19 JUN 21 resulting in rubbish being swept into the Pacific Ocean.

Introduction

2. A warning was issued at 19 0947 JUN 21, for heavy rain between the hours 20 1300 19 JUN 2021 to 20 1100 JUN 2, North of Tologa. 'Heavy rain may cause streams and rivers to rise rapidly. Surface flooding and slips are also possible and driving conditions may be hazardous. Expect 100 to 150mm of rain. Peak intensities of 20 to 30mm/hr this evening, and again tomorrow morning with possible thunderstorms.

3. A secondary heavy rain warning was issued for 19 June 21, between the hours 2000 19 JUN 2021 to 1300 20 JUN 21, North of Tologa. 'Heavy rain may cause streams and rivers to rise rapidly. Surface flooding and slips are also possible and driving conditions may be hazardous. Expect a further 70 to 100mm of rain to accumulate on top of what has already fallen. Peak intensities of 20 to 30mm/h Sunday morning with possible thunderstorms.

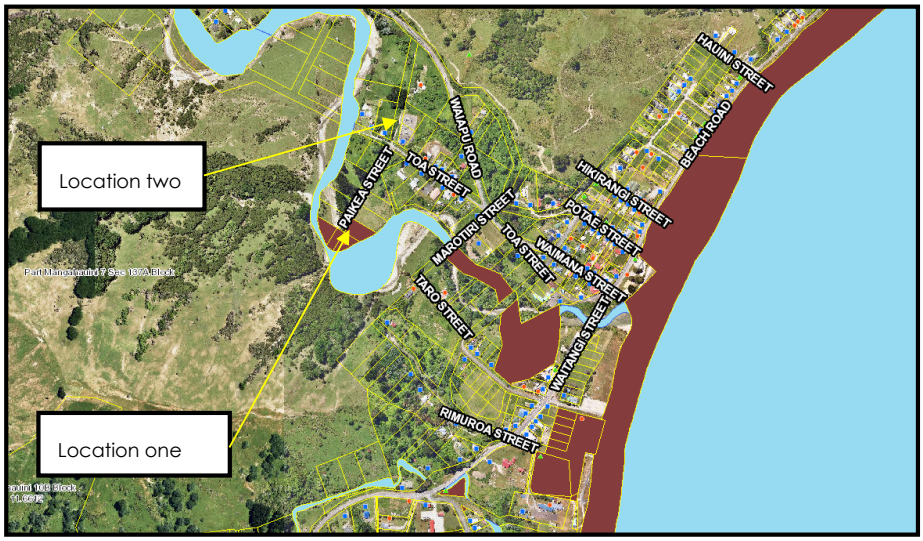
Site visit

4. A site visit was conducted 21 JUN 2021 to assess the flood damage to the Tokomaru Transfer Station. The Transfer Station perimeter fence failed to contain the contents, compiling the issue was large plastic containers and other items are stored outside the perimeter fence aligned with the consent this resulted in beached rubbish indicated by *figure 1, beached rubbish.*

Figure 1,beached rubbish

Proposed new locations

5. There are a possible two locations that have been identified based on the land that GDC own is Tokomaru Bay. The first location indicated by *figure 2, location one* is the paddock located behind the transfer station. The proposed option is to build the ground 3 meters in height and a concrete pad placed on top.



Trees and foliage

6. Willow trees were planted to help stabilize the LB circumference of the landfill. Many of these Willows were uprooted and scattered across the transfer station. Existing willows and root plants have had their root bases exposed. It is HIGHLY LIKLEY that another weather event will drag these trees downstream this winter. It is Highly LIKLEY that further planting of trees will not stabilize the bank. The trees will not be able to establish a root system, the LB contains old cars bodies and other metal material. The existing uprooted large willow trees are eroding away, it is HIGHLY LIKELY extensive exposure of the Tokomaru Legacy Landfill will continue.

