Auckland Hamilton Tauranga Wellington Christchurch Invercargill

PATTLE DELAMORE PARTNERS LTD

Kaitaia Wastewater Treatment Plant – Flood Assessment

Far North District Council

Kaitaia Wastewater Treatment Plant - Flood Assessment

Prepared for

Far North District Council

July 2021

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900**
Website **http://www.pdp.co.nz**
Auckland Hamilton Tauranga Wellington
Christchurch Invercargill

Quality Control Sheet

TITLE	Kaitaia Wastewater Treatment Plant - Flood Assessment
CLIENT	Far North District Council
VERSION	Final
ISSUE DATE	19 July 2021
JOB REFERENCE	A03576803
SOURCE FILE(S)	A03576803R001_Final.docx

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Phil Hook

Reviewed and Approved by

SIGNATURE

Hayden Easton

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council, Northland Regional Council and Thomson Surveying Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

Far North District Council (FNDC) has engaged Pattle Delamore Partners Limited (PDP) to undertake a flood hazard and displacement assessment for the reconsenting of the Kaitaia Wastewater Treatment Plant (WWTP).

The assessment indicates that the Kaitaia WWTP is likely to have enough minimum freeboard threshold for 1% AEP events.

The effect on floodwater displacement from the Kaitaia WWTP being located within the active floodplain is considered to be minimal, with a calculated increase of water level of 13 mm during the 1% plus Climate Change AEP event.

Table of Contents

Table of Figures

Table of Tables

1.0 Introduction

Far North District Council (FNDC) has engaged Pattle Delamore Partners Limited (PDP) to undertake a flood hazard and displacement assessment for the reconsenting of the Kaitaia Wastewater Treatment Plant (WWTP).

With the Kaitaia WWTP resource consent expiring in 2021, FNDC is required to demonstrate:

1. The Kaitaia WWTP will not be inundated by a 1% (with climate change) Annual Exceedance Probability (AEP) flood event; and,
2. The Kaitaia WWTP does not cause excessive near field (floodplain directly adjacent to the WWTP) flooding due to the displacement of flood water in accordance with Section C.3.1.9 of the Proposed Regional Plan for Northland.

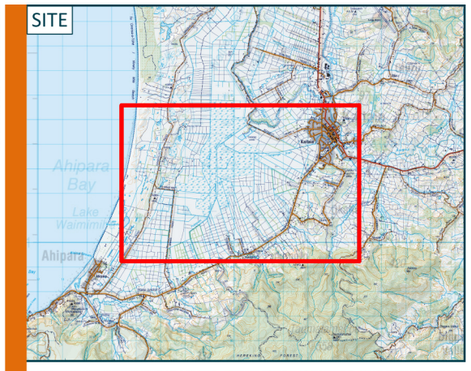
The following report outlines the methodology used and the findings of the assessment.

2.0 Site Description

The Kaitaia WWTP is located adjacent to the Awanui River. The WWTP has an existing bund surrounding the area to restrict flood water affecting site operations, oxidation ponds and wastewater treatment performance.

Figure 1 presents the location of the WWTP adjacent to the Awanui River and the location of the bund that surrounds the plant.

SITE



N

KAITAIA
GILL RD
BONNETT RD
KOHUHU ST
NORTH RD
GRIGG ST
JAMIESON RD
MATTHEWS AVE
ALLEN ST
DUNN ST
KORIMAKO LANE
COMMERCE ST
EMPIRE ST
PUCKEY AVE
WEST LANE
SH 1
MELBA ST
LAKE RD
TAHUNA RD
CHURCH RD
DOMINION RD
EDEN TCE
BANK ST
WORTH ST
REDAN RD
OXFORD ST
ENID AVE
TE MAIRE AVE
SOUTH RD
PUKEPOTO RD
NORMAN SENN AVE
OKAHU DOWNS DR
OKAHU RD
SANDHILLS RD
CLARKE RD
BRASS RD
TANGONGE RD
ARAROA RD
KAITAIA-AWAROA RD
LARMER RD

KEY :
- WASTEWATER TREATMENT PLANT
- FLOOD CELL EXTENT
- 10 YEAR FLOOD EXTENT
- 50 YEAR FLOOD EXTENT
- 100 YEAR FLOOD EXTENT
- 100 YEAR FLOOD EXTENT WITH CLIMATE CHANGE

0 250 500 750
METRES

SCALE : 1:25,000 (A3)

NO.	REVISION	DATE	BY
B	FINAL	JUL 21	NE
A	ISSUED FOR REVIEW	JUN 21	NE

SOURCE:
1. AERIAL IMAGERY (FLOWN .....) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. FLOOD EXTENT DATA SOURCED FROM NORTHLAND REGIONAL COUNCIL, 08/04/21.