Perimeter fencing

7. The perimeter fence suffered extensive damaged indicated by *figure 2 perimeter fence entry gate*, a new entry gate, posts, and wind break will need to be replaced. The original fencing was not fit for purpose and if repairs are conducted on the Tokomaru Transfer Station alternative wire fence netting should be consider ensuring containment of surface rubbish. Silt caught in the fence indicated the water level approx. 1 meter high over the transfer station, other aeras were two meters high indicated by figure *1 Tokomaru Landfill, low point*. The perimeter fence failed to contain surface rubbish and large containers and other rubbish were washed out along the beach it is ALMOST CERTAIN rubbish and fine plastics washed into the Pacific Ocean.

Figure 2, Perimeter fence entry gate

RMA 1991

8. *Section 15(1)(b) (RMA) 1991 states; discharging a contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating because of natural processes from that contaminant) entering water is prohibited unless expressly allowed by a national environmental standard or other regulations, or resource consent.*

9. *In accordance with 15 (2A) (a and b) of the (RMA) 1991, a contaminant into the air, or onto the land, from a place or any other source, weather moveable or not, in a manner that contravenes a regional rule is prohibited unless the discharge is expressly allowed by national environmental standard, other regulations or by resource consent.*

Landslip

10. The landslip located on the RB across from the revetment wall has moved approx. 15 meters falling into the Mangahauini river indicate in *appendix A and figure 3, Landslip*. During the site visit water was running down the slip feeding into the Mangahauini river pushing more land forward. It is HIGHLY LIKELY that this recent slip has not stabilized and will need more time to settle, It is ALMOST CERTAIN that this will not happen over the winter months.

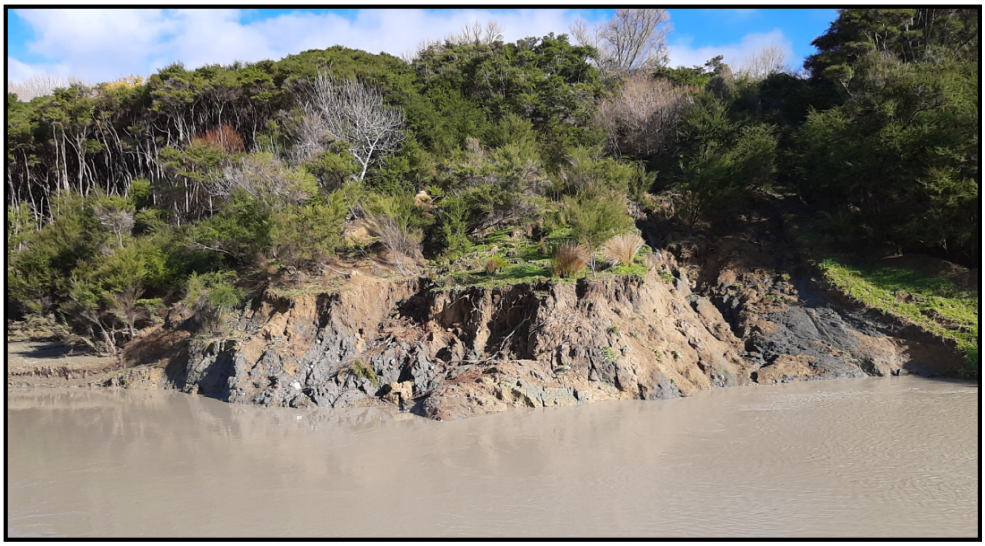


Figure 3, Landslip

Mangahauini River

11. The Mangahauini River has widened, and the contributing Umukuri stream has expanded. The river has a substantial impact zone when in flood, located by the low point indicated by *figure 1 Tokomaru Landfill (c)*. It is ALMOST CERTAIN the impact zone will continue to expose the contents of the LB and washing containments into the Pacific Ocean.

Rock Revetment

12. A seventy-meter rock revetment was established in 2020, the revetment has been weakened by the flood event, upstream has been washed away exposing the geo textile paper indicated by *figure 4, damage to revetment wall.* The rock revetment needs continued monitoring and maintenance after heavy rain, rising waters and after every winter. It is HIGHLY LIKELY if strict on-going assessments are not conducted the more of the revetment will wash away exposing the landfill contents. If a continuation of the rock revetment is employed, it will measure 400 meters and will require a monitoring and maintenance plan for the consent it is HIGHLY LIKELY this will be costly. The previous seventy-meter revetment wall cost approx. $80,000 a continuation of this wall will LIKLEY cost a minimum of $400,0000 not including heightening the LB at the low point. It is ALMOST CERTAIN a continuation of the revetment until a plan for removal of the landfill is not viable and will HIGHLY LIKELY cause reputation damage to GDC for wasted money.

Figure 4, damage to Revetment wall

Relocation of Transfer Station Recommendation

13. The transfer station should remain open for the flood recovery, once this is complete Te Puia Springs Transfer Station is to become the primary location for refuse and recycling. Tokomaru population is approx. 444, a proposed new site location and design shown by *figure 3, proposed Transfer Station Design,* for a smaller Transfer Station is to be established reflecting the populations demand. The design is a round about style with bins appropriately sized for their contents. A crossing located on the left-hand size so people can park up and safely carry their recycling to the bin in high traffic periods. Both sides of the roundabout designs have large pull over areas for a car and trailers for ease of disposable. A cage with painted lines on the concrete will allow the division of Plastic containers, Gas bottles and whiteware.

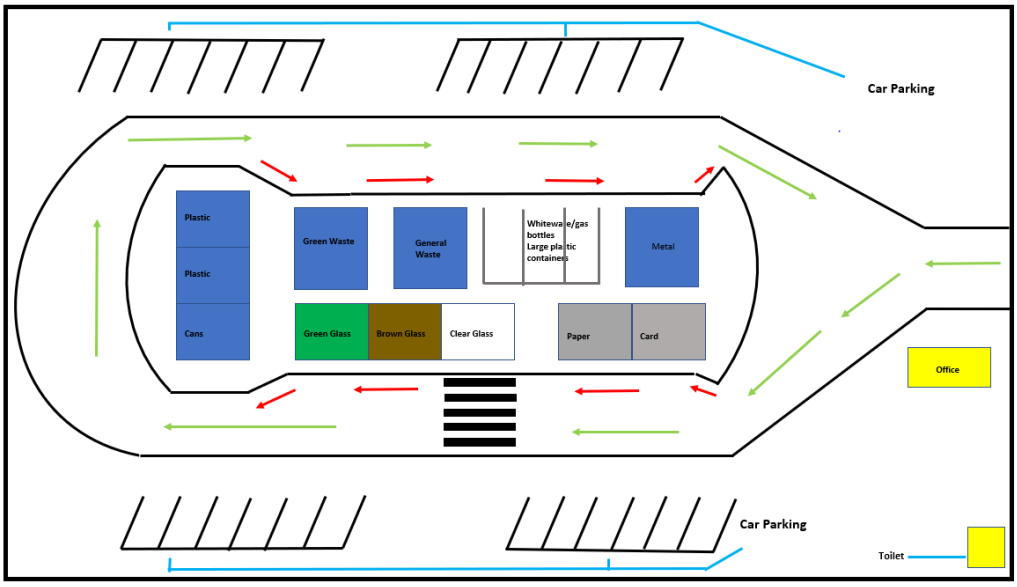


Figure 5, Proposed Transfer Station

Removal of Tokomaru Landfill

Strengths

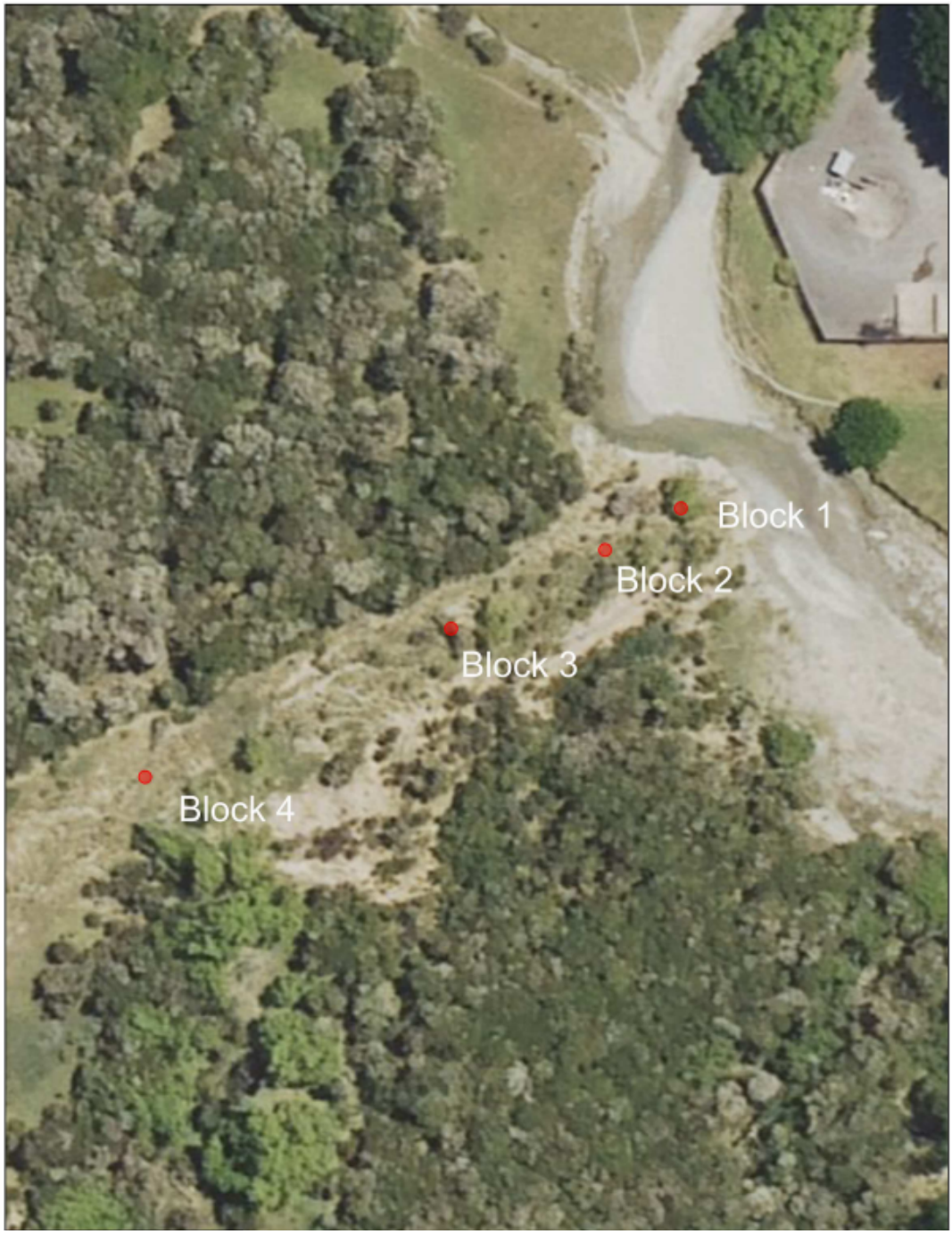