CLIENT
Far North District Council

FIGURE
FIG 2: NRC FLOOD HAZARD MAP

PROJECT
FLOOD HAZARD ASSESSMENT OF ENVIRONMENTAL EFFECTS

A03576803.aprx - A03576803d0001

3.0 Methodology

The following sections outline the methodology used to undertake the flood hazard and displacement assessment. The following information was provided by Northland Regional Council (NRC): 10%, 5%, 1% and 1% plus Climate Change AEP flood heights, flood water depths, and other associated flood modelling data. The 1% AEP plus climate change scenario was modelled using the RCP (Representative Concentration Pathway) 4.5 scenario, which predicts a temperature increase of 2.4°C by 2100 (DHI Group, 2020). In addition, surveyed bund height information of Kaitaia WWTP was provided by Thomson surveying, Kerikeri.

3.1 Flood Hazard Methodology

To characterise the flood hazard to Kaitaia WWTP, the NRC 1% plus Climate Change AEP flood hazard maps were interrogated to identify if Kaitaia WWTP was predicted to be inundated. Based on the NRC flood maps (See Figure 2) it appears that the flood level may exceed the bunds surrounding the Kaitaia WWTP.

KEY :

- WASTEWATER TREATMENT PLANT
- 10 YEAR FLOOD EXTENT
- 50 YEAR FLOOD EXTENT
- 100 YEAR FLOOD EXTENT
- 100 YEAR FLOOD EXTENT WITH CLIMATE CHANGE

0 100 200
METRES

SCALE : 1:5,000 (A3)

NO.	REVISION	DATE	BY
B	FINAL	JUL 21	NE
A	ISSUED FOR REVIEW	JUN 21	NE

SOURCE:
1. AERIAL IMAGERY (FLOWN .....) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. FLOOD EXTENT DATA SOURCED FROM NORTHLAND REGIONAL COUNCIL, 08/04/21.

CLIENT

Far North District Council

FIGURE

FIG 1: KAITAIA WWTP AND 1% PLUS CLIMATE CHANGE FLOOD CELL

PROJECT

FLOOD HAZARD ASSESSMENT OF ENVIRONMENTAL EFFECTS

A03576803 aprx - A03576803GIS002

To further assess the flood hazard to Kaitaia WWTP, the bunds surrounding the plant were surveyed to determine their respective height in comparison with the modelled flood levels. The survey was conducted in New Zealand Vertical Datum (NZVD) 2016.

A comparison was made between the surveyed bund heights and the digital elevation model (DEM) that was used for the modelling. This was to assess if there is additional bias within the flood height dataset, and if an offset should be used in the expected freeboard calculation.

If bias was calculated, and assessed as relevant, the flood height could then be compared with surveyed bund heights. To determine the site wide impact of the flood hazard on the Kaitaia WWTP, multiple locations around the treatment plant we assessed. The result of the comparison is discussed in Section 4.0.

3.2 Floodwater Displacement Methodology

Floodwater displacement assessments are required due to construction activities infilling the floodplain which displaces floodwater and increases flood levels locally. NRCs proposed plan requires assessments on floodwater displacements for any structure within a flood area.

To carry out the floodwater displacement assessment of the Kaitaia WWTP on the surrounding floodplain area, this required a retrospective approach, as Kaitaia WWTP is already in place. Therefore, the results of the assessment will show a decrease in local flood water level.

To calculate the displaced floodwater volume and therefore the change in water level due to the Kaitaia WWTP, the following steps were undertaken:

1. Calculate Flood Cell (modelled near-field flood area) area for each AEP event (see section 3.2.1);
2. Calculate the bunded area of Kaitaia WWTP; and,
3. Using average depth of each AEP event combined with Step 1 to determine flood cell volume.

It is expected, due to the increase in flood area, if the Kaitaia WWTP did not exist, the near field flood height would decrease.

3.2.1 Flood Cell Area

To determine the area of the flood cell, PDP used the 10% AEP flooding extent as a basis to inform the flood cell extents under the 1% plus Climate Change AEP event. Using the 10% AEP gave an indication of where the flood cell was “connected” to the near field flooding extent of the WWTP.

As the floods decrease in AEP (i.e. become larger) the flooding extents join in and around Kaitaia. Therefore, as part of the flood cell determination an assessment of what remained "near field" and what wasn't "near field" was required. PDP assessed how the flood was "connected" to ensure that the flooding extents remained relevant to the near field flooding of Kaitaia WWTP. Overall, due to the flooding extents being potentially reduced due to this process the likely impact to the displacement calculations is considered conservative.

4.0 Flood Hazard Assessment

As identified in Figure 2, flood modelling indicates Kaitaia WWTP may be inundated under multiple AEP flood event scenarios. Due to this risk, further assessment was required.

Initially PDP requested modelling information from DHI Group who undertook the flood modelling on NRC's behalf. Specifically, information was sought regarding how the bunds were represented within the model. The following correspondence from DHI Group was received:

> *"The banks of the ponds are only modelled using the mesh in this area, which will have averaged out the bank level over the area of the mesh elements. This would lower the effective bank level of the ponds. The full overflow from the floodplain into the ponds only appears to occur in the 100yr with climate change event. Given that the map shows that the bank level of the pond is not "wet" this indicates that the actual bank level is higher than the water level reached in this scenario, so in reality the ponds should not be overtopped by the flooding." (Pers Comms Antionette Tan, 2021)*

Therefore, the flexible mesh design of MIKE21 models is responsible for the predicted flooding of Kaitaia WWTP. A comparison was also carried out between the height of the modelling background DEM (Digital Elevation Model) created from LiDAR imagery (Light Detection and Ranging) and the surveyed bund heights to establish if there was any additional error (Table 1).

Further investigation to compare flood levels from modelling with the bund height was undertaken. Expected freeboard under the 1% and 1% with climate change AEPs was also calculated. This comparison is carried out in Table 2 below.

The flood hazard mapping and DEM provided to PDP by NRC was undertaken in One Tree Point Datum (1964). Given that the survey conducted by Thomson Surveying was undertaken in NZVD 2016 datum, a comparison between points in the Thomson Survey (NZVD, 2016) and Flood Modelling (One Tree Point,1964) was carried out using the LINZ New Zealand Vertical Datum Conversion tool. The comparison showed that there was an average of 2 mm difference, which is well within survey instrument error/bias, between the two datums so are therefore determined as the same for this assessment.

Table 1 compares the average surveyed bund height with the DEM used for the flood hazard assessment.

Table 1: DEM/Survey Bund Height Comparison

Survey Bund Height (m)	DEM Bund Height (m)	Difference in Level (m)
7.567	7.853	0.286

Notes: Bund Heights in respective datum levels as discussed prior

It is expected that the difference between the modelled bund height and the surveyed bund height is due to differences in LiDAR flying levels and other errors that can occur between surveys. Due to the large variance between the survey and modelling, this assessment will continue to use the flood modelling DEM height to determine the flood hazard to Kaitaia WWTP.

Table 2: Flood Hazard Assessment

DEM Bund Height (mAOD[3])	Flood Height 1% AEP (m AOD)	Flood Height 1% AEP plus Climate Change (mAOD)	Expected Freeboard 1% AEP (m)	Expected Freeboard 1% AEP plus Climate Change (m)
7.631	7.087	7.412	0.544	**0.219**
7.682	7.087	7.412	0.595	**0.270**
7.733	7.087	7.412	0.646	**0.321**
7.683	7.087	7.412	0.596	**0.271**
7.763	7.087	7.412	0.676	**0.351**
7.764	7.087	7.412	0.676	**0.352**
7.688	7.087	7.412	0.601	**0.276**
7.868	7.087	7.412	0.781	**0.456**
7.682	7.087	7.412	0.595	**0.270**
7.935	7.087	7.412	0.848	0.523

Notes:

1. *Flood and Bund Heights calculated in One Tree Point Datum*
2. ***Bolded** figures are below 500 mm freeboard*
3. *mAOD (metres Above One Tree Point Datum)*

The expected freeboard around Kaitaia WWTP is greater than 500mm under a 1% AEP flood scenario. The expected freeboard under a 1% AEP plus climate change flood scenario is less than 500 mm.

The current WWTP is designed to not flood under current conditions (i.e. a 1% AEP event) and has a designed freeboard of at least 500 mm. The assessment in Table 2 shows that Kaitaia WWTP does not flood under a 1% AEP plus climate change either. However, under a 1% AEP plus climate change scenario the minimum freeboard will be 200 mm. Therefore, it is not expected that Kaitaia WWTP will be affected by flood water, however due to the freeboard being less than 500 mm, the bunds around Kaitaia WWTP may need to be raised in the future to protect the plant from inundation in a 1% AEP plus climate change scenario.