14. The river will gain more flood plain width and reduce the pressure on the banks, reducing the rate of erosion during flow velocity. Removal of the legacy Landfill will result in no further threat of contamination and leachate into the Mangahauini river and the Pacific Ocean in the future.

Weaknesses

15. It is HIGHLY UNLIKELY that contamination during the removal process will happen if the work is conducted during our driest months. The removal of the Landfill will result in a cavity that will need to be filled with rock material, from the riverbed or outsourced. It is HIGHLY LIKELY the ecosystem will be affected during the excavation process and is HIGHLY LIKELY the ecosystem will recover within 12 months. The landfill content will need to be relocated, the current Waiapu landfill is due to close in 2024 and does not have the capacity to receive the contents. It is HIGHLY LIKELY air pollution will be affected during the removal of the Tokomaru Landfill. It is HIGHLY LIKLEY neighbouring properties will be concerned about the erosion of their properties if the landfill is removed.

REMOTE/HIGHLY UNLIKELY	**LESS THAN 10%**
IMPROBABLE/UNLIKELY	**20-25%**
REALISTIC POSSIBILITY	**25-50%**
LIKELY	**55-70%**
HIGHLY LIKELY	**75-80%**
ALMOST CERTAIN	**GREATER THAN 90%**

Appendix A



As a result of the flooding block one has now been sweept away.

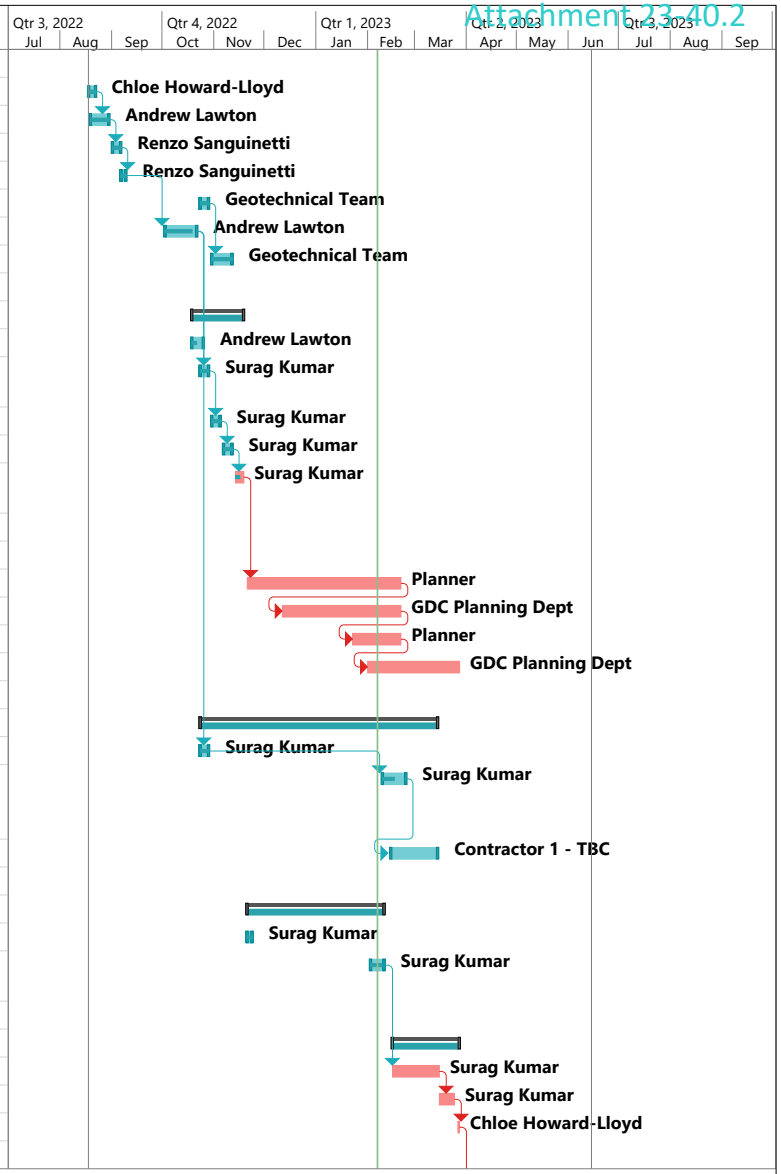
Appendix B

Metal protruding from the Tokomaru Legacy Landfill after the 19 JUN 21 flood event.

Appendix C

Further metal protuding from the Tokomaru Legacy Landfill after the 19 JUN 21 flood event.