NRC published the Awanui River Scheme Asset Management Plan in 2015 which the purpose of the management plan is to:

> *"Provide a single document that provides for the present and future management of the Awanui River Flood Scheme assets, in a way that ensures efficient and effective delivery of specified levels of service. It also ensures compliance with regulatory requirements, including:*
>
> - *Resource Management Act 1991*
> - *Soil Conservation and Rivers Control Act 1941*
> - *Civil Defence Emergency Management Act 2002*
> - *Local Government Act 2002*
> - *Local Government Rating Act 2002*
> - *Land Drainage Act 1908*
> - *Regional Policy Statement*
> - *Long Term Council Community Plan*
> - *Northland River Management Policy*
> - *Managing Flood Risk – A Process Standard NZS 9401:2008."*

The Kaitaia WWTP currently sits within the Awanui River Scheme. Objective 1 of the Scheme Management Plan outlines that the level of service of the scheme is to contain flood flows up to a 1% AEP Flood Level with a minimum of 500 mm freeboard. Based on this definition, the Kaitaia WWTP is currently designed with adequate freeboard.

5.0 Flood Displacement Assessment

The Proposed Regional Plan for Northland Section C.3.1.9 states that:

"The placement of an obstruction (including a structure) in a flood hazard area (including a high-risk flood hazard area), an overland flow path, a river or an artificial watercourse that will, or is likely to divert water onto other property, is a discretionary activity:

For the avoidance of doubt this rule covers the following RMA activities:

- *Placement of an obstruction (including a structure) in a flood hazard area (including a high-risk flood hazard area), an overland flow path, or an artificial watercourse that will, or is likely to, divert water onto other property (s9(2)).*
- *Placement of an obstruction (including a structure) or deposition of an obstruction in, on, or under the bed of a river that will, or is likely to, divert water onto other property (s13(1)).*
- *Damming and diversion of water within a flood hazard area (including a high-risk flood hazard area), an overland flow path, a river, or an artificial watercourse (s14(2)).*"

The following displacement calculations are based off the flood heights of each return period event (e.g. 1% AEP event including climate change). To calculate floodwater displacement, the bunded area of Kaitaia WWTP, flood cell area of the adjacent flooding (See Figure 2), and volume of the flood cell was used. The impact on the flood level will be a reduction in the estimated near field floodwater depth, due to Kaitaia WWTP already being in place when the modelling was undertaken.

Table 3: Flood Displacement Calculation

AEP Event	Volume of Flood Cell (m^3)	Total Area for Water Displacement (m^2)	Change in Water Level (mm)
10% (1 in 10 year)	7,069,150	10,385,800	7
2% (1 in 50 year)	12,595,000	12,622,900	10
1% (1 in 100 year)	14,721,850	13,337,500	11
1%+CC (1 in 100 year plus climate change)	18,803,100	14,500,700	13

The change in water level identified Table 3, is if Kaitaia WWTP was not located within the floodplain (i.e. the flood level would decrease if the WWTP was not in place). Table 3 shows that the maximum effect of Kaitaia WWTP on near field flood levels is 13 mm. Overall, a 13 mm effect on flood displacement is considered minimal over such a vast area of flooding (14 km^2). It is also likely that wind effects on the flood cell would cause a greater effect (i.e. capillary waves) than 13 mm of displacement caused by Kaitaia WWTP.

6.0 Conclusion

Northland Regional Council Flood Maps currently indicate that the Kaitaia WWTP is likely to be inundated under a 1% plus Climate Change AEP flood scenario. As the Kaitaia WWTP is located within a floodplain FNDC needs to demonstrate that:

- Kaitaia WWTP does not flood under a 1% AEP event; and,
- The effect of Kaitaia WWTP on the displacement of nearby flood water.

The assessment indicates that the Kaitaia WWTP is likely to have enough minimum freeboard threshold for 1% AEP events.

The effect on floodwater displacement from Kaitaia WWTP being located within the active floodplain is considered to be minimal, with a calculated increase of water level of 13 mm during the 1% plus Climate Change AEP event. Adding additional height to the bunds will likely have a minimal effect on the surrounding flood levels.

7.0 References

DHI Group (2020) *Awanui Flood Model Upgrade: Model Build, Calibration and Design.*

Northland Regional Council (2015) *Awanui River Scheme Asset Management Plan*. Found at: https://www.nrc.govt.nz/media/srmaluup/awanuischemeassetmanagementplan2015website.pdf

Northland Regional Council (2021) *Northland Proposed Regional Plan.* Found at: https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/

Northland Regional Council (2019) *River Flood Hazard Maps.* Found at: https://www.nrc.govt.nz/floodmaps/