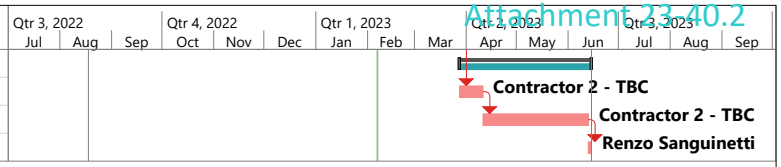
ID	Task Name	Duratio	Start	Finish	Predeces	% Work Complete	comments
1							
2	Offer Approved	2 days	Thu 18/08/22	Mon 22/08/22		100%	
3	Project Setup and Tasking	7 days	Fri 19/08/22	Tue 30/08/22	2	100%	
4	Topographic Survey - Prep	3 days	Thu 1/09/22	Tue 6/09/22	3	100%	
5	Topographic Survey - Reduce	3 days	Tue 6/09/22	Fri 9/09/22	4	100%	
6	Geotechnical Testing	5 days	Mon 24/10/22	Fri 28/10/22		100%	
7	Temporary Revetment Design	15 day	Mon 3/10/22	Fri 21/10/22	5	80%	
8	Compaction Testing	10 day	Mon 31/10/22	Fri 11/11/22	6	100%	
9							
10	**Design**	**23 day**	**Wed 19/10/22**	**Fri 18/11/22**		**80%**	
11	Draft Layout	5 days	Wed 19/10/22	Tue 25/10/22		50%	
12	Earthworks Design / Pavement Design	5 days	Mon 24/10/22	Fri 28/10/22	7	100%	
13	Stormwater Design	5 days	Mon 31/10/22	Fri 4/11/22	12	100%	
14	Final Site Layout Design	5 days	Mon 7/11/22	Fri 11/11/22	13	100%	
15	Final Drawings inc Revetment Design	5 days	Mon 14/11/22	Fri 18/11/22	14	50%	
16							
17	**Consent**	**53 day**	**Mon 21/11/22**	**Wed 1/02/23**		**0%**	**GDC**
18	Earthworks Consent	66 day	Mon 21/11/22	Mon 20/02/23	15	0%	
19	Processing Time	51 day	Mon 12/12/22	Mon 20/02/23	18	0%	
20	Allowance for RFI Queries	21 day	Mon 23/01/23	Mon 20/02/23	19	0%	
21	Consent Approval	39 day	Wed 1/02/23	Mon 27/03/23	20	0%	
22							
23	**Enabling Works**	**102 da**	**Mon 24/10/22**	**Tue 14/03/23**		**29%**	**Detailed Quote by Email**
24	Scheudle Enabling Works	5 days	Mon 24/10/22	Fri 28/10/22	7	100%	
25	Procure Contractor	10 days	Fri 10/02/23	Thu 23/02/23	24	50%	Tree felling quote procured remaning quotes to be procured after procurement memo is approved
26	Construct Enabling Works	20 day	Wed 15/02/23	Tue 14/03/23	25	0%	Depends on procurement memo approval
27							
28	**Contract**	**60 day**	**Mon 21/11/22**	**Fri 10/02/23**	**17**	**87%**	**Inivited Tenders Price Quality Method**
29	Prepare Schedule	3 days	Mon 21/11/22	Wed 23/11/22	17	100%	Depends on procurement memo approval
30	Prepare 3915 Contract and RFP	6 days	Fri 3/02/23	Fri 10/02/23	17	80%	
31							
32	**Procurement (Method TBC)**	**28 day**	**Thu 16/02/23**	**Mon 27/03/23**	**17**	**0%**	**Depends on procurement memo approval**
33	Procurement	20 day	Thu 16/02/23	Wed 15/03/23	30	0%	
34	Assessment	7 days	Thu 16/03/23	Fri 24/03/23	33	0%	
35	Award	1 day	Mon 27/03/23	Mon 27/03/23	34	0%	
36							



Project: Toko Waste Transfer an
Date: Tue 7/02/23

Task	Inactive Task	Manual Summary Rollup	External Milestone	Manual Progress	
Split	Inactive Milestone	Manual Summary	Deadline		
Milestone	Inactive Summary	Start-only	Critical		
Summary	Manual Task	Finish-only	Critical Split		
Project Summary	Duration-only	External Tasks	Progress		

ID	Task Name	Duratio	Start	Finish	Predeces	% Work Complete	comments
37	**Construction**	**57 day**	**Tue 28/03/23**	**Wed 14/06/23**		**0%**	
38	Contract Documentation	10 day	Tue 28/03/23	Mon 10/04/23	35	0%	
39	Construction	45 day	Tue 11/04/23	Mon 12/06/23	38	0%	
40	As-Built	2 days	Tue 13/06/23	Wed 14/06/23	39	0%	



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Task	Inactive Task	Manual Summary Rollup	External Milestone	Manual Progress
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Milestone	Inactive Summary	Start-only	Critical	
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Project Summary	Duration-only	External Tasks	Progress	